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საქართველოს განათლებისა და მეცნიერების სამინისტრო
საქართველოს ტექნიკური უნივერსიტეტი
წყალთა მეურნეობის ინსტიტუტი
გარემოს დაცვის ეკოცენტრი

მე-4 საერთაშორისო სამეცნიერო-ტექნიკური კონფერენცია „წყალთა მეურნეობის, გარემოს დაცვის, არქიტექტურისა და მშენებლობის თანამედროვე პრობლემები“

27 - 30 სექტემბერი, 2014

ეძღვნება წყალთა მეურნეობის ინსტიტუტის 85 წლის იუბილეს

MINISTRY OF EDUCATION AND SCIENCE OF GEORGIA
GEORGIAN TECHNICAL UNIVERSITY
WATER MANAGEMENT INSTITUTE
ECOCENTER FOR ENVIRONMENTAL PROTECTION

4th INTERNATIONAL SCIENTIFIC AND TECHNICAL CONFERENCE „MODERN PROBLEMS OF WATER MANAGEMENT, ENVIRONMENTAL PROTECTION, ARCHITECTURE AND CONSTRUCTION“

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МИНИСТЕРСТВО ПРОСВЕЩЕНИЯ И НАУКИ ГРУЗИИ
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ЭКОЦЕНТР ОХРАНЫ ОКРУЖАЮЩЕЙ СРЕДЫ

4-ая МЕЖДУНАРОДНАЯ НАУЧНО-ТЕХНИЧЕСКАЯ КОНФЕРЕНЦИЯ „СОВРЕМЕННЫЕ ПРОБЛЕМЫ ВОДНОГО ХОЗЯЙСТВА, ОХРАНЫ ОКРУЖАЮЩЕЙ СРЕДЫ, АРХИТЕКТУРЫ И СТРОИТЕЛЬСТВА“

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2014

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<u>ი უ ბ ი ლ ე</u>

წყალთა მეურნეობის ინსტიტუტი – 85

საქართველოს ტექნიკური უნივერსიტეტის წყალთა მეურნეობის ინსტიტუტი სამხრეთ კავკასიაში ერთ-ერთი უძველესი სამეცნიერო დაწესებულებაა, რომელიც ფაქტობრივად ჩამოყალიბდა 1925 წელს, ხოლო მთავრობის დადგენილებით გაფორმდა 1929 წლის 27 სექტემბერს. იგი ყოფილი ამიერკავკასიის წყალთა მეურნეობის ინსტიტუტის, საქართველოს ჰიდროტექნიკისა და მელიორაციის სამეცნიერო კვლევითი ინსტიტუტის, საქართველოს მეცნიერებათა ეროვნული აკადემიის წყალთა მეურნეობის და საინჟინრო ეკოლოგიის ინსტიტუტის და, ბოლოს, სსიპ წყალთა მეურნეობის ინსტიტუტების სამართალმემკვიდრეა.

საქართველოს მთავრობის 2010 წლის 27 ივლისის №210 დადგენილებით განხორციელდა სსიპ წყალთა მეურნეობის ინსტიტუტის რეორგანიზაცია და იგი შეუერთდა საქართველოს ტექნიკურ უნივერსიტეტს, როგორც დამოუკიდებელი სამეცნიერო-კვლევითი ერთეული. 2011 წლიდან ის ფუნქციონირებს, როგორც საქართველოს ტექნიკური უნივერსიტეტის წყალთა მეურნეობის ინსტიტუტი.

წყალთა მეურნეობის ინსტიტუტი წლების განმავლობაში სამხრეთ კავკასიაში წარმოადგენდა ამ პროფილის ერთადერთ დაწესებულებას, რომლის დანიშნულება იყო წყალდიდობებისა და წყალმოვარდნების, ეროზიულ-ღვარცოფული მოვლენების, ბუნებრივი კატასტროფების, ზღვისა და მდინარეების სანაპირო ზონების, მელიორაციის (ჭარბტენიანი ტერიტორიების დაშრობა, მორწყვა არიდულ ზონებში), წყალსაცავების, ჰიდროტექნიკური ნაგებობების კვლევები დაპროექტების, მშენებლობისა და ექსპლუატაციის პერიოდში, მათი საიმედოობის კვლევა და სხვა მსგავს პრობლემებთან დაკავშირებული საკითხები. მოგვიანებით, ინსტიტუტის ბაზაზე აზერბაიჯანსა და სომხეთში შეიქმნა ანალოგიური დანიშნულების სამეცნიერო კვლევითი ორგანიზაციები, რომლებიც ამჟამადაც ფუნქციონირებენ და რეგულარულად თანამშრომლობენ წყალთა მეურნეობის ინსტიტუტთან.

ინსტიტუტს დაარსებიდან 1947 წლამდე ხელმძღვანელობდნენ: **კ. მიხაილოვი, ე. გაბიევი, ნ. სოკოლოვსკი, დ. გალილოვი, შ. ბიტლაზარი, გ. ლარინი და პ. სოლოდი.**

1947-1968 წლებში ინსტიტუტს სათავეში ედგა პროფესორი **მიხეილ გაგოშიძე**, რომელმაც დიდი ღვაწლი დასდო მის განვითარებას;

1968-2005 წლებში კი ინსტიტუტს ხელმძღვანელობდა მსოფლიოში ცნობილი მეცნიერი და ორგანიზატორი, საქართველოს მეცნიერებათა ეროვნული აკადემიის აკადემიკოსი, რუსეთის სოფლის მეურნეობის მეცნიერებათა აკადემიის აკადემიკოსი, საქართველოს სახელმწიფო პრემიის ლაურეატი მეცნიერებისა და ტექნიკის დარგში, ა. კოსტიაკოვის ოქროს მედლის ერთ-ერთი პირველი მფლობელი, ტექნიკის მეცნიერებათა დოქტორი, პროფესორი **ცოტნე მირცხულავა.** უნდა აღინიშნოს, რომ მეტად მნიშვნელოვანია მისი წვლილი ინსტიტუტის მიღწევებსა და საერთაშორისო ავტორიტეტის შექმნაში. 2006 წელს იგი აღიარეს საქართველოს წლის საუკეთესო მეცნიერად ტექნიკის დარგში.

2005 წლიდან ინსტიტუტს ხელმძღვანელობს საინჟინრო აკადემიის ნამდვილი წევრი, ტექნიკის მეცნიერებათა დოქტორი, პროფესორი **გივი გავარდაშვილი**, რომელმაც აქტიურად გააგრძელა აკადემიკოსი ცოტნე მირცხულავას დაწყებული საქმე. დიდია მის ღვაწლი ინსტიტუტის გადარჩენისა და შენარჩუნების საქმეში, როდესაც 2006-2010 წწ. ქვეყანაში მიმდინარეობდა უძრავი ქონების მასიური და სწრაფი პრივატიზაცია. უნდა

ითქვას, რომ **გ. გავარდაშვილის** აქტიური მუშაობითა და საქართველოს პარლამენტის თავმჯდომარის მოადგილის, საქართველოს მეცნიერებათა ეროვნული აკადემიის პირველი ვიცე-პრეზიდენტის, აკადემიკოს **ფრიდონ თოდუას** (*ფოტო 1*) მამულიშვილური დახმარებით, რაზედაც ინსტიტუტის დირექცია და მეცნიერ-თანამშრომლები დიდად მადლიერნი არიან, 2008-2010 წწ მოხერხდა მსოფლიოში ცნობილი ჰიდროტექნიკური ლაბორატორიის შენარჩუნება, რომელშიც აქტიურად მიმდინარეობს ჩვენი ქვეყნისთვის საჭირო წყალთა მეურნეობის, მელიორაციული და გარემოს დაცვის ღონისძიებების ჰიდრავლიკური მსხვილმასშტაბიანი ლაბორატორიული მოდელირება, ასევე სასწავლო-სამეცნიერო პროგრამების განხორციელება სასოფლო-სამეურნეო მელიორაციაში.

ფოტო. 1. აკადემიკოს ფ. თოდუასთან სამუშაო შეხვედრისას (2009 წ. ივნისი)
Photo 1. At the meeting with Academician F. Todua (June, 2009).
Фото 1. Во время рабочей встречи с академиком Ф. Тодуа (июнь, 2009 г.)

საქართველოს ტექნიკური უნივერსიტეტის რექტორის აკადემიკოს არჩილ ფრანგიშვილის მხარდაჭერით, პროფესორ გივი გავარდაშვილისა და ასოცირებული პროფესორის ზურაბ ლობჟანიძის ხელმძღვანელობით მეცნიერთა ჯგუფმა (პროფ. ვ. თევზაძე, პროფ. ი. იორდანიშვილი, აკადემიური დოქტორები: ი. ირემაშვილი, გ. ჩახაია, შ. კუპრეიშვილი, ვ. შურღაია, რ. დიაკონიძე, ლ. წულუკიძე, ჯ. კახაძე და სხვ.) სასოფლო-სამეურნეო მელიორაციაში მოამზადა პროფესიული სწავლების, ბაკალავრიატის, მაგისტრატურისა და დოქტორანტურის პროგრამები, რომლებმაც წარმატებით გაიარა სახელმწიფო აკრედიტაცია და 2012 წლიდან პირველად საქართველოს ტექნიკური უნივერსიტეტის ისტორიაში მზადდება ამ პროფილის კადრები. აკადემიკოსი ა. ფრანგიშვილი, პროფესორები – თ. ბაციკაძე, გ. გავარდაშვილი და აკადემიური დოქტორი ჯ. კახაძე არიან ერთ-ერთი პირველი ორგანიზატორები და აქტიური მხარდამჭერები სამტრედიის რაიონში სოფელ დიდ ჯიხაიშში, ნიკო ნიკოლაძის სახელობის პროფესიული სწავლების ცენტრის აღდგენის საქმეში, რაც კიდევ ერთი საშვილიშვილო საქმეა ჩვენი ქვეყნისათვის პროფესიული კადრების აღზრდის საქმეში სოფლის მეურნეობის მიმართულებით.

სამეცნიერო-კვლევითი და სასწავლო პროგრამების განხორციელება ასევე აქტიურად მიმდინარეობს ინსტიტუტის საცდელ-სამელიორაციო კვლევით ბაზებზე, რომელიც განთავსებულია საქართველოს სხვადასხვა რეგიონებში: ქ. ფოთში (შავი ზღვისა და კოლხეთის დაბლობის პრობლემების კვლევა), გორის რ-ნის სოფელ კარალეთში (მორწყვის რეჟიმებისა და რწყვის თანამედროვე მეთოდების კვლევა); დუშეთის რ-ნის სოფელ არახვეთში (ბუნების სტიქიური მოვლენების კვლევა და პროგნოზირება), გარდაბნის რ-ნის სოფელ გამარჯვებაში (სპეციფიკური ნიადაგების, მათ შორის თაბაშირშემცველის მელიორაცია და სასოფლო-სამეურნეო ათვისება), სიღნაღის რ-ნის სოფელ ხორნაბუჯში (საქართველოს დამლაშებული და ბიცობი ნიადაგების მელიორაცია, მორწყვის რეჟიმების

დაზუსტება საქართველოს არიდულ ზონებში).

ინსტიტუტში ამჟამად ფუნქციონირებს თანამედროვე კომპიუტერული ტექნიკით აღჭურვილი ხუთი განყოფილება: 1. ბუნებრივი კატასტროფების განყოფილება (ხელმძღვანელი – გეოგრაფიის აკადემიური დოქტორი, ასოც. პროფესორი რობერტ დიაკონიძე); 2. ზღვებისა და წყალსაცავების განყოფილება (ხელმძღვანელი – ტექნიკის მეცნიერებათა დოქტორი ირინა იორდანიშვილი); 3. მელიორაციის განყოფილება (ხელმძღვანელი – ტექნიკის აკადემიური დოქტორი ვლადიმერ შურღაია); 4. გარემოს დაცვისა და საინჟინრო ეკოლოგიის განყოფილება (ხელმძღვანელი – ტექნიკის აკადემიური დოქტორი, ასოც. პროფესორი გოგა ჩახაია); 5. მელიორაციული სისტემების დაპროექტებისა და ექსპერტიზის განყოფილება (ხელმძღვანელი – ტექნიკის აკადემიური დოქტორი, ასოც. პროფესორი შორენა კუპრეიშვილი).

ინსტიტუტში მუშაობს 77 თანამშრომელი, აქედან 54% მეცნიერ-თანამშრომელია, მათ შორის: 1 – საქართველოს მეცნიერებათა ეროვნული აკადემიკოს-მდივანი და ამავე აკადემიის სოფლის მეურნეობის განყოფილების გამგე **ოთარ ნათიშვილი,** 4 – საინჟინრო აკადემიის, 4 – ეკოლოგიის აკადემიის აკადემიკოსი, 7 – მეცნიერებათა დოქტორი, 16 – აკადემიური დოქტორი, 3 – დოქტორანტი და 4 – მაგისტრი. ინსტიტუტში სამეცნიერო-კვლევით მუშაობას ხელმძღვანელობს სამეცნიერო საბჭო 7 წევრის შემადგენლობით. ინსტიტუტში მომუშავე ადმინისტრაციისა და მეცნიერ-თანამშრომლების საშუალო ასაკი არ აღემატება 55 წელს.

ინსტიტუტში ამჟამად მუშავდება 17 საბიუჯეტო თემა, რომლებიც აქტუალურია ქვეყანაში მიმდინარე გახშირებული ბუნებრივი კატასტროფებისა და გარემოს დაცვის ღონისძიებების მეცნიერულად დამუშავების თვალსაზრისით.

გ. გავარდაშვილის ხელმძღვანელობითა და სახელმწიფოს მხარდაჭერით 2009 წლის სექტემბერში UNESCO-ს ეგიდით ჩატარდა საერთაშორისო სიმპოზიუმი „წყალდიდობები და მასთან ბრძოლის თანამედროვე პრობლემები", რომელიც მიეძღვნა საქართველოს წყალთა მეურნეობის ინსტიტუტის დაარსებიდან 80 წლის იუბილეს. სიმპოზიუმის მუშაობაში მონაწილეობა მიიღო მსოფლიოს 22 ქვეყნის მეცნიერ-სპეციალისტებმა, ხოლო სიმპოზიუმის მეცნიერულ დონეს მაღალი შეფასება მისცა UNESCO–მ, რაც გამოიხატება სიმპოზიუმზე მიღებული რეზოლუციის სახელმძღვანელო დოკუმენტად მიღებით გაეროს წევრი ქვეყნებისათვის.

ინსტიტუტის თანამშრომლების თავდაუზოგავი შრომის შედეგია, რომ 2005 წელს ინსტიტუტის კოლექტივის მრავალი სამეცნიერო პროექტის, კვლევებისა და მსოფლიოს ერთ-ერთი საუკეთესო, მსოფლიოში ცნობილი ჰიდროტექნიკური ლაბორატორიის ფუნქციონირების გამო საქართველოს წყალთა მეურნეობის ინსტიტუტი დაჯილდოვდა შვეიცარიის დიპლომით "Century International Quality Era Award". 2009 წელს – ამერიკის ბიოგრაფიის ინსტიტუტის (ABI) ოქროს მედლით, საქართველოს მეცნიერებათა ეროვნულმა აკადემიამ ინსტიტუტი 2-ჯერ: 2008 და 2009 წლებში დააჯილდოვა დიპლომებით, როგორც ქვეყნის საუკეთესო სამეცნიერო-კვლევითი დაწესებულება სოფლის მეურნეობის დარგში.

2006 წლიდან ინსტიტუტის დირექტორმა გ. გავარდაშვილმა სსიპ-ის დაფუძნების შემდეგ საერთაშორისო თანამშრომლობის მემორანდუმები გააფორმა მსოფლიოში აღიარებულ ისეთ სამეცნიერო-სასწავლო კვლევით ცენტრებსა და უნივერსიტეტებთან, როგორიცაა:

- ჰესენის უნივერსიტეტი (გერმანია, 2006 წ.);
- მოსკოვის ლომონოსოვის სახელობის უნივერსიტეტი (რუსეთი, 2006 წ.);
- ცენტრალური ჩინეთის ნორმალის უნივერსიტეტი (ჩინეთი, 2007 წ.);

- ერევნის არქიტექტურისა და მშენებლობის სახელმწიფო უნივერსიტეტი (სომხეთი, 2008 წ.);
- აზერბაიჯანის ჰიდროტექნიკისა და მელიორაციის სამეცნიერო-კვლევითი ინსტიტუტი (აზერბაიჯანი, 2008 წ.);
- სომხეთის წყლის პრობლემებისა და ჰიდროტექნიკური ნაგებობების სამეცნიერო-კვლევითი ინსტიტუტი (სომხეთი, 2008 წ.);
- ყირგიზეთის მეცნიერებათა ეროვნული აკადემიის წყლის პრობლემებისა და ჰიდროტექნიკური ნაგებობების სამეცნიერო-კვლევითი ინსტიტუტი (ყირგიზეთი, 2008 წ.);
- მერილენდის უნივერსიტეტი (აშშ, 2009 წ.);
- ბაქოს სახელმწიფო უნივერსიტეტი (აზერბაიჯანი, 2009 წ);
- უკრაინის ჰიდროტექნიკისა და მელიორაციის სამეცნიერო-კვლევითი ინსტიტუტი (უკრაინა, 2009);
- აზერბაიჯანის წყლის პრობლემების სამეცნიერო-კვლევითი ინსტიტუტი (აზერბაიჯანი, 2009 წ);
- ხარკოვის სამრეწველო ნარჩენების მართვის სამეცნიერო-ცენტრი (უკრაინა, 2009 წ.);
- ბოკუს უნივერსიტეტის ჰიდრავლიკისა და წყლის მენეჯმენტის ინსტიტუტი (ავსტრია, 2010 წ.)
- ვროცლავის გარემოს დაცვისა და სიცოცხლის შემსწავლელი მეცნიერებების უნივერსიტეტი (პოლონეთი, 2010 წ.);
- ვარშავის აგრარული უნივერსიტეტი (პოლონეთი, 2012 წ.)
- მეშჩერსკის სამეცნიერო-კვლევითი ცენტრი (რუსეთი, 2013 წ.)
- მდინარე იანძის სამეცნიერო-კვლევითი ინსტიტუტი (ჩინეთი, 2014);
- ბელარუსის სახელმწიფო სოფლის მეურნეობის აკადემია (მინსკი, 2014);
- ოსტროვას ტექნოლოგიური უნივერსიტეტი (ჩეხეთი, 2014 წ.);
- ბელარუსის მელიორაციის ინსტიტუტი (მინსკი, 2014);
- ბელორუსის სახელმწიფო აგრარულ ტექნიკური უნივერსიტეტი (გორკი, 2014).

2006-2013 წლებში შოთა რუსთაველის ეროვნული სამეცნიერო ფონდიდან ინსტიტუტმა მიიღო 17 საგრანტო პროექტზე დაფინანსება, ამავე წლებში 6 გრანტი დაფინანსდა პრეზიდენტის სახელობის ახალგაზრდა მეცნიერთათვის, ხოლო 3 – საკონფერენციო სამოგზაურო გრანტის ეგიდით. შოთა რუსთაველის ეროვნული სამეცნიერო ფონდიდან ინსტიტუტში ამჟამად მუშავდება 3 საგრანტო პროექტი.

2007-2011 წლებში ინსტიტუტში დამუშავდა საერთაშორისო მნიშვნელობის 3 საგრანტო პროექტი, აქედან 1 დაფინანსდა ამერიკის მეცნიერებათა ეროვნული აკადემიიდან, მეორე – ევროკავშირიდან (FP-7), ხოლო მესამე კი – შვეიცარიის თანამშრომლობისა და განვითარების სააგენტოდან (SDC);

2011-2013 წლებში საქართველოს ტექნიკური უნივერსიტეტიდან დაფინანსდა (ე.წ. შიდა გრანტები) 7 პროექტი. 2009–2012 წლებში ინსტიტუტში დამუშავდა სახელმწიფო სტრატეგიული მნიშვნელობის 9 პროექტი, ხოლო 2008-2014 წლებში ინსტიტუტში ექსპერტიზა ჩაუტარდა გარემოზე ზემოქმედების შეფასების 15 პროექტს. 2006-2013 წლებში

ინსტიტუტის თანამშრომლებმა გამოგონებაზე მიიღეს საქართველოს 6 პატენტის მოწმობა (ინსტიტუტს თავისი არსებობის 85 წლის მანძილზე აგრეთვე მიღებული აქვს 120-ზე მეტი საავტორო მოწმობა გამოგონებაზე, რომელთა 35%-ზე მეტი დანერგილია პრაქტიკაში).

2009-2013 წლებში ინსტიტუტის მეცნიერ-თანამშრომლებმა: საქართველოს სამეცნიერო ჟურნალებში გამოაქვეყნეს 161 სამეცნიერო სტატია, ხოლო საზღვარგარეთ – 31, მონოგრაფია – 10 (მათ შორის 1 საზღვარგარეთ), 12 სახელმძღვანელო, 4 მოდული, 16 საუნივერსიტეტო სასწავლო პროგრამა; ინსტიტუტის მეცნიერ-თანამშრომლებმა 95 მოხსენება გააკეთეს და, შესაბამისად, ამდენივე სამეცნიერო სტატია გამოაქვეყნეს 66 საერთაშორისო და 29 საქართველოში ჩატარებულ სამეცნიერო კონფერენციებსა და სიმპოზიუმებში. ინსტიტუტის 2 ახალგაზრდა მეცნიერი კვალიფიკაციის ამაღლების მიზნით სტაჟირებით იმყოფებოდა პოლონეთში, ვროცლავის უნივერსიტეტში, ხოლო ამჟამად, ინსტიტუტის 5 მეცნიერ-თანამშრომელი აქტიურადაა ჩართული ნიდერლანდების საელჩოს მიერ დაფინანსებულ პროგრამაში – NFP, რომელიც ითვალისწინებს ქ. დელფტში იუნესკოს – წყლის განათლების ინსტიტუტში (Institute for Water Education) სტაჟირების გავლას 2014 წლის ოქტომბრის თვეში. რაც შეეხება ახალგაზრდა დოქტორანტების მომზადებას, პროფ. გ. გავარდაშვილის ხელმძღვანელობით ინსტიტუტის 2-მა თანამშრომელმა (თამრიკო სუპატაშვილი და მაკა გუგუჩია) გაიმარჯვა 2013 წლის შოთა რუსთაველის ეროვნული სამეცნიერო ფონდის მიერ გამოცხადებულ დოქტორანტურის საგანმანათლებლო პროგრამების საგრანტო კონკურსში და თითოეულმა მათგანმა სამეცნიერო-კვლევითი სამუშაოების განხორციელებისათვის მიიღეს დაფინანსება 21 000 ლარის ოდენობით.

2013 წლის 20 მარტს ინსტიტუტში სტუმრად იმყოფებოდნენ საქართველოს რეგიონული განვითარებისა და ინფრასტრუქტურის მინისტრი დავით ნარმანია (ამჟამად ქ. თბილისის არჩეული მერი), ადმინისტრაციის ხელმძღვანელი შოთა მურღულია (ამჟამად ქ. ქუთაისის არჩეული მერი), საქართველოს ტექნიკური უნივერსიტეტის რექტორი, აკადემიკოსი არჩილ ფრანგიშვილი, პრორექტორი, პროფ. ლევან კლიმიაშვილი, სტუ-ს პერსპექტიული განვითარების სამსახურის უფროსი, პროფ. თ. ბაციკაძე და სხვ. (***ფოტო 2***). საუბარი შეეხო ქვეყანაში საიმედო ინფრასტრუქტურული პროექტების განხორციელების მიზნით ინსტიტუტის ჰიდროტექნიკურ ლაბორატორიაში კონსტრუქციების მსხვილმასშტაბიანი მოდელირების განხორციელებას. სამეცნიერო-სასწავლო კვლევების განხორციელებისათვის კი დღის წესრიგში დგება ინსტიტუტის ჰიდროტექნიკური ლაბორატორიის თანამედროვე დონეზე მოდერნიზაცია, რომელიც საქართველოს ტექნიკური უნივერსიტეტის რექტორის, აკადემიკოს არჩილ ფრანგიშვილის ერთ-ერთ პრიორიტეტს წარმოადგენს.

საქართველოს პრემიერ-მინისტრის 2008 წლის 29 აგვისტოს №252 ბრძანებით ინსტიტუტი აქტიურად მონაწილეობდა საქართველოში საომარი მოქმედებების შედეგად გარემოსათვის მიყენებული ზიანის შემფასებელი კომისიის მუშაობაში; წყალთა მეურნეობის ინსტიტუტმა, მხოლოდ ერთადერთმა ორგანიზაციამ, განახორციელა რუსეთის აგრესიის შედეგად გარემოზე მიყენებული (ბორჯომისა და გორის რეგიონებში) ზარალის ეკოლოგიურ-ეკონომიკური გაანგარიშება, რაც შემდგომ ქვეყნის მთავრობის მიერ გამოყენებულ იქნა გადამწვარი ტყეების აღდგენის მიზნით ინვესტიციების მოზიდვისათვის.

ინსტიტუტში 85 წლის განმავლობაში ტრადიციულად ტარდებოდა საერთაშორისო თუ საკავშირო სამეცნიერო-ტექნიკური კონფერენციები, სემინარები და სამუშაო შეხვედრები, ხოლო UNESCO-ს ეგიდით ინსტიტუტში საერთაშორისო კონფერენცია ჩატარდა სამჯერ: 1969 წელს – „წყალდიდობის საწინააღმდეგო ღონისძიებები; 1995 წელს – „ადამიანი და ზღვა" და 2009 წელს – წყალდიდობები და მასთან ბრძოლის თანამედროვე

მეთოდები", რომელიც მიეძღვნა ინსტიტუტის დაარსებიდან 80 წლის იუბილეს (იხ. სატიტულო ბოლო გვერდი).

ფოტო 2. **სტუმრად ჰიდროტექნიკურ ლაბორატორიაში (22.03.2013). მარჯვნიდან: აკადემიკოსი ა. ფრანგიშვილი, შ. მურღულია, დ. ნარმანია და პროფ. გ. გავარდაშვილი**

Photo 2. Visit to the Hydrotechnical laboratory (22.03.2013). the right: Academician A. Prangishvili, Sh. Murghulia, D. Narmania and Professor G. Gavardashvili

Фото 2. В гидротехнической лаборатории (22.03.2013). Справа: академик А. Прангишвили, Ш. Мургулия, Д. Нармания и проф. Г. Гавардашвили

2014 წლის 25-30 სექტემბერს ჩატარდება მე-4 საერთაშორისო სამეცნიერო-ტექნიკური კონფერენცია თემაზე – „წყალთა მეურნეობის, გარემოს დაცვის, არქიტექტურისა და მშენებლობის თანამედროვე პრობლემები", რომელიც ეძღვნება საქართველოს ტექნიკური უნივერსიტეტის წყალთა მეურნეობის ინსტიტუტის დაარსებიდან 85 წლის იუბილეს.

1934 წლიდან ინსტიტუტში ტრადიციულად გამოდის რეცენზირებული სამეცნიერო შრომათა კრებული (ანოტაციებით ქართულ, ინგლისურ და რუსულ ენებზე, საერთაშორისო სერიული ნომრით ISSN – 1512-2344), რომელიც 2005 წლიდან იბეჭდება ყოველ წელს და ვრცელდება მსოფლიოს 20-ზე მეტ ქვეყანაში. მორიგი №69 სამეცნიერო შრომათა კრებული გამოვა 2014 წელს და ასევე მიეძღვნება ინსტიტუტის დაარსებიდან 85 წლის იუბილეს.

2009-2014 წლებში მოპოვებული დიდი წარმატებების გარდა ინსტიტუტი 85 წლის იუბილეს სამწუხაროდ დიდი დანაკარგითაც ხვდება – ისეთი ღვაწლმოსილი, დამსახურებული მეცნიერების გარეშე, როგორებიც იყვნენ: აკად. ცოტნე მირცხულავა, ტექნ. მეცნ. დოქტ., პროფ. ნინა ვარაზაშვილი, სოფლის მეურნეობის მეცნიერებათა აკადემიის აკადემიკოსი ვახტანგ თევზაძე, ტექნ. მეცნ. დოქტორები: პროფ. ოთარ ნანიტაშვილი და ალექსანდრე გელუტაშვილი, ასევე ტექნ. მეცნ. კანდიდატები: ნოდარ მოდებაძე, მაკა ცანავა, გურამ ჩიტიშვილი, გამარლი დოხნაძე, მერაბ ჯიქია, მეცნიერ-თანამშრომლები – დავით ლორთქიფანიძე, იაგორ მახარაძე და სხვები.

საგაზეთო თუ ინტერნეტ-გამოცემებში ხშირად აღნიშნულია, რომ წყალთა მეურნეობის ინსტიტუტს, როგორც ქვეყნის ერთ-ერთ სტრატეგიული მიმართულების ინსტიტუტს, მრავალი საერთაშორისო, საკავშირო თუ ეროვნული მნიშვნელობის პროექტი აქვს დამუშავებული, ასევე ავტორია მრავალი სახელმწიფო სტანდარტისა და პროგრამის, მონაწილეობა აქვს მიღებული პარლამენტის კომიტეტებში შესაბამისი პროფილის საკანონმდებლო აქტების მომზადებაში.

2014 წლის 8 აგვისტოს ინსტიტუტში ჩატარდა მეცნიერ-თანამშრომელთა გაფართოებული სხდომა, სადაც მიღებულ იქნა გადაწყვეტილება ინსტიტუტისათვის მსოფლიოში ცნობილი მეცნიერის, აკადემიკოს ცოტნე მირცხულავას სახელის მინიჭების თაობაზე. აღნიშნული დოკუმენტაცია გადაეცა საქართველოს ტექნიკურ უნივერსიტეტის აკადემიურ საბჭოს შემდგომი მსვლელობისათვის.

ინსტიტუტი თავისი მოღვაწეობის 85 წლის განმავლობაში ავტორია წყალთა მეურნეობის, მელიორაციის, გარემოს დაცვის, წყალსამეურნეო ობიექტების საიმედოობისა და რისკის პროგნოზირების შეფასების საკითხებში მრავალი სამეცნიერო მეთოდისა და მეთოდოლოგიის, რომლებიც უკვე გამოყენებულია მთელი რიგი ეროვნული თუ საერთაშორისო მნიშვნელობის 500-ზე მეტ პროექტში. გამომდინარე ზემოთქმულიდან, ვიმედოვნებთ, რომ მე-4 საერთაშორისო კონფერენცია თავისი მეცნიერული მიმართულებების აქტუალობითა და მასშტაბურობით ხელს შეუწყობს ჩვენი პლანეტის გარემოს მდგრადობისა და მოსახლეობის უსაფრთხოების უზრუნველყოფას.

საერთაშორისო კონფერენციის
საორგანიზაციო კომიტეტი

ANNIVERSARY **ЮБИЛЕЙ**

WATER MANAGEMENT INSTITUTE 85

Water Management Institute of Georgian Technical University is the one of the oldest scientific institutions in the South Caucasus, which was actually founded in 1925 and approved by Resolution of Government 27 September, 1929. It is a successor of the former Water Management Institute of Transcaucasia, Georgian Scientific and Research Institute of Hydrotechnics and Melioration, Water Management and Engineering Ecology Institute of National Science Academy of Georgia and finally LEPL Water Management Institute.

On the basis of Georgian Government Resolution №210 of July 27, 2010 LEPL Water Management Institute was reorganized and joined to the Georgian Technical University, as the independent scientific and research unit. Since 2011 it operates as Water Management Institute of Georgian Technical University.

Water Management Institute over the years was the only institution of such profile in the South Caucasia, the purpose of which was research of floods and high waters, erosion phenomena, natural disasters, coastal zones of seas and rivers, melioration (draining of areas of high humidity, irrigation in remote areas), reservoirs and hydrotechnical facilities in the period of design, construction and operation, study of their reliability and other issues related to such problems. Later the similar research organizations were established on the basis of the Institute in Azerbaijan and Armenia, which are operating up to date and regularly collaborate with Water Management Institute.

In 1947-1968 at the head of the Institute was Professor **Mikheil Gagoshidze**, who made a substantial contribution to development of the Institute.

Since the founding up to 1947 Institute was headed by: **K. Mikhailov, E. Gabiev, N. Sokolovsky, D. Galilov, S. Bitlazar, G. Larin** and

ИНСТИТУТУ ВОДНОГО ХОЗЯЙСТВА 85

Институт водного хозяйства Грузинского технического университета на Южном Кавказе – одно из старых научных учреждений, которое сформировалось фактически в 1925 году, но по Постановлению правительства было оформлено 27 сентября 1929 года. Он преемник бывшего Закавказского института водного хозяйства, Грузинского научно-исследовательского института гидротехники и мелиорации, Грузинского института водного хозяйства и инженерной экологии Национальной АН Грузии и, наконец, Публично-правового юридического лица – института водного хозяйства.

Согласно Постановлению правительства Грузии №210 от 27 июля 2010 года была осуществлена реорганизация Публично-правового юридического лица института водного хозяйства, и он был присоединен к Грузинскому техническому университету, как самостоятельная научно-исследовательская единица. С 2011 года он функционирует как Институт водного хозяйства Грузинского технического университета.

Институт водного хозяйства на протяжении многих лет представлял собой единственное учреждение этого профиля на Южном Кавказе. Его назначением были исследования, в период проектирования, строительства и эксплуатации, наводнений и паводков, эрозионно-селевых явлений, природных катастроф, прибрежных зон моря и рек, мелиорации (осушение переувлажненных земель, орошение аридных зон), водохранилищ, гидротехнических сооружений, исследование их надежности и вопросов, связанных с подобными проблемами. Позже, на базе института, были созданы научно-исследовательские организации аналогичного назначения в Азербайджане и Армении, которые функционируют и в настоящее время и регулярно сотрудничают с Институтом водного хозяйства.

В 1947-1968 годах во главе Института стоял профессор **Михаил Сергеевич Гагошидзе**, который внес большой вклад в его развитие.

Со дня основания института до 1947 года Институтом руководили **К. Михайлов, Е. Габиев,**

P. Solod.

In 1968-2005 the Institute was headed by Academician of Georgian National Academy of Sciences, Academician of Russian Academy of Agricultural Sciences, laureate of State Prize in Sciences and Technology, one of the first owners of A. Kostiakov Gold Medal, Doctor of Technical Science, Professor **Tsotne Mirtskhulava**. Should be noted his substantial contribution to the achievements of Institute and creating its international standing. In 2006 he was named the best Georgian scientist in technology.

Since 2005 the Institute is headed by the Full Member of Engineering Academy, Doctor of Technical Science, Professor Givi Gavardashvili, who actively continued the work begun by Tsotne Mirtskhulava. He made a great contribution to salvation of Institute in 2006-2010, when the massive and fast privatization was carried out in the country. Should be noted that thanks to active work of G. Gavardashvili and patriotic assistance of Deputy Chairmen of Parliament, First Vice-President of Georgian National Academy of Sciences, Academician **Fridon Todua** (***photo 1, page 4***), for what Institute Directorate and research staff are very grateful, in 2008-2010 it appeared possible to preserve the laboratory, where is actively taking place large-scale hydraulic laboratory modeling of activities related to water management, melioration and environmental protection and also implementation of educational and scientific programs in agricultural melioration.

With the assistance of Rector of Georgian Technical University Academician Archil Frangishvili the group of scientists with the lead of Professor Givi Gavardashvili and Associated Professor Zurab Lobzhanidze (professor V. Tevzadze, professor I. Iordanishvili, academic doctors: I. Iremashvili, G. Chakhaia, Sh. Kupreishvili, V. Shurghaia, R. Diakonidze, L. Tsulukidze, J. Kakhadze and others) developed the bachelor's, master's and doctoral programs in the field of agricultural melioration, which successfully passed

Н. Соколовский, Д. Галилов, Ш. Битлазар, Г. Ларин и П. Солод.

В 1968-2005 годах Институтом руководил известный в мире ученый и организатор, академик Национальной АН Грузии, лауреат Государственной премии Грузии в области науки и техники, один из первых обладателей золотой медали А. Костякова, доктор технических наук, профессор **Цотне Евгеньевич Мирцхулава**. Нужно отметить, что очень важен его вклад в достижения Института и создание его международного авторитета. В 2006 году его признали лучшим ученым Грузии в области техники.

С 2005 года институтом руководит действительный член Инженерной академии, доктор технических наук, профессор **Гиви Гавардашвили**, который активно продолжил дело, начатое академиком Цотне Мирцхулава. Велики его заслуги в деле спасения и сохранения института, когда в 2006-2010 г.г. проводилась массовая и быстрая приватизация недвижимой собственности. Необходимо отметить, что благодаря активной работе **Г. Гавардашвили** и патриотической поддержке первого вице-президента Национальной АН Грузии, академика **Фридона Тодуа** (***фото 1, стр. 4***), за что дирекция института и научные сотрудники очень ему признательны, в 2008-2010 г.г. удалось сохранить знаменитую гидротехническую лабораторию. В этой лаборатории проводится гидравлическое крупномасштабное лабораторное моделирование мероприятий водного хозяйства, мелиорации и охраны окружающей среды, необходимых для нашей страны, а также осуществление учебно-научной программы сельскохозяйственной мелиорации.

При поддержке ректора Грузинского технического университета академика Арчила Прангишвили и под руководством профессора Гиви Гавардашвили и ассоциированного профессора Зураба Лобжанидзе, группа научных сотрудников – проф. В. Тевзадзе, проф. И. Иорданишвили, академические доктора: И. Иремашвили, Г. Чахая, Ш. Купреишвили, В. Шургая, Р. Диаконидзе, Л. Цулукидзе, Дж. Кахадзе и др. – подготовили программы профессиональной учебы, бакалавриата, магистратуры и докторантуры по сельскохозяйственной мелиорации.

State accreditation and since 2012 the first time in the history of Georgian Technical University takes place the training of personnel of this profile.

The Academician A. Prangishvili, Professors T. Batsikadze, G. Gavardashvili and academic doctor J. Kakhadze are one of the first organizers and active supporters of restoration of Niko Nikoladze Professional training center in Didi Djikhaishi village, Samtredia region that is one more glorious work in education of professional staff for our country.

Implementation of scientific and research programs are also actively carried out at the experimental melioration bases of Institute in different regions of Georgia: Poti (research of Black sea and Kolkheti lowland problems); Karaleti village, Gori district (research of irritation regimes and modern methods of irrigation); Arakhveti village, Dusheti district (research and forecast of natural phenomena), Gamardjveba village, Gardabani district (melioration and agricultural absorption of specific soils, including gypsum-containing), Khornabudji village, Sighnaghi district (melioration of saline and sodic soils of Georgia, elaboration of irrigation regimes in remote areas of Georgia).

Five departments equipped with modern computer hardware are operating in Institute nowadays: 1. Department of natural disasters (the head – academic doctor of geography, associated Professor Robert Diakonidze); 2. Department of seas and reservoirs (the head – Doctor of Technical Science Irina Iordanishvili); Department of melioration (the head – academic doctor of technology Vladimer Shurghaia); 4. Department of environmental protection and engineering ecology (the head - academic doctor of technology, associated professor Goga Chakhaia); Department of designing and expertize of melioration systems (the head – academic doctor of technology, Professor Shorena Kupreishvili).

The 77 employees are working at the Institute, 54% of them are scientific employees, including: 1 Academician-Secretary of Georgian National

Эти программы успешно прошли аккредитацию и с 2012 года, впервые в истории Грузинского технического университета, готовятся кадры этого профиля.

Академик А. Прангишвили, профессора – Т. Бацикадзе, Г. Гавардашвили и академический доктор Дж. Кахадзе – являются одними из первых организаторов, которые активно поддерживают восстановление Центра профессиональной учебы им. Нико Николадзе в селе Диди Джихаиши Самтредского района. Это является еще одним славным делом для нашей страны в воспитании профессиональных кадров в области сельского хозяйства.

Также активно протекает осуществление научно-исследовательских и учебных программ на опытно-мелиоративных исследовательских базах института, которые располагаются в разных регионах Грузии: г. Поти – исследование проблем Черного моря и Колхидской низменности, село Каралети Горийского района – исследование режима орошения и современных методов полива, село Арахвети Душетского района – исследование и прогнозирование стихийных явлений природы, село Гамарджвеба Гардабанского района – мелиорация и сельскохозяйственное освоение специфических почв – в том числе содержащих гипс, село Хорнабуджи Сигнахского района – мелиорация засоленных и солонцовых почв, уточнение режимов орошения в аридных зонах Грузии.

В настоящее время в Институте функционируют пять отделов, оснащенных современной компьютерной техникой: 1. Отдел природных катастроф (руководитель – академический доктор географии, асоц. профессор Роберт Диаконидзе); 2. Отдел морей и водохранилищ (руководитель – доктор технических наук Ирина Иорданишвили); 3. Отдел мелиорации (руководитель – академический доктор техники Владимир Шургая); 4. Отдел охраны окружающей среды и инженерной экологии (руководитель – академический доктор техники, асоц. профессор Гога Чахая); 5. Отдел проектирования мелиоративных систем и экспертизы (руководитель – академический доктор техники, асоц. профессор Шорена Купреишвили).

В Институте работает 77 сотрудников, отсюда 54% – научные сотрудники, в том числе: 1 – академик-секретарь Национальной АН

Academy of Sciences and head of Agricultural department of Academy Otar Natishvili, 4 academicians of Engineering Academy, 4 academicians of Ecological Academy, 7 Doctors of Sciences, 16 Academic doctors, 3 doctoral candidates and 4 holders of master's degree. Research and scientific work of the Institute is headed by Science Board consisting of 7 members. Average age of admi nistration staff and scientific employees does not exceed 55 years.

The 17 budget topics are being developed at the Institute nowadays; these themesare relevant in context of frequent natural disasters and scientific development of measures for environmental protection.

International Symposium "Floods and modern problems of fightingagainst them" led by G. Gavardashvili and with assistance of Government was held in September 2009 under the aegis of UNESCO, it was dedicated to the 80th anniversary of the founding of Water Management Institute. Scientific experts of 22 countries took part in the Symposium and it was praised by UNESCO, in witness whereof the Resolution adopted at the Symposium has been recognized as a guidance document for UN member countries.

The result of selfless work of the Institute staff is that in 2005 Georgian Water Management Institute was awarded a diploma of Switzerland «Century International Quality Era Award» for numerous research projects, researches and operation of one of the best in the world hydrotechnical laboratory. In 2009 it received a Gold medal of American Biographical Institute (ABI). National Science Academy of Georgia awarded the Institute twice: in 2008 and 2009, as the best scientific and research institutions of the country in agricultural field.

Since 2006 after becoming a LEPL Director of the Institute G. Gavardashvili concluded Memoranda of international Cooperation with such internationally acclaimed research centers and universities as:

Грузии и зав. отделом сельского хозяйства той же академии **Отар Георгиевич Натишвили**, 4 – академика Инженерной академии, и 4 – академика Академии экологии, 7 – докторов наук, 16 – академических доктора, 3 – докторанта и 4 – магистра. Научно-исследовательской работой Института руководит Ученый совет в составе 7 членов. Средний возраст, работающих в Институте администрации и научных сотрудников не превышает 55 лет.

В настоящее время в Институте разрабатывается 17 бюджетных тем, которые актуальны с точки зрения протекающих природных катастроф и научной разработки мероприятий по охране окружающей среды.

Под руководством Г. Гавардашвили и при поддержке государства под эгидой ЮНЕСКО в сентябре 2009 года был проведен Международный симпозиум «Наводнения и современные проблемы борьбы с ними», который был посвящен 80-летнему юбилею Института водного хозяйства Грузии. В работе симпозиума приняли участие ученые 22 стран мира, научный уровень симпозиума был высоко оценен ЮНЕСКО, что выражается в принятии руководящим документом – резолюции симпозиума для стран членов ООН.

Результатом самоотверженного труда сотрудников Института является то, что в 2005 году за многие научные проекты, исследования коллектива института и функционирование лучшей, известной в мире гидротехнической лаборатории Институт водного хозяйства Грузии был награжден дипломом Швейцарии "Century International Quality Era Award", В 2009 году Американским институтом биографии (ABI) – золотой медалью, Национальной АН Грузии 2 раза: в 2008 и 2009 годах был награжден дипломами, как лучшее научно-исследовательское учреждение Грузии в области сельского хозяйства.

С 2006 года директор Института Г. Гавардашвили после основания публично-правого лица оформил Меморандумы международного сотрудничества с такими признанными в мире научно-учебными центрами и университетами, как:

- University of Hessen (Germany, 2006);
- Lomonosov Moscow State University (Russia, 2006);
- Central China Normal University (China, 2007);
- Yerevan State University of Architecture and Construction (Armenia, 2008);
- Azerbaijan Scientific-Research Institute of Hydrotechnics and Melioration (Azerbaijan, 2008);
- Armenian Scientific-Research Institute of Water Problems and Hydrotechnical Facilities (Armenia, 2008);
- Scientific-Research Institute of Water Problems and Hydrotechnical Facilities of National Science Academy of Kirghizia (Kirghizia, 2008);
- University of Maryland (USA, 2009);
- Baku State University (Azerbaijan, 2009);
- UkrainianScientific-Research Institute of Hydrotechnics and Melioration (Ukraine, 2009);
- Azerbaijan Scientific-Research Institute of Water Problems (Azerbaijan, 2009);
- Kharkov Scientific Center of Industrial Waste Management (Ukraine, 2009);
- BOKU Hydraulic and Water Management Institute (Austria, 2010);
- Wroclaw University of Environmental and Life Sciences (Poland; 2010);
- Warsaw Agrarian University (Poland, 2012);
- Meshchersky Scientific-Research Center (Russia, 2013);
- Yangtze River Scientific Research Institute (China, 2014);
- State Agricultural Academy of Belarus (Minsk, Republic of Belarus, 2014);
- Ostrava Technical University (Ostrava, Czech Republic, 2014);
- Belarusian Reclamation Institute (Minsk, Republic of Belarus, 2014);
- Belarusian Agricultural Academy (Gorki, Republic of Belarus, 2014).

- Гессенский университет (Германия, 2006 г.);
- МГУ им. Ломоносова (Россия, 2006 г.);
- Университет Центрального Китая (Китай, 2007 г.);
- Ереванский государственный университет архитектуры и строительства (Армения, 2008 г.);
- Азербайджанский научно-исследовательский институт гидротехники и мелиорации (Азербайджан, 2008 г.);
- Армянский научно-исследовательский институт водных проблем и гидротехнических сооружений (Армения, 2008 г.);
- Научно-исследовательский институт водных проблем и гидротехнических сооружений Национальной АН Киргизии; (Киргизия, 2008 г.);
- Мерилендский университет (США, 2009 г.);
- Бакинский государственный университет (Азербайджан, 2009 г.);
- Украинский научно-исследовательский институт гидротехники и мелиорации (Украина, 2009 г.);
- Азербайджанский научно-исследовательский институт водных проблем (Азербайджан, 2009 г.);
- Харьковский научный центр управления промышленными отходами (Украина, 2009);
- Институт гидравлики и водного менеджмента университета БОКУ (Австрия, 2010 г.);
- Вроцлавский университет охраны окружающей среды и наук, изучающих жизнь (Польша, 2010 г.);
- Варшавский аграрный университет (Польша, 2012 г.);
- Мещерский научно-исследовательский центр (Россия, 2013 г.);
- Научно-исследовательский институт реки Янцзы (Китай, 2014 г.);
- Государственная сельскохозяйственная академия Беларуси (Минск, 2014 г.);
- Технологический университет Острава (Чехия, 2014 г.).
- Институт мелиорации Беларуси (Минск, 2014 г.);
- Белорусская сельскохозяйственная академия (г. Горки, республика Беларусь, 2014 г.).

In 2006-2013 the Institute received funding for 17 grant projects from Shota Rustaveli National Scientific Fund, in the same period 6 grants have been financed under President's grant for young scientists and 3 – under the aegis of Conference Travel Grants. 3 grant projects from Shota Rustaveli National Scientific Fund are being developed in the Institute nowadays.

The 3 grant projects of international importance were developed in the Institute in 2007-2011, 1 of them was financed by National Academy of Science of the United States, the second – by EU (FP-7) and the third – by Swiss Development Cooperation (SDC);

In 2011-2013 7 projects (so-called internal grants) were financed from Georgian Technical University. In 2009-2012 9 projects of strategic importance were developed in the Institute and in 2008-2014 15 projects on environmental impacts assessment were examined by its staff. In 2006-2013 employees of Institute get 6 patent certificates for their inventions (for 85 years of existence the Institute has got more than 120 certificates for inventions, more than 35% of which were put into practice).

In 2009-2013 scientific workers of the Institute published 161 research articles in Georgian scientific journals and 31 articles abroad, 10 monographs (1 of them abroad), 12 manuals, 4 modules, 16 university training programs; scientific staff of the Institute presented 95 reports and published the same number of articles within 66 international scientific conferences and symposia and 29 similar events in Georgia.

Two young scientists of the Institute have been trained in Wroclaw University in Poland and at the moment 5 scientific workers actively participate in the NFP program financed by the Embassy of Netherlands, which implies the training in UNESCO Institute for Water Education in Delft in October, 2014. As to doctoral candidates, under the guidance of Professor G. Gavardashvili two employees of the Institute (Tamriko Supatashvili

В 2006-2013 годах Институт получил финансирование на 17 грант-проекта из Национального научного фонда им. Шота Руставели, в эти же годы было профинансировано 6 Президентских грантов для молодых ученых, 3 из них под эгидой участия в поездке на конференцию. В настоящее время в Институте разрабатывается 3 грант-проекта Национального научного фонда им. Шота Руставели.

В 2007-2011 годах в Институте были разработаны 3 грант-проекта международного значения, отсюда 1 был профинансирован Национальной АН Америки, второй – Евросоюзом (FP-7), а третий – Швейцарским агентством развития и сотрудничества (SDC).

В 2011-2013 годах Грузинским техническим университетом было профинансировано (т.н. внутренние гранты) 7 проектов. В 2009-2012 годах в Институте было разработано 9 проектов стратегического назначения, а в 2008-2014 годах в Институте была проведена экспертиза оценки влияния на окружающую среду (15 проектов). В 2006-2013 годах сотрудниками Института были получены 6 патентов Грузии на изобретения (за 85 лет своего существования Институтом получено более 120 авторских свидетельств на изобретения, более 35 % которых внедрены в практику).

В 2009-2013 годах научными сотрудниками Института были опубликованы: в научных журналах Грузии 161 научная статья, за рубежом – 31, 10 монографий (из них 1 за рубежом), 12 учебников, 4 модуля, 16 университетских учебных программ; научные сотрудники Института выступили с 95 докладами и, соответственно, столько же статей было опубликовано в трудах 66 Международных и 29 Грузинских научных конференций и симпозиумов.

Двое молодых ученых проходили стажировку в Польше во Вроцлавском университете для повышения квалификации. В настоящее время 5 научных сотрудников активно подключены к программе NFP, финансируемой посольством Нидерландов, которая предусматривает прохождение стажировки в Институте образования в сфере водных ресурсов ЮНЕСКО (Institute for Water Education) в г. Дельфте, в октябре 2014 года. Что касается подготовки молодых докторантов – 2 сотрудника Института

and Maka Guguchia) won Grant Competition of Doctoral Educational Programs announced by the Shota Rustaveli National Scientific Fund in 2013 and each of them got funding for scientific-research work in the amount of 21 000 GEL.

20 March, 2013 the Institute was visited by Minister of Regional Development and Infrastructure of Georgia David Narmania (elected mayor of Tbilisi nowadays), Chief of Staff Shota Murgulia (currently elected Mayor of Kutaisi), Rector of Georgian Technical University Academician Archil Prangishvili, Vice Rector Levan Klimiashvili, Head of GTU Prospective Development Department Professor Tamaz Batsikadze and others (***photo 2, page 8***). At the meeting there was discussed implementation of large-scale modeling of constructions in hydrotechnical laboratory of the Institute for implementation of reliable infrastructural projects. In its turn for carrying out researches the order of a day is modernization of laboratory at the modern level that is one of the priorities for Rector of Georgian Technical University Academician Archil Prangishvili.

According to the order of Georgian Vice-Minister №252 of August, 2008 the Institute actively participated in work of Commission for evaluation of damage caused to environment as a result of military actions in Georgia; Water Management Institute was the only organization, which implemented ecological and economical evaluation of damage caused to environment as the result of Russia aggression (in Borjomi and Gori regions), that was later used by the Government for attraction of investments for rehabilitation of burned out forests.

International and union scientific-research conferences, seminars and working meetings took place in the Institute during 85 years and under the aegis of UNESCO were held 3 international conferences: 1969 – “Anti-flood Measures”, 1995 – “Man and the sea” and 2009 – “Floods and modern methods of fighting against them”, which

(Тамрико Супаташвили и Мака Гугучия) под руководством проф. Г. Гавардашвили одержали победу в конкурсе образовательных программ докторантуры, объявленном Национальным научным фондом им. Шота Руставели в 2013 году и каждая получила финансирование по 21000 лари для проведения научно-исследовательских работ.

20 марта 2013 года Институт посетили Министр регионального развития и инфраструктуры Давид Нармания (в настоящее время избранный мэр г. Тбилиси), руководитель администрации Шота Мургулия (в настоящее время избранный мэр г. Кутаиси), ректор Грузинского Технического Университета, академик Арчил Прангишвили, проректор проф. Леван Климиашвили, начальник службы перспективного развития ГТУ, проф. Т. Бацикадзе и др. (***фото 2, стр. 8***). Разговор касался проведения в гидротехнической лаборатории Института крупномасштабного моделирования конструкций с целью осуществления надежных инфраструктурных проектов. Для проведения научно-учебных исследований на повестке дня стоит вопрос модернизации гидротехнической лаборатории Института на современном уровне, которая является одним из приоритетов ректора Грузинского технического университета академика Арчила Прангишвили.

Согласно приказу премьер-министра Грузии № 252 от 29 августа 2008 года Институт принимал активное участие в работе комиссии по оценке ущерба, нанесенного окружающей среде в результате военных действий в Грузии; только Институт водного хозяйства представил экологически-экономический расчет ущерба, нанесенного окружающей среде (в регионах Боржоми и Гори) в результате агрессии России, который позже был использован правительством страны в привлечении инвестиций с целью восстановления сожженных лесов.

В течение 85 лет в Институте традиционно проводились Международные или Союзные научно-технические конференции, семинары и рабочие встречи, но под эгидой ЮНЕСКО Международные конференции проводились трижды: в 1969 году – «Мероприятия по борьбе с наводнениями»; в 1995 году – "Человек и море"

was dedicated to the 80th anniversary of the founding of the Institute (see the last title page).

25-30 September, 2014 is planned 4th International Scientific-Technical Conference “Modern Problems of Water Management, Environment, Architecture and Construction”, which is dedicated to the 85th anniversary of the founding of Water Management Institute of Georgian Technical University.

Since 1934 the collection of scientific papers are traditionally published in the Institute (with annotations on Georgian, English and Russian language, international serial number ISSN – 1512-2344), since 2005 the edition of scientific papers has become an annual and is distributed in more than 20 countries. The issuance of the next collection of scientific papers №69 is planned in 2014 and it will be dedicated to 85th anniversary of the Institute founding.

Unfortunately the Institute meets its 85th anniversary with the bereavements, without such honored scientists as: Academician Tsotne Mirtskhulava, Doctor of Technical Science Professor Nina Varazashvili, Academician of Academy of Agricultural Science Vakhtang Tevzadze, Doctors of Technical Science Professors Otar Nanitashvili and Alexander Gelutashvili, candidates of technical science Nodar Modebadze, Maka Tsanava, Guram Chitishvili, Gamarli Dokhnadze, Merabi Jikia, scientific officers David Lortkipanidze, Iagor Makharadze and others.

Newspapers and online media frequently note that Water Management Institute, as one of strategic importance institute in the country, is the developer of numerous projects of international, union and national importance and the author of many state standards and programs, the Institute has also participated in the meetings of parliamentary committees for preparation of legislative acts of appropriate profile.

8 August 2014 in Institute held advanced session of scientific workers, where was made decision about awarding institute name of World known scientist, academician Tsotne Mirtskhulava. A noted document was given to Georgian Technical University for further action.

и в 2009 году – "Наводнения и современные методы борьбы с ними", которая была посвящена 80-летнему юбилею Института (см. последнюю титульную страницу).

25-30 сентября 2014 года будет проведена 4-я Международная научно-техническая конференция «Современные проблемы водного хозяйства, охраны окружающей среды, архитектуры и строительства», которая будет посвящена 85-летнему юбилею Института.

С 1934 года Институт традиционно издает рецензированный сборник научных трудов (с аннотациями на грузинском, английском и русском языках, с международным серийным номером ISSN-1512-2344), который с 2005 года издается ежегодно и распространяется в более 20 странах мира. Очередной сборник научных трудов № 69 выйдет в 2014 году и будет также посвящен 85-летнему юбилею института.

Помимо больших успехов, достигнутых в 2009-2014 годах, к сожалению, Институт встречает 85 летний юбилей с большими утратами – без таких заслуженных ученых, как: академик Цотне Евгеньевич Мирцхулава, доктор тех. наук Нина Георгиевна Варазашвили, академик Академии с/х наук Вахтанг Тевзадзе, доктора тех. наук: проф. Отар Наниташвили и Александр Гелуташвили, а также кандидаты тех. наук: Нодар Модебадзе, Лейла Цанава, Гурам Читишвили, Гамарли Дохнадзе, Мерали Джикия, научные сотрудники – Давид Лордкипанидзе, Иагор Махарадзе и др.

В газетных и Интернет изданиях часто отмечается, что Институт водного хозяйства, как один из Институтов стратегического назначения, разработал много проектов международного, союзного и национального значения, а также является автором многих государственных стандартов и программ, принимал участие в подготовке законодательных актов соответствующего профиля в комитетах парламента.

8 августа 2014 г. в Институте было проведено расширенное заседание научных сотрудников, где было принято решение о присвоении Институту имени академика Ц.Е. Мирцхулава, известного в научном мире ученого. Указанная документация передана академическому Совету Грузинского Технического Универси-

Institute is the author of numerous methods and methodology relating to water management, melioration, environmental protection, reliability of water features and risk prediction, which are already used in more than 500 projects of national and international importance. Based on the above stated, we hope that 4th International Conference with its topicality and immensity will contribute to environmental sustainability and security of population.

International Conference Organizing Committee

тета для его дальнейшего хода.

За 85 лет своей деятельности Институт является автором многих научных методов и методологий по вопросам водного хозяйства, мелиорации, охраны окружающей среды, оценки надежности и прогнозирования риска водохозяйственных объектов, которые уже использованы в более 500 проектах национального или международного значения. Мы надеемся, что 4-я Международная конференция своей актуальностью и масштабностью будет способствовать устойчивости окружающей среды планеты и обеспечению безопасности населения.

Организационный комитет международной конференции

Earth sciences

THE FEATURES OF FORMATION OF GROUNDWATER RESOURCES IN THE MOUNTAIN AREAS OF AZERBAIJAN

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ABSTRACT: The decisions have been received for rational utilization from irrigative soils, the available hydrogeological-meliorative condition has been studied and its improvement measures have been grounded under market economical condition.

KEYWORDS: hydrogeological-meliorative condition, paying use from water, Water Users Association, irrigating land.

Исследования по изучению земли

ОСОБЕННОСТИ ФОРМИРОВАНИЯ РЕСУРСОВ ПОДЗЕМНЫХ ВОД ГОРНЫХ ТЕРРИТОРИЙ АЗЕРБАЙДЖАНА

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ВВЕДЕНИЕ

Горно-складчатые зоны Азербайджана представлены азербайджанской частью Большого Кавказа, Малого Кавказа и Горным Талышом. Горный Талыш, на юго-востоке, отделен от Малого Кавказа долиной р. Араз, однако в геоструктурном районировании он рассматривается в составе Малого Кавказа.

Несмотря на то, что для разных целей, в т.ч. для водоснабжения населенных пунктов, орошения земель, водопоя скота в пределах отдельных площадей в разное время проводились специальные исследования, гидрогеологические условия горных территорий Азербайджана раскрыты не полностью.

ОСНОВНАЯ ЧАСТЬ

Для азербайджанской части горно-складчатой зоны Большого Кавказа характерно резкое расчленение рельефа с врезом гидрографической сети на 1500-1800 м, пестрота литологического состава слагающих пород, их выветренность в верхней зоне и разбитость многочисленными тектоническими нарушениями, повышенное количество атмосферных осадков, спорадически

развитый маломощный почвенный покров. Геолого-гидрогеологические условия предопределили наличие здесь трещинных и трещинно-пластовых вод в зоне выветривания и трещинно-жильных вод, приуроченных к глубинным тектоническим разломам. Отличительной особенностью азербайджанской части Большого Кавказа является то, что в геологическом отношении он представлен в основном осадочными отложениями.

Малый Кавказ, также характеризуется сильной расчлененностью рельефа, мощной зоной выветривания и трещиноватостью слагающих отложений, связанной с разрывно-тектоническими нарушениями, наличием спорадически развитого маломощного делювиального суглинистого чехла и почвенного покрова, речных долин и небольших межгорных котловин. Подземные воды не имеют строгой приуроченности к стратиграфическим горизонтам и встречаются в отложениях от современных до древнейших. Однако степень обводненности различных пород неодинакова и зависит от их состава, трещиноватости и дренированности территории. Наибольшей водообильностью отличаются известняки сильно трещиноватые, а местами закарстованные, менее обводнены вулканогенные породы и совсем слабо-интрузивные образования. Характер распределения родникового стока указывает на радиальное направление подземного стока от центра горной зоны к ее периферии и полностью аналогичен распределению поверхностного стока.

Сильная пересеченность рельефа способствующая интенсивной дренированности, ограниченность областей формирования и скудные источники питания подземных вод, обусловили сложность гидрогеологических условий Горного Талыша. В пределах региона выделяются обособленные структуры, которые представляют собой изолированные друг от друга небольшие по размеру бассейны, в пределах которых происходит весь цикл формирования подземных вод.

Геолого-гидрогеологические условия горных территорий обуславливают проявления подземных вод в виде восходящих и нисходящих родников.

Несмотря на ограниченность элювиально-делювиальных образований в Большом Кавказе, с ними связаны спорадически распространенные подземные воды. Дебиты большинства родников, этих отложений, составляют менее 1 л/с. Дебиты отдельных родников достигают до 25 л/с. Воды элювиально-делювиальных отложений пресные, с минерализацией 0,15-0,25 г/л. Воды гидрокарбонатные, кальциевые или кальциево-магниевые, изредка более сложного состава.

К ледниковым отложениям, развитым в районе высокогорных вершин Базардюзи, Шахдаг и др. приурочены постоянно действующие нисходящие родники с дебитом от 1 до 30 л/с. Минерализация вод – 0,2-0,4 г/л, химический состав – гидрокарбонатный кальциевый.

Многочисленные родники приуроченные к отложениям от четвертичного до девонского возраста в горно-складчатой зоне Малого Кавказа и в Горном Талыше, имеют в основном дебит от 0,1-1,0 до 2-3 л/с, доходя иногда до 10 л/с. В Нахчыване зафиксированы родники с дебитами 100-150 л/с. Величина минерализации родниковых вод обычно – 0,3-0,6 г/л, химический состав – гидрокарбонатный кальциевый. В Дашкесанском и Кедабекском районах встречаются сульфатные натриевые родники с величиной минерализации до 1,0 г/л.

В горных зонах наибольшее хозяйственное значение имеют подземные воды аллювиальных отложений, слагающие поймы рек и выстилающие их русла. Приуроченные к подрусловому потоку родники имеют самый разнообразный дебит. Так, например, дебит родника в пойме р. Бабачай в районе сел. Ерфи составляет 23 л/с, родника у сел. Велесли в долине р. Гейчай – 30 л/с. Воды пресные, преимущественно гидрокарбонатные кальциевые.

Мощность аллювиальных отложений в долинах рек Шамахы-Гобустанской зоны составляет в основном 5-68 м, рек Губа-Гусарской зоны – от 12,5 до 37,8 м. Дебиты скважин, составляют 0,5-8,5 л/с. Коэффициент фильтрации водосодержащих пород колеблется в пределах 1,7-14,2 м/сут. По качеству, подрусловые воды в основном пресные с минерализацией 0,5-1,0 г/л, гидрокарбонатного

кальциево-натриевого, сульфатно-хлоридно-гидрокарбонатного натриево-кальциевого составов. Встречаются слабосолоноватые воды с величиной минерализации 1,3-1,4 г/л хлоридно-сульфатного натриевого состава, приуроченные к бортам долин рек. Наибольшие расходы подрусловых вод по рекам Большого Кавказа доходят до 40-60 тыс.м^3/сут.

Мощность подрусловых отложений в Малом Кавказе меняется от 9 до 70 м, по р.р. Хачинчай, Каркарчай доходит до 96-106 м. Дебиты скважин варьируют в пределах 3-12 л/с, коэффициенты фильтрации водосодержащих пород – от 5-8 до 50-60 м/сут. Расход подруслового потока составляет 12-40 тыс.м^3/сут, а по р. Тертерчай доходит до 62 тыс.м^3/сут. Величина минерализации подрусловых вод этой зоны обычно – 0,3-0,8 г/л, химический состав гидрокарбонатный кальциевый, гидрокарбонатный натриевый.

В вулканогенно-туфовых отложениях Малого Кавказа выявлены многочисленные родники с дебитами 8-10 л/с, иногда 50-70 л/с. Величина минерализации гидрокарбонатных кальциевых вод вулканогенных отложений не превышает 0,1-0,5 г/л.

Разведочными скважинами глубиной от 40-50 до 200-250 м в Большом Кавказе вскрыты безнапорные и напорные воды в отложениях четвертичного, палеоген-неогенового, мелового и юрского возрастов. Уровни безнапорных вод устанавливаются на глубине от 0,5-1,0 м до 10-57 м, дебиты скважин меняются в пределах 0,8-5,5 л/с. Дебиты скважин пробуренных на напорные воды меняются от 0,8 до 10 л/с, пьезометрические уровни устанавливаются как ниже – на глубине 5-8 м, так и выше на (+) 0,8-4,0 м от дневной поверхности. Наибольшие дебиты приурочены к песчанистым и известковым отложениям. Коэффициенты фильтрации водосодержащих пород колеблются в широком диапазоне в пределах от 0,01-0,2 до 12-15 м/сут.

Величина минерализации вскрытых скважинами подземных вод Большого Кавказа меняется от 0,3-0,5 до 8-10 г/л, химический состав весьма пестрый, встречаются всевозможные сочетания анионов и катионов.

В горно-складчатой зоне Малого Кавказа и в Горном Талыше безнапорные и напорные воды вскрыты разведочными и эксплуатационными скважинами глубиной до 250-300 м. Дебиты скважин 0,1-4,2 л/с. Напорные воды в Малом Кавказе связаны преимущественно с тектоническими нарушениями и трещинами. Дебиты скважин пробуренных на напорные воды меняются в пределах 0,8-12 л/с.

Величина минерализации безнапорных и напорных подземных вод Малого Кавказа меняется от 0,3-0,5 до 20-22 г/л, химический состав пестрый и изменчивый.

Наблюдается определенная закономерность в распределении химического состава и величины минерализации подземных вод Большого Кавказа. С северо-запада на юго-восток по мере снижения гипсометрических отметок возрастает общая минерализация и состав воды изменяется от гидрокарбонатного кальциевого до гидрокарбонатного натриевого и даже сульфатного натриевого, что связано с увеличением глинистости водовмещающих пород, уменьшением расчлененности рельефа и снижением количества атмосферных осадков. В пределах Большого Кавказа накопление подземных вод и пути их движения обусловлены тектоническим строением региона, наличием зоны выветривания, развитием многочисленных трещин и тектонических разрывов, а также структурно-текстурными особенностями флишевого комплекса и метаморфических пород. Эти особенности условий накопления и движения подземных вод в горной зоне обуславливают процесс формирования подземных вод глубокой циркуляции, приобретающих характер минеральных. С тектоническими разрывами северо-западного направления связаны выходы минеральных и термальных вод, что определяет линейное расположение источников. К основным линиям приурочены термальные воды, а к ответвлениям – холодные минеральные источники.

Источники минеральных вод в Большом Кавказе расположены в Гахском (с минерализацией 0,9-1,2 г/л, дебитами 0,4-2,2 л/с), Огузском (минерализация 0,7-1,1 г/л, дебиты 0,06-1,2 л/с), Габалинском (минерализация 0,03-1,1 г/л, дебитами 0,4-2,2 л/с), Исмаиллинском (минерализация 0,5-16 г/л, дебиты 0,01-0,02 л/с), Шамахинском районах (минерализация 0,3-1,8 г/л, дебиты 0,02-0,3 л/с). Ряд источников характеризуются повышенной температурой. В этом отношении следует отметить источники Илису с температурой воды 40°С и Курмух с температурой 30,5°С в Кахском районе, Бумские источники с температурой 39,4°С в Гебелинском районе, Халхалские источники с температурой 32°С в Огузском районе, Чаганские источники с температурой 32°С в Шамахинском районе. Воды этих источников в основном слабоминерализованные с величиной 0,3-1,7 г/л, по химическому составу гидрокарбонатно-сульфатные натриево-кальциево-магниевые, ощущается запах сероводорода.

Отличительной особенностью минеральных вод азербайджанской части Большого Кавказа является то что, здесь, в отличие от других частей этого горного сооружения не встречаются углекислые воды и практически все воды сероводородные. Ряд из источников содержат йод, бром, бор, силикаты.

Подавляющее большинство минеральных, в т.ч. и термальных вод Азербайджана сосредоточено на Малом Кавказе. В Кельбаджарском районе известны источники Истису, Боядлы, Багырсах, Готурлу, Тутгун и др. (минерализация 2,0-6,3 г/л, дебиты 0,02-1,4 л/с), в Лачинском районе – Минкенд, Дамгалы, Шамкенд, Туршсу, Ахмедли и др. (минерализация 0,4-3,7 г/л, дебиты 0,02-2,5 л/с), в Кедабекском районе – Чалдаш, Хар-хар, Славянка, Союдлу и др. (минерализация 0,6-1,5 г/л, дебиты 0,01-0,2 л/с), в Дашкесанском районе – Алаханчаллы, Дашкесан. (минерализация 2,5-2,8 г/л, дебиты 0,05-2,8 л/с), в городе Шуша – Туршсу (минерализация 1,05 г/л, дебиты 0,01 л/с), в Гадрутском районе – Туг, Доми (минерализация 1,2-1,4 г/л, дебиты 0,02-0,6 л/с). В этом отношении особое место занимает горная зона Нахчывана. Здесь проявляются известные Бадамлы, Сираб, Вайхыр, Нагаджир, Тиви и др. источники, с весьма широким диапазоном изменения минерализации от 0,5 до 7,4 г/л и дебитов от 0,02 – до 7,6 л/с. Эти воды, в основном углекислые.

По термальным свойствам, Кельбаджарская группа источников (Нижний и Верхний Истису, Багырсах, и др.) имеет температуру 28-74°С, воды по химическому составу гидрокарбонатно-хлоридные натриевые, содержат радон, стронций, титан, бром и др. микроэлементы. Минкед-Ахмедлинская группа источников углекислых вод характеризуется более низкой температурой (22-29,5°С), химический состав подземных вод гидрокарбонатно-хлоридный натриевый. Нахчыванская группа характеризуется слаботермальными подземными водами. Температура источников Вайхыр, Нагаджир, Джульфа 22-26°С, из скважин получена вода с температурой 41-52°С, с хлоридным натриевым химическим составом. Вайхырская и Нагаджирская воды с гидрокарбонатным натриевым химическим составом.

Если геолого-структурные и литофациальные особенности предгорных порово-пластовых бассейнов подземных вод, общность источников питания обуславливают тесную гидродинамическую связь между безнапорным и напорными водоносными горизонтами, в горных бассейнах порово-трещинных вод несколько другая картина. В Малом Кавказе подземные воды, приуроченные к трещинам связанным с интрузиями, в большей степени питают локальные площади распространения поровых вод. В Большом Кавказе трещины в осадочных отложениях питаются в основном атмосферными осадками, то есть источники питания поровых и трещинных вод общие. Практически отсутствует связь между подземными водами разных трещин.

РЕКОМЕНДАЦИИ

Считается целесообразным:

– комплексное исследование условий формирования подземных вод;

– региональная оценка ресурсов подземных вод Большого Кавказа, Малого Кавказа и Горного Талыша;

– разработка схемы интегрированного использования водных ресурсов;

– создание и усовершенствование мониторинга подземных вод.

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Water Economy

MARKET ECONOMY AND HYDROGEOLOGICAL-MELIORATIVE STATE OF IRRIGATIVE SOILS UNDER NEW REFORMS CONDITION

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ABSTRACT: The decisions have been received for rational utilization from irrigative soils, the available hydrogeological-meliorative condition has been studied and its improvement measures have been grounded under market economical condition.

KEYWORDS: hydrogeological-meliorative condition, paying use from water, Water Users Association, irrigating land.

The reforms in melioration and water economy are conducted with the reforms in an agrarian field in connection with transition to the market economy in the Republic of Azerbaijan. In this connection the new structures which can act more quickly under the market economy condition are formed, a part of the water economy objects are rented for the water users.

As a result of abolition of kolkhozes and sovkhozes in connection with the conducted reforms in the agrarian industrial complex, 56.5 thousand km of irrigative canals, (25.8 thousand km), the collector drainage nets in a length of 25.8 thousand km, 107 thousand different hydrotechnical plants, 795 pumping stations, other home economical objects in their balance have been given to the Azerbaijan Melioration and Water Economy ASC balance by the Republic Ministers Cabinet's special decision since 2000. At present the effective measures are fulfilling for normal activity of these systems which are in difficult situation.

According to the market economy, the melioration is begun to be performed over irrigation services and use licenses of water and paying usage principles. At present more than 550 Water User Associations act in the republic corresponding to the normative-juridical documents being received on the basis of the laws about "Azerbaijan Republic Water Code", "Bases of Agrarian Reforms", "Melioration and Irrigation", "About Institutions", for the purpose of protection of the land owners and water users' rights and benefits. These associations are busy with the water provision problems of 46% of total irrigative areas, or 628 thousand hectare of the area.

Formation of associations is intended by surrounding irrigative soils wholly. The scientific-methodical and technical assistance is rendered to the associations' activity by Azerbaijan Melioration and Water Economy ASC.

A main purpose in associations' formation consists of creation of inter-economical melioration and irrigation systems exploitation and protection, sharing of irrigative water among association members, provision of rational usage of water, collecting of water compensation, and solution of arguments appeared during water use and other problems.

The further activity of the associations will assist for transition to self-controlling in the following system, holding of the systems, economizing on separable budget means and transition of this field to the whole self-financing.

All the available chances were mobilized in connection with situation which appeared in water use of the country economy, especially agriculture. The additional measures were performed over enhancements of rationality of exploitation and repair-restoration works, using from local and other alternative water resources widely.

According to Azerbaijan Republic Ministers Cabinet's decision number of 150 with a date of October 26, 1996 "About approval of regulations (statue) of the rules of paying use from water in the Republic of Azerbaijan" from irrigative water was passed to paying use by stages in the republic beginning from January 1, 1997.

A main purpose in fulfillment of paying use from water is to provide using of the water resources rationally and economically and consists of improvement of technical state in hydromeliorative systems. Paying use of water enhance an economic interest of the producers and consumers and makes a chance for bearing of state charges directed to reliable water maintenance, keeping strict count of water.

The water tariff is realized according to the regions and districts depending on natural climate condition, water resources maintenance, irrigation sources type and technical standard of irrigation system, irrigation techniques and methods, economical and social state of economy.

An importance of the economical rationality increase of the new economical forms (farmer, cooperative and private good management) which are developed under economical reforms condition in the country is great.

A total area of the irrigative soils was 1424.4 thousand hectare in January 1, 2014, the same areas were provided with the complex melioration as a drained area in 609.4 thousand hectare in the Republic [1].

Subsoil waters of irrigative soils are near the surface till 2.0 m in 372.5 thousand hectare, and they are at a more depth than the surface in 1037.2 thousand hectare. 266.4 thousand hectare or 18,7% of irrigative soils is salinized weakly; 239.7 thousand hectare or 16,8% is salinized to at mean, strong and very strong degree.

Improvement of hydrological-meliorative state in soils is required in 237 thousand hectare or 16.6% of soil areas. New collectors drainage nets of these soils must be built in 105.6 thousand hectare, but the available collector-drainage systems should be repaired in 131.5 thousand hectare [1]. Beside it, fundamental leaching in 503.8 thousand hectare of salinized area, chemical melioration in 36.5 thousand hectare of area, conduction of the fundamental smoothness works in 22.1 thousand hectare of area, enhancement of water maintenance corresponding to the tillage areas structure in 25.7 thousand hectare, construction of the irrigative nets in a complex form again in 61.5 thousand hectare of area. The problems are created in accordance with 94 thousand hectare from strong and very strong salinization, 35.5 thousand hectare from mean and strong solonetzification and approach (till 1.0 m) of 18 thousand hectare of subsoil waters the surface enhancement of mineralization limit of irrigative water (more than 3.0 g/l) in 294.2 thousand hectare, being of meliorative condition in the satisfactory state in 237.1 thousand hectare by exposing of 506.2 thousand hectare of irrigative soils to salinization.

Hydrogeological-meliorative condition in 1248769 hectare of general irrigative soils is controlled by the net which was formed in hydrometric station on 18 main irrigation canals and collectors consisting of 8692 regime-observation wells. At present the zones of the hydrogeological-meliorative condition which are under control occupy Shirvan, Mughan-Salyan, Mil, Garabagh arrays of the whole Kur-Araz plain and also irrigative soils of Ganikh-Ayrichay, Masalli-Lankaran and Samur-Absheron irrigation arrays. Long utilizing and available hydrogeological-meliorative regime-observation net gives a chance to compose maps for slope depth of subsoil water and its mineralization, to control the meliorative condition of soils, to correct irrigation regime, to improve technical state of collector-drainage net and to maintain an efficiency of the meliorative measures.

The state program "About Reliable Provision" of population with food products in 2008-2015 in the Republic of Azerbaijan and fulfillment of "Constant Development State Program" in melioration and water economy of the Azerbaijan Republic approved by the president's disposal with date of August 25, 2008 will change water maintenance of the whole regions fundamentally, meliorative condition will be improved in soils to a significant degree, an opportunity will be made for drawing of thousands hectare of irrigative soil areas good for use into crop rotation in agriculture.

For this purpose 16 water stores of which total capacity is 772 thousand cubic meters, irrigative canals in 825 km of length, protector dike in 118 km of length will be built, 434 thousand hectare of new irrigation soil areas will be given for use, water maintenance of irrigative areas more than 385 thousand hectare and meliorative condition of 256 thousand hectare or area will be improved for fulfillment of the measures intended in both Programs. All the further measures will make a situation for enhancement of productivity in soil and increase of product manufacturing for 1.5-2.0 times on average.

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Environmental protection

LONG-WAVE BALANCE OF GRASS SURFACE AND FALLOW IN WROCŁAW-SWOJEC

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ABSTRACT: Long-wave radiation balances of surfaces with grass and without grass (fallow) in the years 1961-2014 were compared. Balance components were calculated on the base of results from continuous actinometric measurements, realized in Wrocław-Swojec Observatory in the period VIII 2007 – IV 2014. The base of calculation was hourly values of long-wave radiation from grass surface, fallow and atmosphere, registered in analyzed time. In first research stage their daily courses for particular months and daily means for following days in 7 years period (2007-2014) were compared. Year by year changes of measured radiation values and values of its balances were analyzed too. In the next stage multiple regression equations, combining values of long-wave radiation of grass surface, fallow and atmosphere with elementary meteorologic elements, mainly air temperature, humidity, vapour pressure deficit, precipitation, evaporation and insolation, were derived. On the base of these equations with very high determination index ($R2 \approx 0.99$) and relative small estimation error, there were calculated missing values from the years 1961-2007. The equation were verified with the cross-validation method (LOO version), to avoid using to many parameters in equations. Meteorologic data using in reconstruction came from standard meteorologic, evaporometric and actinometric measurements have realized in Wrocław-Swojec Observatory since 1961. Research revealed not only higher values of radiation from fallow than grass area, but also that compared; measured values of long-wave radiation from these surfaces are considerably higher than values of atmospheric long-wave back radiation. In reconstructed 54-years period were besides noticed stronger increasing trend of radiation from fallow than grass surface. It shows that in local scale, clearly buffer effect of plant cover occurs, against to contemporary taking place climate changes. In comparison with fallow, representing to large extent urban surfaces without plant cover, in analyzed climatic effects of grass radiation are observed moderating characteristics of sustained plant cover. These characteristics are favorable for agriculture and forest area topoclimate forming. Apart from biophysical qualities of grass surface it is connected with its albedo and evapotranspiration, which is stronger than transpiration of fallow.

KEYWORDS: long-wave radiation balance, long-wave radiation, grass, fallow, atmosphere, topoclimate.

Охрана окружающей среды

ДЛИННОВОЛНОВОЙ БАЛАНС РАДИАЦИИ ПОВЕРХНОСТИ ТРАВЫ И ПОЧВЫ БЕЗ РАСТЕНИЙ ВО ВРОЦЛАВЕ-СВОЙЦЕ

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ВВЕДЕНИЕ

В современное время местные изменения землепользования переплетаются с общим трендом уменьшения сельскохозяйственной и лесной территории. Существуют предпосылки, что экспансия антропогенического пространства без растительного покрова обуславливают продолжительные топоклиматические последствия, которые могут оказывать влияние на изменчивость климата в больших пространственных масштабах. Существующие исследования доказывают, что растительный покров исполняет роль своеобразного буфера по отношению к происходящей изменчивости климата в общем характере (Bryś 2010; Bryś и Bryś 2003, 2007; Kędziora 1999; Olejnik и др. 2002). Точное определение этих зависимостей требует распознания механизмов течения энергии, которые вызывают изменения баланса солнечной радиации разных поверхностей.

Цель исследований – это сравнение динамики длинноволнового баланса радиации поверхности травы и почвы без растений с 2007 по 2014 год, а даже реконструкция хода длинноволновой радиации этих контрастных поверхностей во Вроцлаве-Свойце с 1961 по 2014 год. Агро - и гидрометеорологическая Обсерватория Вроцлав-Своец расположена на востоке города Вроцлав (юго-западная часть Польшы) в его периферийной, земледельческой части (51º07' N, 17°10' E) на высоте 118 метров выше уровня моря.

МЕТОДИКА ИССЛЕДОВАНИЙ

Все компоненты остаточной солнечной радиации Q* [W·m^{-2}] над поверхностью травы и над поверхностью без растений были измерены пиранопиргеометром CNR-1 (фото1). Радиационный баланс является суммой коротковолнового ***K**** и длинноволнового ***L**** баланса в соответствии с формулой (Oke 1995, Paszyński и др. 1999):

$$Q* = K\downarrow - K\uparrow + L\downarrow - L\uparrow \qquad (1)$$

где: $Q*$ – остаточная солнечная радиация [W·m^{-2}];
$K\downarrow$ – суммарная солнечная радиация [W·m^{-2}];
$K\uparrow$ – отраженная радиация [W·m^{-2}];
$L\downarrow$ – встречное излучение атмосферы [W·m^{-2}];
$L\uparrow$ – излучение земной поверхности [W·m^{-2}];
$K* = K\downarrow - K\uparrow$ – коротковолновой баланс (0,1–4 μm);
$L* = L\downarrow - L\uparrow$ – длинноволновой баланс (4 μm–80 μm).

На основе суточных данных всех этих компонентов, измеренных с августа 2007 по апрель 2014 года, выведены формулы уравнений регрессии, чтобы сделать реконструкцию хода *Q** (остаточной солнечной радиации) и её компонентов с 1961 по 2014 год во Вроцлаве-Свойце. Этими исследованиями занималась Брыс (2013). В этих исследованиях использованы:

– статистический анализ вариации ANOVA;

– тест *cross validation*;

– анализ хода 12-месячных скользящих осредненных величин.

Фото 1. Датчики пиранопиргеометра CNR-1, наблюдающие остаточную солнечную радиацию *Q** **поверхности травы и почвы без растений с аугуста 2007 по апрель 2014 года во Вроцлвве-Свойце**

АНАЛИЗ РЕЗУЛЬТАТОВ НАБЛЮДЕНИЙ
(с августа 2007 по апрель 2014 года)

Измерения суммарной солнечной радиации K↓ во Вроцлаве-Свойце с августа 2007 по апрель 2014 года проявляют динамику летнего и зимнего сезона (рис.1). Величины колебались с 20,4 Wm^{-2} (декабрь 2007 и 2009) по 259,2 $W{\cdot}m^{-2}$ (в июне 2008 года). Тренд в этом периоде оказался отрицательным, но незначительным.

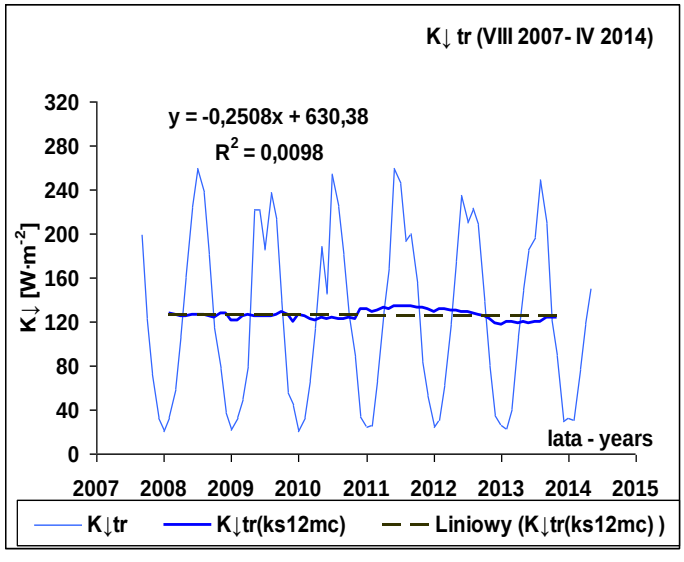


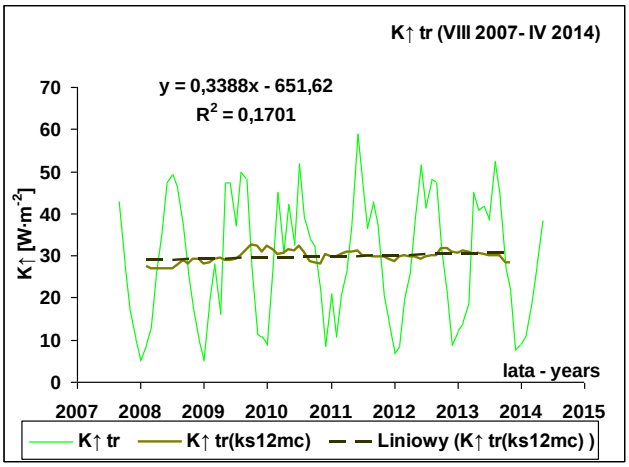
Рис. 1. Ход суммарной солнечной радиации K↓ во Вроцлаве-Свойце с августа 2007 по апрель

Ход отраженной от поверхности травы K↑tr и отраженной от почвы без растений K↑ug радиации значительно больше отражения коротковолновой энергии от поверхности травы K↑tr (рис. 2).

В вегетационном сезоне альбедо травы больше чем альбедо поверхности без растений, которая нагревается болше и изменяет цвет на светлый. Зимой альбедо поверхности увеличивается. Это зависит от снежного покрова и его толщины (рис.3).

Встречное излучение атмосферы L↓atm в периоде 2007-2014 (рис.4 – ниже) значительно меньше величины излучения земной поверхности с травой L↑tr и поверхности без растений L↑ug (рис. 4 – выше).

Наблюдающие в зимних месяцах величины потока встречного излучения атмосферы L↓atm отличаются малой суточной изменчивостью (до ок. 10-15 $W \cdot m^{-2}$). В тёплых месяцах средняя суточная изменчивость была отчётлива и достигала даже 40 $W \cdot m^{-2}$ (в июле 2008 года). Амплитуда колебаний в месячном ходе – это минимум 261,1 $W \cdot m^{-2}$ в феврале 2012 г. и максимум 374 $W \cdot m^{-2}$ в июне 2010 г. Это указывает на решающее влияние температуры и способность эмиссии атмосферы, которые представляют целые процессы абсорбции и эмиссии всех компонентов воздуха. Колебания потока L↓atm возникли даже из изменений влажности, облачности и загрязнения атмосферы.



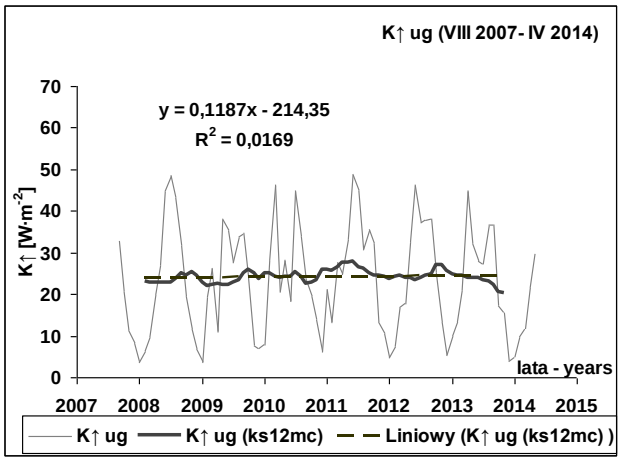


Рис. 2. Ход отраженной от поверхности травы K↑tr и отраженной от почвы без растений K↑ug солнечной радиации и ход 12-месячных скользящих осредненных величин и их линейного тренда (Liniowy) во Вроцлаве-Свойце с августа 2007 по апрель 2014 года

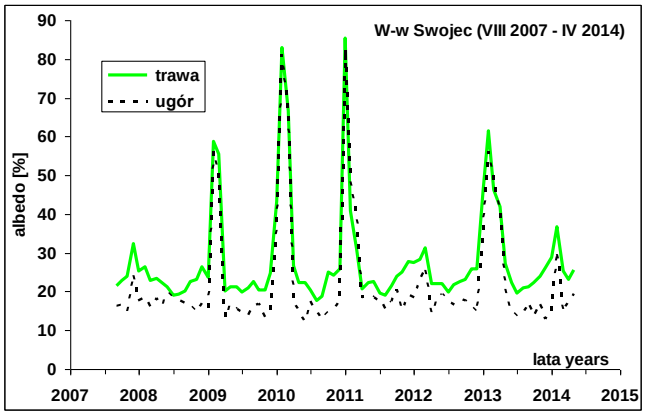
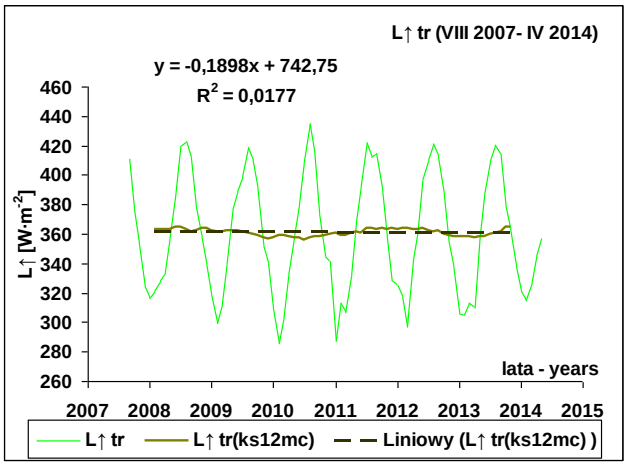
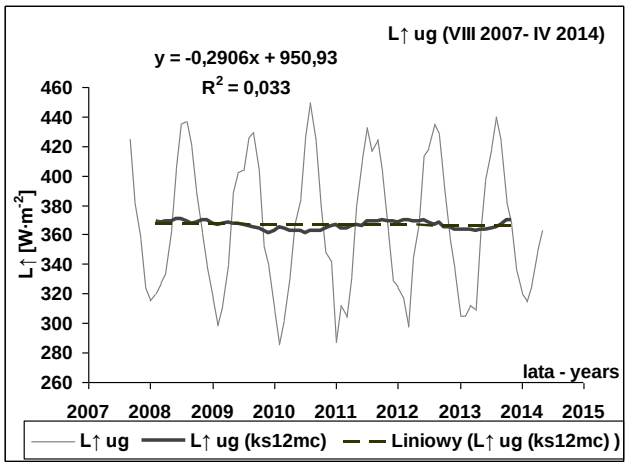


Рис. 3. Альбедо поверхности травы (trawa) и поверхности без растений (ugór) во Вроцлаве-Свойце с аугуста 2007 по апрель 2014 года





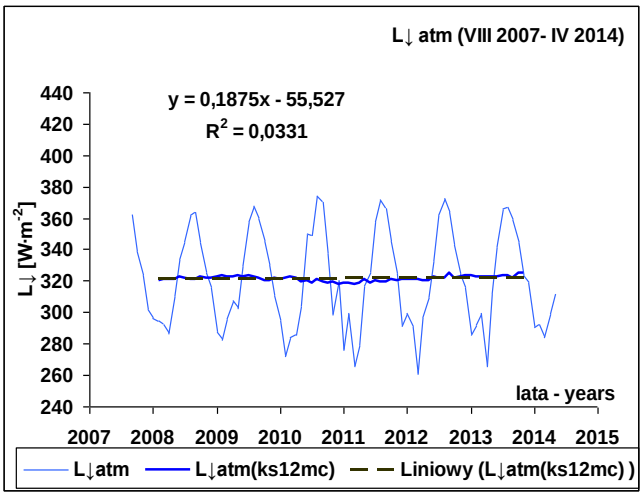


Рис. 4. Излучение земной поверхности травы L↑tr и поверхности без растений L↑ug, ниже - встречное излучение атмосферы L↓atm а даже на всех графиках ходы 12-месячных скользящих осредненных величин и их линейного тренда (Liniowy) во Вроцлаве-Свойце с августа 2007 по апрель 2014 года

Излучение земной поверхности с травой L↑tr оказалось ниже чем излучение поверхности без растений L↑ug (рис. 5).

С августа 2007 по апрель 2014 года появляются положительные тренды длинноволнового баланса, которые очень обеспеченные и существенные для поверхности без растений (L*ug).

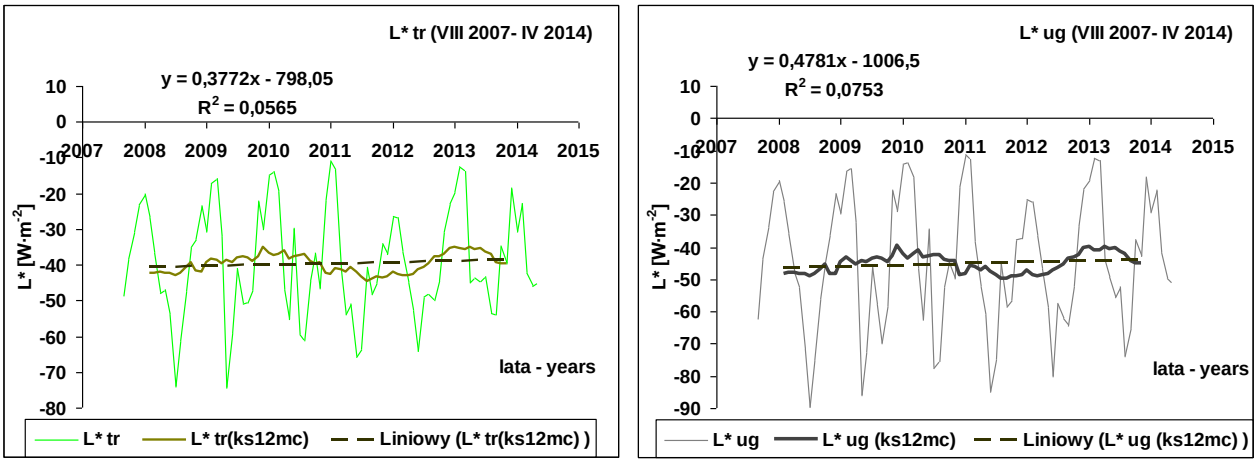


Рис. 5. Длинноволновой баланс травы L*tr и поверхности без растений L*ug, а также на 2 графиках ходы 12-месячных скользящих осредненных величин и их линейного тренда (Liniowy) во Вроцлаве-Свойце, с августа 2007 по апрель 2014 года

РЕКОНСТРУКЦИЯ КОРОТКОВОЛНОВОГО И ДЛИННОВОЛНОВОГО БАЛАНСА
(с января 1961 по апрель 2014 года)

Многолетние наблюдения суммарной солнечной радиаций (рис. 6 – ниже) во Вроцлаве (1961-2014) и современные наблюдения датчиками новой генерации **(**CNR-1) дали возможность реконструкции компонентов коротковолнового и длинноволнового баланса. Используя методы множественной регрессии, восстановлен приблизительный, многолетний ход и тенденция баланса остаточной солнечной радиации над поверхностью, покрытой растительностью и без растений с января 1961 г. по апрель 2014 года. На рис.6. (ниже) указаны тренды суммарной солнечной радиации K↓ во Вроцлаве-Свойце. Ходы скальзащих осреднёных величин (12-месячных) указывают на волновой характер явления. Для остаточной солнечной радиации (рис. 6 – выше) тренды изменяются на противоположные в переломе 70/80 годов двадцатого века. В климатологической литературе

этот перелом называется затемнением (dimming) - до 80 лет и прояснением (brightening) с 80 лет до сих пор (Stanhill, 2007).

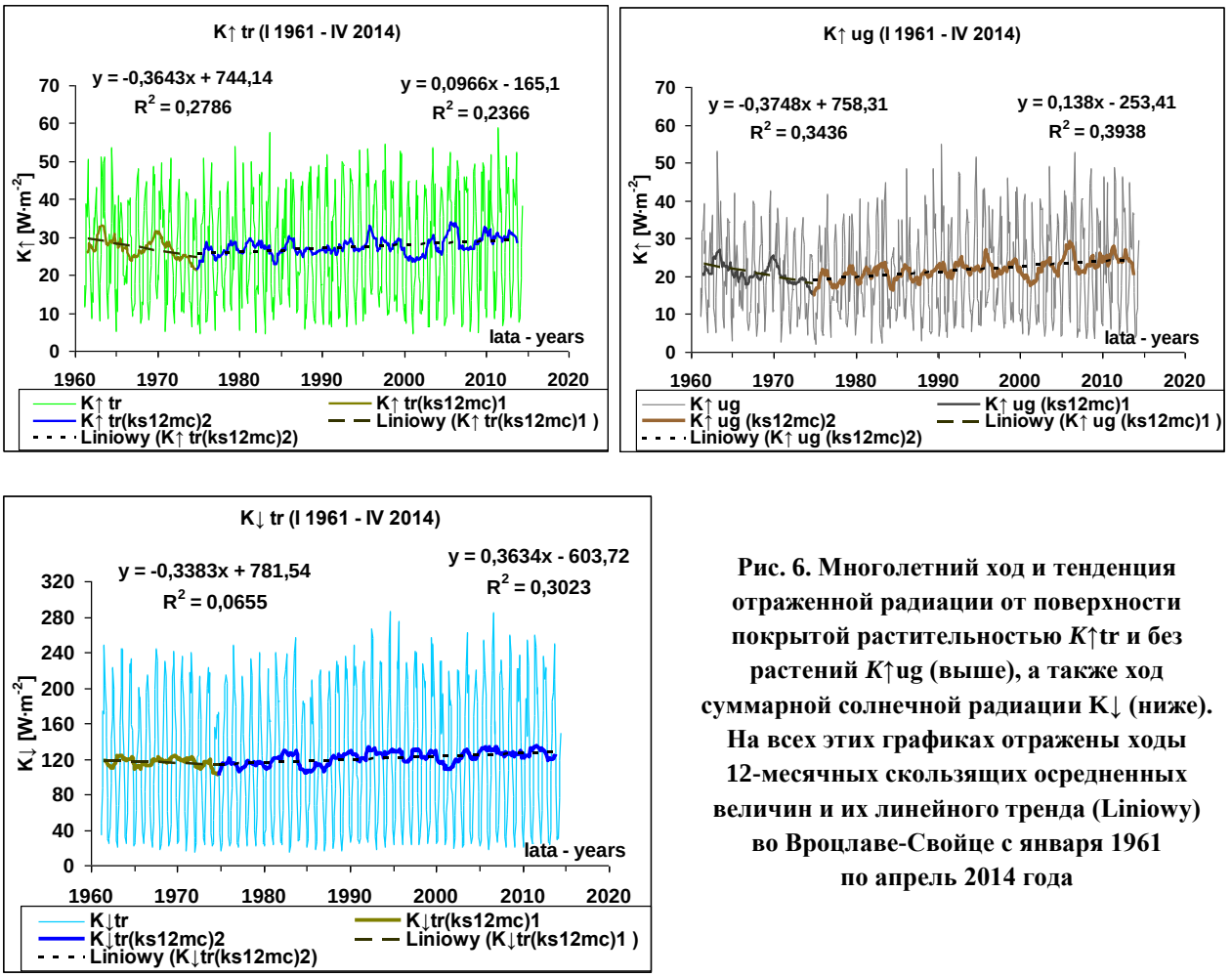
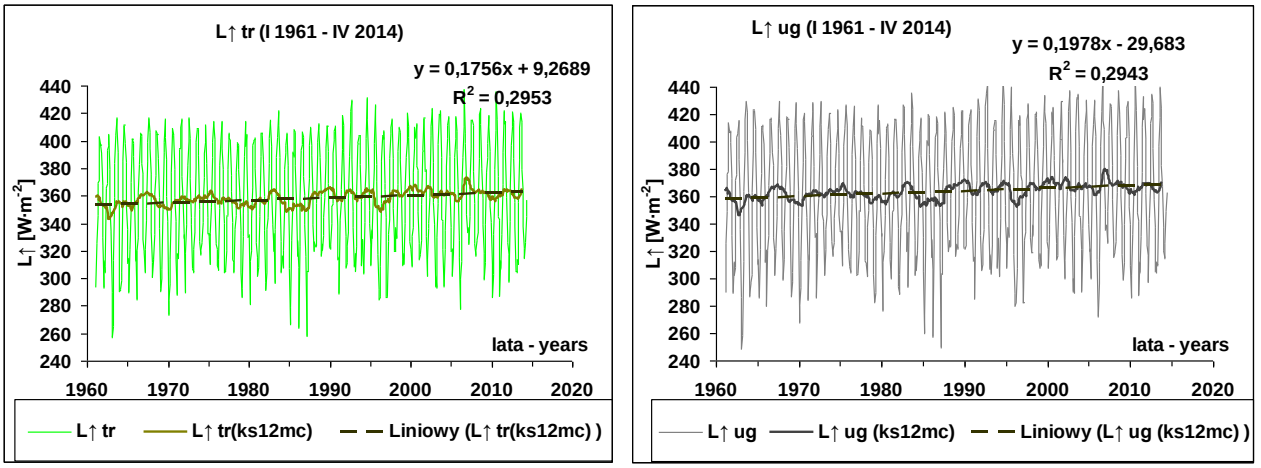


Рис. 6. Многолетний ход и тенденция отраженной радиации от поверхности покрытой растительностью *K*↑tr и без растений *K*↑ug (выше), а также ход суммарной солнечной радиации K↓ (ниже). На всех этих графиках отражены ходы 12-месячных скользящих осредненных величин и их линейного тренда (Liniowy) во Вроцлаве-Свойце с января 1961 по апрель 2014 года

Статистические расчеты дали возможность реконструкции хода величин для встречного излучения атмосферы L↓atm (рис. 7 – ниже) и излучения земной поверхности травы L↑tr и поверхности без растений L↑ug (рис.7 – выше) с января 1961 по апрель 2014 года.



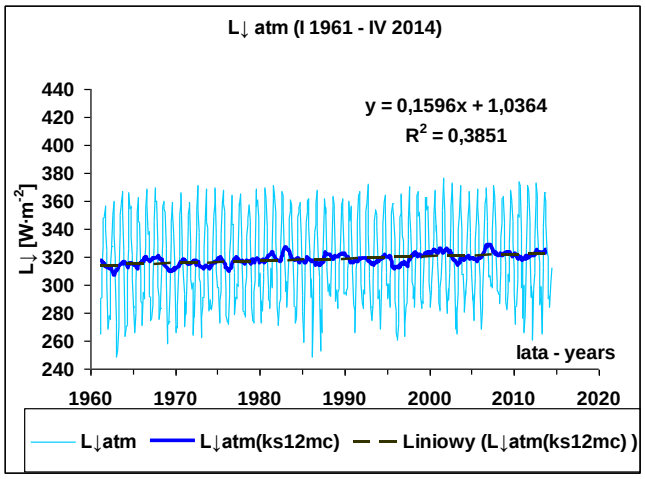


Рис. 7. Излучение земной поверхности травы L↑tr и поверхности без растений L↑ug (выше), а также встречное излучение атмосферы L↓atm (ниже). На всех графиках ходы 12-месячных скользящих осредненных величин и их линейного тренда (Liniowy) во Вроцлаве-Свойце с января 1961 по апрель 2014 года

В реконструкции факторов длинноволнового баланса с января 1961 по апрель 2014 года, обнаружено больший положительный тренд излучения поверхности без растений L↑ug, чем для травы L↑tr. Это свидетельствует о появлении в топоклиматическом масштабе отчётливого буферного эффекта растительного покрова в отношении к современным изменениям климата.

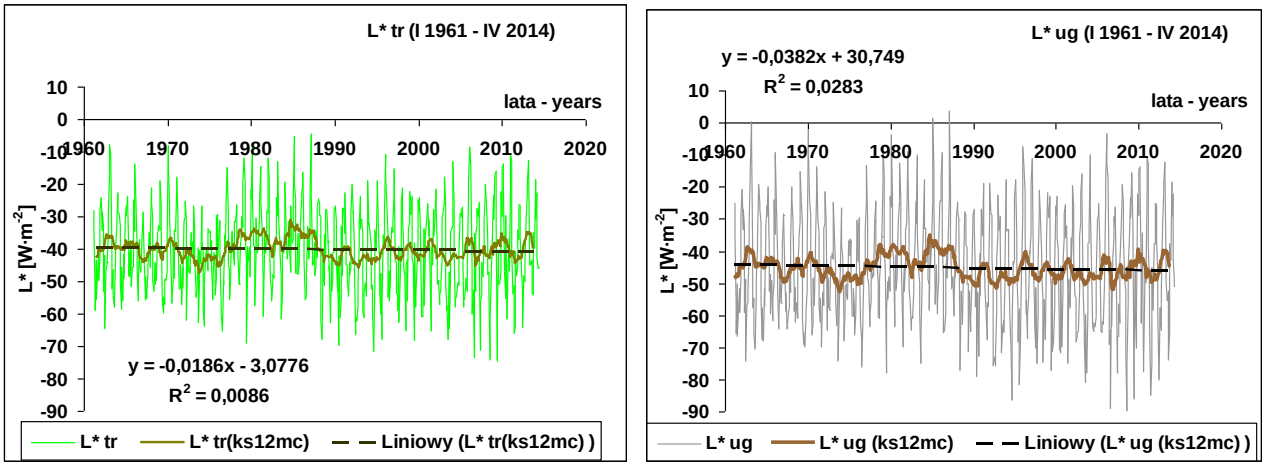


Рис. 8. Длинноволновой баланс земной поверхности травы L*tr и поверхности без растений L*ug, а также ходы 12-месячных скользящих осредненных величин и их линейного тренда (Liniowy) во Вроцлаве-Свойце с января 1961 по апрель 2014 года

Знаменательной особенностью исследованных ходов длинноволнового баланса этих контрастных поверхностей (рис. 8) является волновой характер их изменчивости, проявляющий наиболее сильно в 80-ых годах двадцатого века. Существенное буферное влияние покрова растений на климатологические последствия воздействия солнечной радиации на активную поверхность – это эффект термоизоляционных и транспирационных свойств растительного покрова. Растительность – это важный буфер, который смягчает глобальное потепление.

ВЫВОДЫ

1. Исследования обнаружили не только большие длинноволновые излучения земной поверхности без растений L↑ug чем поверхности с травой L↑tr, но также факт, что встречное излучение атмосферы L↓atm оказалось ниже чем L↑tr и L↑ug.

2. Динамика воздействия связана с альбедо, которое для поверхности травы больше, чем для поверхности без растений.

3. Изменчивость длинноволнового баланса L* и его факторов (L*↑tr, L*↑ug, L↓atm) обусловлены не только многолетними изменениями в коротковолновом балансе (K*), но также многолетней динамикой термики и влажности атмосферы и её подстилающего слоя.

4. Растительный покров (трава) в сравнении с поверхностью без растения (пар) смягчает появление сильных изменений (величины и знака положительных и отрицательных трендов) и их многолетних колебаний.

5. С августа 2007 по апрель 2014 появляются положительные тренды длинноволнового баланса, которые очень обеспеченные и существенные для поверхности без растений (L*ug). Они противоположны для наследственной тенденции L* в периоде с января 1961 по апрель 2014 года, которая здесь существенная только для пара L*ug.

6. Значительной особенностью исследованных ходов длинноволнового баланса этих контрастных поверхностей является волновой характер их изменчивости, проявляющий наиболее сильно в 80-ых годах двадцатого века.

7. В исследованных радиационных ходах контрастных поверхностей отражаются существенные разницы между растительной средой и почвой без растений в сфере особенностей абсорбции суммарной солнечной радиации, а также эмиссии длинноволновой энергии (теплоты).

8. Исследования указывают на необходимость охраны растительного пространства – буфера, который смягчает отрицательные эффекты общего потепления.

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Environmental protection

THE LABORATORY RESEARCH OF RESOURCE SAVING BIOENGINEERING MEASURE (GEO MAT „LUFFAEROMAT") AGAINST SOIL DEGRADATION RUNNING ON THE VULNERABILITY MOUNTAIN SLOPES

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ABSTRACT: Against soil degradation exist many measure (engineering, forest-reclamation measures, geo mats), from them distinguished geo mats with their effectively. In the world is known many geo mat against erosion degradation (Jute Mat, Covamat, Eromat and etc.), but many of them produced as a result of difficult process of plants biomass processing, making its sewing thread and knitting, which is also important restrictive factor for using geo mats.

With considering above mentioned, we propose geo mat ,,Luffaeromat", which are made easily, particularly from naturally prepared fiber-labyrinth inner of plant Luffa dry fruit, which after cutting along length, connect to each other with hemp yarn joint and create united geo mat.

For study soil protectable characteristics of geo mat ,,Luffaeromat", carried out laboratory research on it, positive results received on the base on its laboratory research show us necessity its research in the field conditions, to ultimately determine expediency of introduction of geo mat,,Luffaeromat" to achieve stabilization of vulnerability slopes.

KEYWORDS: erosion, geo mat, vulnerability.

INTRODUCTION

As you are aware, soil erosion occurs mainly on vulnerable burnt mountain slopes, burnt forest areas, road, rail and energy corridors, natural technogenic slopes, provoking debris flows and landslides, therefore causing significant harm to the ecological security of the country and its economy. Therefore, very urgent matter is anti-erosion measures of modern innovation and timely implementation.

BASIC PART

In the World is known numerous measures against soil erosion (engineering, forest-reclamation, geomats made of various materials), but in the condition of big grade slopes (20°-60°), use of them contains risks.

Among these measures, lately great attention is paid to geomats (Jute Mat, Covamat, Eromat etc), because they are characterized by a large slope stabilization and restoration of biodiversity in an instant.

Therefore, have proposed of our geomat "Luffaeromat" which is made easy, most of them are produced by plants' biomass processing, converting into thread and complex process of knitting, longitudinal sections of plant Luffa's dry fruit, naturally having labyrinthine fiber structure, are connected with hemp thread stitches forming the whole geomat (see fig. 1, 2).

Fig. 1. Initial and final state of Plant Luffa's mature fruit

Fig. 2. Overall view of geomat „Luffaeromat" created as a result of longitudinal section and connection of Luffa fruit

The positive results of small-scale preliminary laboratory works conducted by us in advance with the aim of specifying the efficiency of our product (geomat „Luffaeromat"), particularly: The soil (with the density close to that of natural soil) taken from the burnt eroded slopes that was covered by geomat „Luffaeromat" was dropped in a 0.5 m^2 sized box and the mixture of soil and grass seeds was put in its labyrinthine fiber layer (see. Fig.3.). During the experiment in laboratory measures air temperature and humidity with one hour interval (see Fig. 4.), which average meanings and schedule of depend height of plural shoots meaning on the time are presented on the Fig. 5, 6, 7.

As it was expected, a small-scale laboratory research on geomat „Luffaeromat" showed positive results (see Fig. 8, 9) that convinced us of the necessity of conducting a large scale research in the natural

environment in future, in order to verify anti-erosion efficiency of geomat ,,Luffaeromat" and confirm the possibility of biodiversity restoration.

Fig. 3. Beginning of the laboratory experiment carried out on geomat „Luffaeromat"

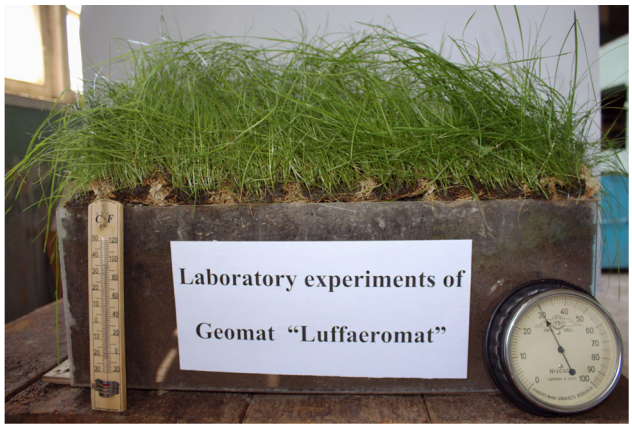

Fig. 4. Overall view. Geomat „Luffaeromat", one month after installation

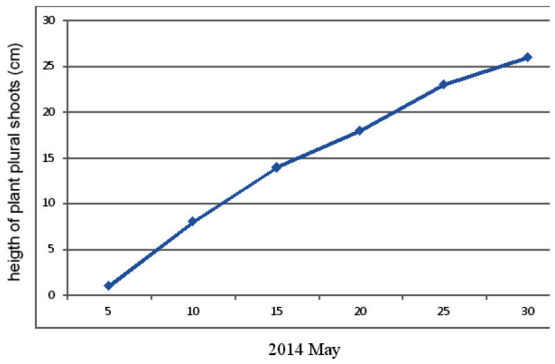

Fig. 5. Schedule of depend height of plural shoots meaning on the time

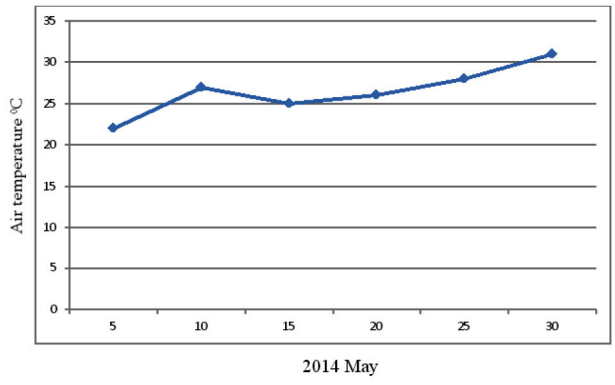

Fig. 6. Schedule of depend temperature on the time

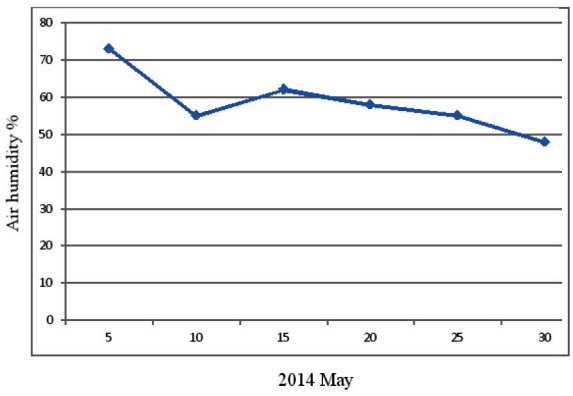

Fig. 7. Schedule of depend humidity on the time

Fig. 8. Geomat „Luffaeromat". Top view. One month since installation.

Fig. 9. Geomat „Luffaeromat" fragment (section). Side view.

We have created the geomat "Luffaeromat" the opportunity lies in the following:

1. The geomat "Luffaeromat" can be used against erosion of slopes inclined by 60^0 degrees, and for restoring the biodiversity. It is fixed with anchors inserted into curved (thick) surfaces of the ground (see fig. 10) ensuring additional stability of the vulnerable slopes.

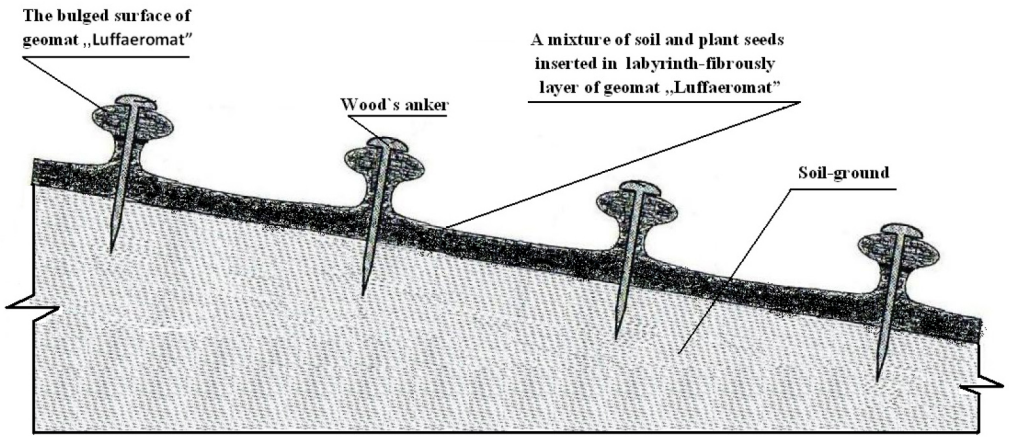

Fig.10. Scheme of geomat installed on a slope.

2. The labyrinthine fiber layer of „Luffaeromat", covered with the mixture of plant seeds and soil, reduces rainwater infiltration characteristics and ensures the moderate infiltration in depth of slopes avoiding the formation of intensive water flows between the geomat and soil despite a high rockiness of slopes;

3. The curved surfaces of geomat "Luffaeromat" protects the mixture of plant seeds and soil from drain and negative impact of the wind (wash/capture) and increases the possibility of biodiversity restoration;

4. The geomat "Luffaeromat "is economical, its 1 m^2 costs **2,5-3,0 USD**, it is cheaper than worldwide approved geomat "Jute Mat" that costs **3,5 USD**, which is very important factor for its promotion and competitiveness not only on the local, but also on the international market;

5. After installation of geomat "Luffaeromat" on eroded slopes, in case of presence of seeds in the soil, a mulching process, contributing to sprouting of the seeds and growth of vegetation, occurs together with a real possibility of sprouting of seeds mixed with soil in labyrinthine fiber layer of geomat, guaranteeing the possibility of instant restoration of biodiversity;

6. The geomat "Luffaeromat", made from natural materials (after biodiversity restoration on eroded slopes), decomposes over time, as it is an organic body, and transforms into organic fertilizer enriching the soil and ensuring the possibility of vegetation growth on the eroded slopes.

CONCLUSION

The above mentioned characteristics of geomat "Luffaeromat" give us the basis to conclude that it has important indicators determining its consumer market competitiveness, superiority and uniqueness. Consequently, we find the installation of our geomat on vulnerable slopes to be an effective and realistic measure for achieving stability and biodiversity restoration of this area.

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Water management

SUSTAINABLE SOIL, FERTIGATION AND WATER EFFICENCY

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ABSTRACT: Sustainable Soil and Water Efficiency are the most important issues on our planet, because our population keeps increasing and our world farm land keeps decreasing.

The solution is to improve the soil health of our farms and increase water efficiency through the use of ProBiotic nutrient and the automation of Fertigation with irrigation.

KEYWORDS: sustainable fertigation, ProBiotic nutrients, soil health, water efficiency, sustainable agriculture.

Sustainable agriculture, sustainable fertigation – bringing irrigation, fertigation and ProBiotic nutrients together to improve plant and soil health. Soil health through increased soil biology and bio-diversity is the key to a healthier plant. It reduces labor and maintenance costs, while improving quality and increasing **Water Efficiency**.

Water Efficiency – irrigation is a key for agriculture and when you add fertigation you create Water Efficiency. This makes water more Efficient by injecting soil and plant nutrients into the water. This efficiency can reduce water use up to 50%, which reduces the energy to pump it.

ProBiotic Nutrients – the health of the soil is the key element to a healthy plant, and adding probiotic nutrients with the base fertilizers through fertigation will improve the soil and plant health.

The Key to a healthy strong plant is in the Root System. Soil heath will promote the growth of a deep dense root system. This relationship between the soil biology and the plant will provide nutrients, amino acids, enzymes and other elements in the soil for the plant, and promote proper growth and fruit or seed for harvest.

Fertigation has proven through the years it is very efficient. Fertigation will feed the plant two ways. The first one, the root feeding – through the roots, second one, foliar feeding – directly into the plant. It combines with the irrigation to bring Automation to the agriculture. This will reduce labor, while feeding the plant and soil very lightly and efficiently with each irrigation cycle.

FOUNDATION FOR A SUSTAINABLE AGRICULTURE

Sustainable Soils are the foundation for a Sustainable Agriculture. The health of the soil is the most important factor for healthy plants and is an efficient management program for all agriculture production.

Many farmers and agronomists do soil tests to determine what the soil has and what must be added, but few tests the soil's health with a bio-assay. This will evaluate the biology and bio-diversity of the soil, as well as determining any possible pathogens but, I am getting ahead of myself.

The future of agriculture and all areas of agronomy are to bring nature back into the process of

growing and managing plants. Just like the medical industry is promoting a healthy body, making it more resistant to disease, healthy soil is an important foundation for a healthy plant.

SOIL CREATION

The story of Hawaii is a great example of how soil biology creates rich soil.

Over fifty million years ago, volcanoes emerged from the Pacific Ocean and became the Hawaiian Islands. The islands emerged from the ocean were nothing but sulfurous volcanic rock sterile with nothing growing. Winds carried dust with bacteria and birds landed and left manure droppings and inoculated the rock with biology. Then weather, rain and biology eroded and decomposed the rock, slowly creating gravel and sand. Then seeds were deposited by birds and the cycle of life was started.

The cycle of life is simple, basic and fundamental to our life. Plants grow, the plants produce leaves and fruit or seeds, which drop to the ground and are decomposed and rot to be converted into humus and nutrients to be taken up by the roots to feed the plant. This natural cycle is the agronomic engine that feeds plants all over our planet and it depends on healthy soil biology.

After millions of years, the decomposition of plant material by soil biology in the soil, combined with rich volcanic minerals, Hawaii has very fertile rich soils. All of this was created by soil biology and the cycle of life.

BLACK RICH SOILS OF THE WORLD

Some of the richest soils in the world are in Russia, Ukraine, Middle America and Argentina, where grass lands would grow each year and leave roots in the soil to decompose into carbon and organic humus particles. After millions of years this would create black rich soils that would produce great crop yields with no fertilization. These regions were the bread basket for the world with their rich black soil, but most are depleted and over used today.

Rich soil can be created the same way on any farm today by building the soil health. As the soil health and the soil biology increase, the decomposition of organic material will be converted into organic humus. Now, we can do it much faster by adding special biotic stimulants to the soil.

Crops will turnover their roots every season by growing new roots and the soil will have thousands of kilos of dead roots waiting to decompose. With the soil rich with bio-diverse biology, the dead roots and other organic matter will be converted into organic humus particles.

NUTRIENT EFFICIENCY

As the soil health increases the soil becomes more nutrient efficient and needs less inputs, like fertilizer and water.

Organic humus particles are great storage areas or sponges in soil and will attract, hold and release water and nutrients 10 times more than clay particles. The soil will become a very efficient biologic engine and increase the efficiency of any mineral / synthetic fertilizer that is applied.

Healthier soil biology will also release nutrients like phosphorus and other minor nutrients such as iron and boron, which are in the soil but tied up and not available. These nutrients are free and only need to be released for the plant to use.

BICARBONATE AND SODIUM ISSUES

Soil pH is always a big question, and if the pH is high, nutrients will not be available to the plant and will be wasted. Many farms have very high pH soils because of high bicarbonates in the water or soil and look to applying sulfur or gypsum as a solution, but building the soil health will buffer the soil pH as well.

Sodium can be one of the issues for resorts and golf courses near an ocean coast or having poor quality water quality from wells. Sodium can build up in the soil, by cation linkage to clay particles and soon become toxic to the plant. It cannot be flushed by rain and the more it is irrigated, the more damage is done. The grass is poisoned by Sodium. It is like irrigating with seawater.

Feeding the soil by broadcasting or injecting through the irrigation with organic additives like humic acid and other organic enzymes has been used with great success on many farms to treat sodium issues as well as high PH. This program should become a continuing program of first treatment and then maintenance.

SOIL MAINTENANCE

A soil nutrient maintenance program is as important as the crop nutrient maintenance. You should feed the soil so the soil will then feed the plant.

This symbiotic relationship has been researched and is finally starting to be understood. The plant tells the biology what it needs and the biology makes it available to the plant. You may not believe it, but that is what has been done in nature for millions of years. Whether it is a forest, jungle, desert, a grass area, or any native area not touched by humans, the plants are fed by this symbiotic relationship between soil biology and the plants and trees.

No one feeds the plants in nature, it is done by the relationship between biology and plants, and this natural way is doing a better job than we are.

SUSTAINABLE FERTIGATION BRINGS SOIL HEALTH AND WATER EFFICIENCY TOGETHER

A fertigation system is the important next level of Automation for irrigation to increase Water Efficiency, which makes water do more.

A fertigation system is a micro-injector to treat the irrigation water with plant and soil nutrients. The injector pump is a special metering pump, which can precisely inject liquids into the pressurized irrigation line. It converts irrigation water into nutrient rich water to feed the soil and plant very lightly with each drop of irrigation water.

WATER EFFICIENCY

Fertigation water is twice as efficient for the soil and plant. It can reduce water, fertilizer, chemicals, labor and energy by as much as 50%.

The fertigation is controlled by the irrigation flow rate and controls the injection rate based on the water flow rate. This is called proportional injection control.

Proportional injection will maintain a consistent ratio of nutrient to water – PPM (parts per million). The rate adjustment knob on the pump will change the PPM of nutrient and water ratio to increase or decrease the nutrient concentration in the water.

Sustainable Fertigation is the principle of injecting plant and soil nutrients (liquid fertilizer) into each drop of irrigation water to lightly feed with each irrigation cycle.

NEW THINKING FOR IRRIGATION

Normally, dry fertilizer is applied two or more times annually and stored in the soil.

A Sustainable Fertigation program will be very different when irrigation is used. It will apply very light rates of nutrients with each irrigation cycle. This close interval feeding is more efficient, and the rate of feeding can be changed with different periods of crop growth.

What is more important, is that with a constant light feeding with each irrigation cycle, you will reduce the amount of fertilizer by up to 50% because it is more efficient. That is because you have very close interval feeding as well as 10% to 15% foliar nutrient uptake.

NUTRIENT PLAN

Sustainable Fertigation will bring light close interval feeding together with the automation of injection to manage the plant color and growth. Also remember the injection rate can be increased or decreased at anytime, based on the plant response and crop maturity.

PROBIOTIC NUTRIENTS

The health of the soil is the key element to a healthy plant, and adding probiotic nutrients with the base fertilizers through fertigation will improve the soil and plant health. Humic based organic nutrients will build the biology and the bio-diversity of the soil. It will also release nutrients tied up in the soil not available to the plant. This will promote a deep, dense root system, which gives the plant more efficient use of water and nutrients. This program will promote a plant with a strong root system, and reduce disease and insect damage. The result is a more efficient plant with better quality, while reducing fertilizer and chemicals.

NEW ENGINE

The Biological Engine will create more roots, increase nutrient efficiency, increase crop production, overall quality and reduce costs. But, more important you will be bringing nature into your management practice for the farm.

INJECTION RATE

The injection rate will be calculated based on the gallons (liters) of nutrient to be applied and irrigation schedule. The irrigation schedule will be used to determine how many hours of irrigation will run per day, week or month.

TURF FEEDING SYSTEMS, INC. – FERTIGATION SYSTEMS

TFS produces a full line of fertigation models that cover all types of application sites - Agriculture - center pivots to over 300 hectares, row crop vegetable with drip irrigation, vineyards, greenhouse and any other irrigation - Landscapes, Sports Fields, Resorts and Golf Courses from 100 meter2 to over 200 hectares.

TFS has been in the fertigation business for over 25 years and have thousands of systems installed worldwide.





ROOTS AND SOIL HEALTH

Roots are the storage zone for water and nutrients for the plant and are a very important factor for the efficiency of the plant. The healthier the soil, it will build a deeper and denser root system and create a more efficient plant.

Good root systems and soil health are two great values for Sustainable Agriculture maintenance and they work together. This combined value is the factor for water reduction, which can be reduced up to 30% in some cases, while producing higher turf grass quality.

Proper probiotic nutrients will build the health of the soil and a deep, dense root system, which gives the plant more efficient use of water and nutrients.

CHEMICAL REDUCTION

A healthy soil with ProBiotic biology will overpower the pathogen disease biology and reduce the use of chemicals. A healthier plant in healthy soil will not be stressed, not in succulent growth, and will have thicker cell walls, which are all factors to be more disease resistant.

It will not eliminate chemicals, but it can reduce the use to the lowest level, which is another great area of savings.

The soil of most farms today is sterile, and they want to keep it that way to reduce the disease. But when soil health is brought back to life and propagated with beneficial biology, an efficient biological engine is added to your agronomic program. This is what is taking place in the native areas around your farm.

Fertigation has proven through the years it is very efficient. It combines with the irrigation to bring Automation to irrigation. This reduces labor, while feeding the plant and soil very lightly and efficiently with each irrigation cycle.

EVERY GROWER MUST GROW TWO CROPS

The first crop is an expanded population of topsoil microorganisms that provide the fertility for the second crop, which is the crop that a grower will harvest.

Sustainable Soils, Fertigation and Water Efficiency – The New Direction for Agriculture

Environmental protection

TIME IDENTIFICATION OF SOIL ABSORBING DURING THE RAIN IRRIGATION BEFORE STARTING FIELD FLOODING

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ABSTRACT: For rational use of water artificial rain should be produced with such intensity and large-size drops which will provide the depth of rainfall penetration till formation the land runoff. In the following article we'll present the method of time calculation before the beginning of field flooding in accordance to rain and soil specification.

KEYWORDS: rain, intensity, soil**,** infiltration.

The duration of rain irrigation before the beginning of flooding the surface of the field by the water depends on the rain intensity, the large- size rain drops and water infiltration capacity of soils. The large-sized rain drops destroy the structure of soil, firm the surface of the soil and thus decreases the water infiltration capacity. The more the rain intensity and the bigger the size of rain drops, the more quickly the puddles of water appears on the surface of the field, forming the water runoff and increasing danger of erosion [2].

For sufficient usage of water, such kind artificial rainfall with such intensity and large-sized raindrops should be produced, which will provide the depth of wetting the soil until formation the overland runoff. However, while following such direction, it is essential to take under consideration that, feeble irrigation provokes performance degradation of rainer and increases energy costs.

Defining the duration of rainfall until the beginning of field flooding, or with the other words before appearing the puddles of water on the field, is also important for defining the theory of formation rain runoff.

At the beginning of rainfall or irrigation, rain water is entirely absorbed by the soil, the speed of infiltration equals to rain intensity and water infiltration capacity of the soil isn't used totally. Hereafter, after soil saturation with water, its infiltration capacity decreases and when it becomes less than rainfall intensity, the puddles appears on the field surface and the flooding begins. From this moment the infiltration begins in flooding conditions, the seed of vertical water infiltration through soil surface K(t) is less than rainfall intensity I(t), further it slowly decreases and aims to constant value K_0. In the researches of pressured infiltration, the infiltration rate also aims to this – K_0 – constant value.

For measuring the speed of pressured infiltration, the following formula by A.N. Kostiakov:

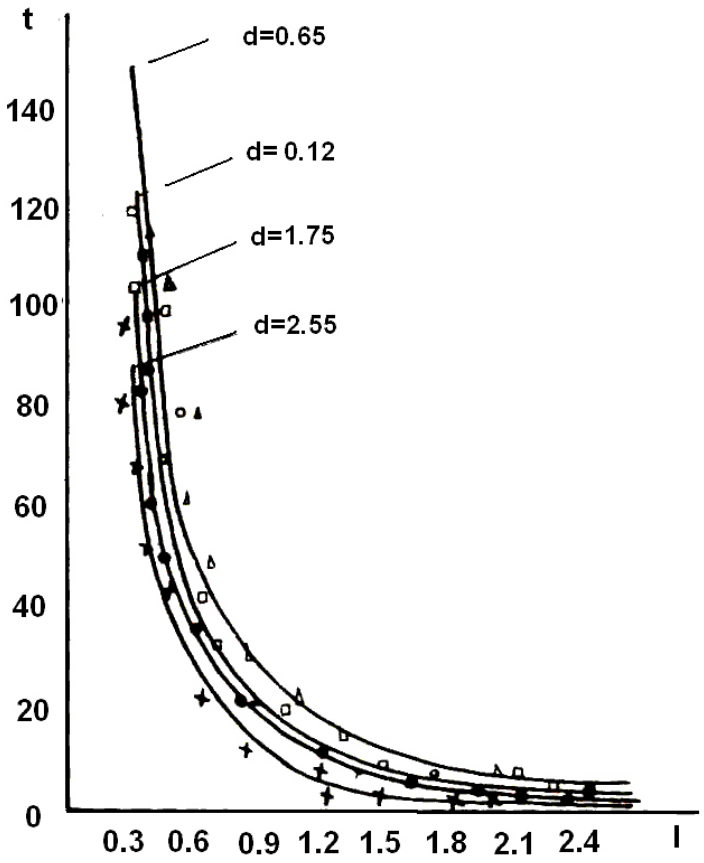
$$K(t) = K_0(t + bt^{-\alpha}), \qquad (1)$$

whereas: a, b and K_0 defines soil infiltration and is founded on the basis of experimental data.

Despite the evident distinction between infiltration processes during the rain and under the condition of the field flooding, the connection between them still exists and the defined piece of function chart (1) could closely depict the alternation of infiltration speed after flooding the field with water during the rainfall.

It's obvious that, placement water content of the soil, on which the speed of pressure infiltration is measured for defining the parameters of α, b and K_0, should coincide with the moisture of the soil of field, on which the irrigation process is suspected to carry out.

Let's move the graphic of the formula to the right, yet unknown dimension t^* (pic. 1), so as to make it go through the point $[t_n, I(t_n)]$.



Pic. 1. Curves of absorption rate volatility

In such case we get the following formula:

$$K_t(t) = K_0\{1 + b(t - t^*)^{-\alpha}\} \qquad (2)$$

We can admit that, according to the (2) formula we can define the law of speed alternation of infiltration after the field flooding with the water, or at $t \geq t_{n^*}$

as, at the moment when flooding begins $(t = t_n)$ the speed of infiltration and rainfall intensity are equal, and we get the following:

$$K_t(t_0) = K_0 \cdot [t + b \cdot (t_n - t^*)^{-\alpha}] = I(t_n) \qquad (3)$$

Water rate, which is infiltrated by the soil surface through a unit of its area, is defined by integral $\int_0^{,b} I(t)dt$. The speed of infiltration at the moment of puddles' formation during the rainfall is defined by the formula (3). During the experiments the same speed of pressure infiltration can be attained by $t = t_n - t^*$

(pic. 2) and is defined by formula (1), that's why the infiltrated water quantity in this case equals $\int_0^{t_{nn}} K(t)dt$.

As the speed of infiltration depends on soil saturation by water, we can write the equality:

$$\int_0^{t_n} I(t)dt = \lambda \int_0^{t_n - t} K(t)dt \qquad (4)$$

While defining the speed of pressure infiltration in flooded circles the height of the water pillar is assigned, but during the rainfall at the moment of puddle formation, this height equals zero; besides, at the last occasion the soil infiltration capacity becomes worse in accordance to impact action of rain drops, that's why in the equality (4) the coefficient of proportionality – λ is brought in. During the irrigation with constant rate $I(t) = I_0 = const$

Equation (3) and (4) with accounts of equation (1) forms the system:

$$K_0[t + b(t_n - t^*)^{-\alpha}] = I_0; \quad \lambda K_0[1 + \frac{b}{t-\alpha}(t_n - t^*)^{-\alpha}](t_n - t^*) = I_0 t_n; \qquad (5)$$

While doing this system about t^* and t_n we get:

$$t_n = \lambda \frac{K_0}{I_0}(\frac{bK_0}{I_0 - K_0})^{\frac{1}{\alpha}}[1 + \frac{I_0 - K_0}{(1-\alpha)K_0}]; \qquad (6)$$

$$t^* = t_n - (\frac{bK_0}{I_0 - K_0})^{\frac{1}{\alpha}} \qquad (7)$$

The formula (2) with account of (7) can be used for defining the speed of infiltration when solving the task about the movement of rainfall runoff. On the base of experiences, which took place at the Black Sea Earth area, Sukhanovski [3] got dependency for defining the time t_n as to the speed of rain drops and rain intensity: $t_n = \frac{3.6 \cdot 10^{-3}}{\rho_k \cdot I^2 \cdot v_k}$, whereas coefficient $3{,}6 \cdot 10^{-3}$ has dimension J/m^2, ρ_k – water density, V_k – the speed of rain drops. According to the formula by Slastixina [5] speed V_k is proportional to the value $\sqrt{d}$, whereas, d – mid-diameter of rain drops. In table 1, it is given the real data of defining value t_0 (minute) in accordance to rain intensity and rain drop diameter using the literature [1]. The soil is liver colored, freshly plowed, irrigation uninterrupted (see table 1).

Table 1

Rain intensity I **mm/min**	**Rain drop diameter –** d**, mm**			
	2.1 – 3.0	**1.5 – 2.0**	**1.0 - 1.4**	**0.4 – 0.9**
2.50	3.5	4.5	5.5	7
2.00	4.0	5.0	6.0	8.0
1.60	5.0	6.0	7.5	9.0
1.20	8.0	10.0	13.0	15.0
0.85	16.0	18.0	23.0	28.0
0.77	19.0	24.0	30.0	41.0

On the base of this table the table 2 is made, where the meaning of value $t_n\sqrt{d}$ is given. Table 2 shows that value $t_n\sqrt{d}$ depends on rain fall intensity and doesn't depend on rain drop diameter. This gives us opportunity to define the value of coefficient λ in accordance to the diameter $\lambda = \frac{\lambda_t}{\sqrt{d}}$ (8). Then the formula (6) will be as following:

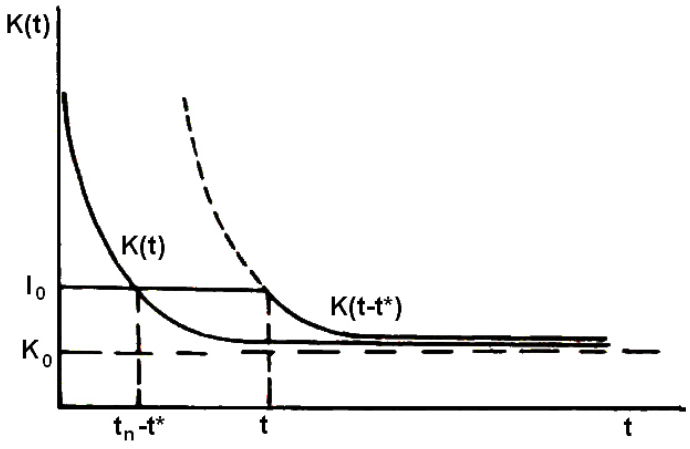
$$t_n = \frac{\lambda_t}{\sqrt{d}} \frac{k_0}{I_0} \left(\frac{bk_b}{I_0 - K_0} \right)^{\frac{1}{\alpha}} \left[1 + \frac{I - K_0}{(1-\alpha)K_0} \right], \qquad (8)$$

whereas λ_k – numerical coefficient having dimension $m^{1/2}$; d – is given as *m*; K_0 and I_0 – are given as *m* hour, then we get t_n in hours:

Table 2

Rain intensity I ***mm/min***	**Rain drop diameter –** d **,** ***mm***				**The average value** $t_n\sqrt{d}$
	2.55	**1.75**	**1.2**	**0.65**	
2.50	5.6	5.9	6.05	5.67	5.60
2.00	6.4	6.60	6.60	6.48	6.52
1.60	8.0	7.92	8.25	7.29	7.67
1.20	12.8	13.20	14.30	17.20	13.12
0.85	25.6	23.80	8.25	22.70	24.35
0.77	30.4	31.70	6.60	32.40	31.90

It's obvious to be aware that the "terminal" velocity of rain drops depends on the height of its' fall, and the speed graphic of pressure infiltration for the soils of different infiltration capacity may intercross [3, 4], that's why the value of coefficient λ in the formula (9) should be set during the irrigation by the different irrigation equipment, at the natural rain fall and for the soils of different infiltration capacity. It may be done on the base of singular experiment defining the parameters which are included in the formula (9). At work [1] there is a lack of information about the parameters *a*, *b* and k_0. If we tentatively define that $\alpha = 0.6$, $b = 2.5$, $k_0 = 0.0045$ m/h, then on the basis of table 2 it won't be difficult to define the value of coefficient $\lambda_1 = 0{,}065$. The results of opposition in calculated and test data are given in pic. 2. It's evident that, having refined the value of parameters *a*, *b* and k_0, we can refine the value of coefficient λ_1. For rotating and impulsive irrigation equipment it gives the real time definition of rain fall from the moment of starting the irrigation up to the field flooding.



Pic. 2. Attitude of rain intensively by flooding starting time

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Environmental protection

INFLUENCE OF DETOXIFICATION METHODS ON THE MIGRATION OF ECOTOXICANTS TO THE SUBSURFACE WATER

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ABSTRACT: The research conducted within a lysimetric experiment aimed at studying the chemical composition of intrasoil water has shown that contaminated black soil has a high absorption capacity of heavy metals (HM). The bulk of HM brought about in a form of water-soluble salts, was adsorbed and converted by soil colloids of podzolized chernozem into relatively stable compositions. Organic and organo-mineral systems where phosphates and used in the volume of 60 kg of P_2O_5 per hectare a year, reduced intake of cadmium in the subsurface water. Mineral systems also impeded migration of zinc and copper to the ground water. On the contrary, high doses of superphosphate in the fertilizer system increased the leaching of *Cd, Pb* and *Cu* to the infiltration waters.

KEYWORDS: podzolized chernozem, heavy metals, intra-soil waters, lysimetric experience, system of the fertilizers.

At present it is obvious that any unexpected negative consequences of anthropogenic activity significantly affect the biochemical behaviour of environment. Heavy metals (HM) after entering the soil are fixed by the horizons containing humus. Meanwhile, the soil itself is a natural body and being polluted becomes a secondary source of pollution to surface air, natural waters and plant products.

Migratory capacity of HM depends on cumulative properties of soil, chemical pollutants and landscape environment [1, 2]. Pollutants coming from the atmosphere tend to concentrate in the soil horizons containing humus. However, in soil with low buffering capacity and under the influence of physic-chemical, biological and other processes HM are transferred from exchange-absorbed state into the soil solution and with downdrafts can be moved into the underlying layers.

Infiltration of HM through the soil profile is accompanied by excretion of organic matter and associated metals. This process is mostly intense for metals associated with high molecular weight fractions of soluble organic substances such as *Cu* and *Pb*. Migration mainly occurs in regular solutions as Zn and Cd are mainly integrated with low molecular weight fractions.

SUBJECTS AND METHODS

Long-term stationary experiments were conducted in lysimeters of experimental design of VNIIGiM (All-Russian Institute of Hydraulic Engineering and Land Reclamation) with pristine soil profile (figure 1). The area of stationary soil lysimeters was equal to 0.78 and 1.17 m^2.

Within the research program there were carried out experiments to study the following fertilizer systems: organic (cattle manure), organomineral and mineral.

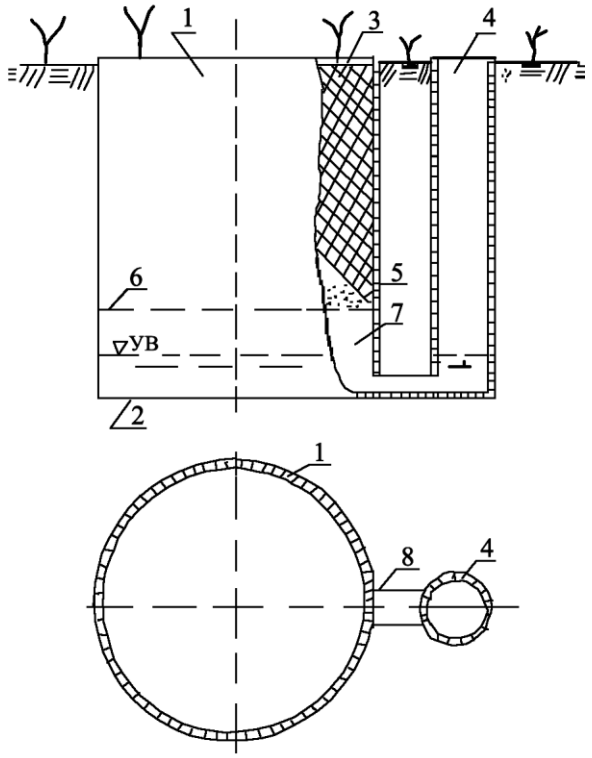

Figure 1. Scheme of the water balance lysimeter

High doses of double superphosphate were used periodically and annually in rotational cropping. The allowance of 100 t/ha (table 1) was accepted for podzolic heavy loam chernozem.

Notation:

1 – case of the lysimeter
2 – bottom of the lysimeter
3 – soil monolith
4 – well for intake of water
5 – gravel filling
6 – gage filter
7 – water level

Table 1

Scheme of establishment and implementation of the field lysimeter experiment

Variants	Names of variants and the fertilizer application system in the crop rotation link
I	Control
II	Cattle manure 100 t/ha – Periodic application
III	Cattle manure 100 t/ha – Periodic application, $N_{60-90}\ P_{60}\ K_{60-120}$ – Annually, depending on a culture
IV	Application of phosphorus, once in 2 years in a dose of 120 kg/ha + Annual application of $N_{60-90}\ K_{60-120}$
V	Application of phosphorus, once in 4 years 240 kg/ha + Annual application of $N_{60-90}\ K_{60-120}$
VI	Annual application of an elevated dose of phosphorus (120 kg/ha) + $N_{60-90}\ K_{60-120}$

The research was conducted in the period between 2006 and 2008. Barley of Nevskiy variety, fodder beet Eckendorf yellow, oat – Horizon.

In the experiment an elevated level of soil contamination was modelled based on the geochemical background of the region: *Cu* – 90, *Zn* – 110, *Pb* – 40, *Cd* – 0.6 mg/kg. For this purpose, chemically pure salts $Zn(CH_3COO)_2 \times 2H_2O$, $CuSO_4 \times 5H_2O$, $Pb(CH_3COO)_2$, $CdSO_4$ were used, taking into account background levels of gross forms of heavy metals in the soil.

RESEARCH RESULTS

In our conditions pollution of the soil with heavy metals was conducted in autumn of the year 2004 by means of water-soluble salts. It is known that due to sorption processes when salt is applied to the soil HM are absorbed by soil colloids, which are presented in the soil as mineral, organic and organomineral compounds. Due to polyfunctionality of soil as a sorbent, its sorption capacity is not the same for different HM and their cations. And processes of internal diffusion of molecules and ions may limit the speed of sorption. It may be also limited by the dissolution rate of soil compounds involved in the subsidence of contaminants. Consequently, when contaminants are released into the soil it takes a long time to establish sorption equilibrium.

There are two periods in the water regime of chernozem: 1. Draining – covers all summer and the first half of autumn, when water is rapidly consumed by plants and evaporates because ascending currents prevail over descending ones; 2. Soaking – starts from the second half of autumn, is interrupted by frosts and continues in spring, because of snowmelt waters and spring rainfall. Mainly the depth of rainfall, its distribution over time and its temperature determines these factors. Summer rainfall moistures only the topsoil. Moisture in the subsurface of chernozems is created by precipitation during the cold period [3]. Therefore, precipitation of the late period creates additional moisture, which contributes to pollution of intrasoil waters with heavy metals.

The studies of Meshchersky Branch of VNIIGiM [4] carried out at the ecological testing area "Meshchera" showed the following concentration ranges of HM in the water infiltrated through sod-podzolic soil: *Pb* – from 0.33 to 0.80 mg/1·10^{-3}; *Cd* from 0.6 to 0.11 mg/l·10^{-3}; *Zn* from 0.16 to 2.37 mg/l·10^{-3}; *Cu* from 0.9 to 0.21 mg/l·10^{-3}.

The research conducted within a lysimetric experiment aimed at studying the chemical composition of intrasoil water has shown that contaminated black soil has a high absorption capacity for HM [5]. The bulk of HM brought about in a form of water-soluble salts, was adsorbed and converted by soil colloids of podzolized chernozem into relatively stable compositions. Contaminated soil of the first variant during the years of research increased migration of Cu and Cd to the intrasoil waters, whereas *Pb* and *Zn* demonstrated a better resistance to washing out in comparison to natural soils (Tables 2 and 3). The studied fertilizer systems in varying degrees increased the release of *Pb* and decreased migration of *Cd* to the infiltration waters. Their contamination with *Pb* increased by 1.6% and equalled 89%, but concentration of *Cd* lowered by 20% and equalled 53%, except from the variant for which increased doses of phosphate were used (variant VI) (tables 2 and 3). In this variant we registered increased leaching of *Cd* to the infiltration waters.

Table 2

Influence of agrochemical rehabilitation on the migration of *Zn* and *Cu* to the intrasoil waters (mg/1·10^{-3})

Variant	Zn			Cu		
	2006	2007	Average	2006	2007	Average
I	0.48	1.28	0.89	0.12	0.36	0.24
II	0.51	2.37	1.44	0.21	0.19	0.20
III	2.08	0.37	1.23	0.23	0.25	0.24
IV	0.40	1.32	0.86	0.12	0.11	0.12
V	0.41	0.11	0.26	0.17	0.10	0.14
VI	0.51	0.96	0.78	1.6	0.11	0.86

In the waters infiltrated through the profile of chernozem organic and organic-mineral fertilizers increased concentration of *Zn* by 62% and 38% respectively. Content of this element decreased by 3.4% and equalled 40.8% under the influence of mineral systems.

Table 3

Influence of agrochemical rehabilitation on the migration of *Pb* and *Cd* to the intrasoil waters (mg/1·10^{-3})

Variant	Pb			Cd		
	2006	2007	Average	2006	2007	Average
I	0.70	0.58	0.64	0.15	0.14	0.15
II	0.62	0.99	0.85	0.06	0.08	0.07
III	1.62	0.80	1.21	0.07	0.13	0.10
IV	0.88	0.80	0.84	0.05	0.19	0.12
V	0.74	0.56	0.65	0.03	0.20	0.12
VI	0.82	1.19	1.01	0.08	0.29	0.18

Under the influence of annual dose of phosphorus (P120) copper like lead and cadmium substantially migrated to infiltration waters. Other mineral fertilizer system (variants IV and V) approximately halved concentration of copper in intrasoil waters. With the organic system a decrease of copper in the waters was less (17%), and with the organic-mineral system concentration has not changed compared to Variant I (control).

CONCLUSIONS

Results of the analytical research showed that organic and organic-mineral systems where phosphates were used in the average volume of 60 kg of P_2O_5 per hectare a year, reduced intake of cadmium in the subsurface water. Mineral systems also impeded migration of zinc and copper to the ground water. On the contrary, high doses of superphosphate in the fertilizer system increased the leaching of *Cd, Pb* and *Cu* to the infiltration waters.

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Hydrology and Meteorology

PROBABILISTIC ASSESSMENT OF VULNERABILITY OF NATURAL RIVERSIDE

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ABSTRACT: Quantitative assessment and forecasting of one or another hydrological phenomenon is important for estimation of vulnerability of natural riverside. Mechanism of riverside destruction by water is considered in the represented work as random process, which is depended both on influence of flow speed and on riverside resistance. As the indicator of this process against such influence is taken riverside characteristic – vulnerability, for determination of which is used a well-known model of the theory of reliability, called "load-strength" model. Proceeding from this fact a result obtained via theoretical formalization in the form of represented formula is considered at this stage as approximation and time factor should be taken into account in the modeling process that will be a step forward in relation to current reality.

KEYWORDS: riverside, vulnerability, Probabilistic assessment.

INTRODUCTION

Modern world is in the period of unprecedented global changes. Areas of vital importance (atmosphere, hydrosphere, lithosphere and biosphere), which are necessary for human's existence are changing in various directions that can probably create a danger for well-being of both present and future generations.

According to UN experts data, against the background of established tendencies of climate changes of the last period among natural disasters, which cause certain ecological problems and social-economic difficulties, such phenomena became rather more frequently and don't give the pas, as floods and freshets.

There is also much tension around mentioned problem in Georgia, where up to 26000 big and small rivers are registered against the diverse orographic background, and most of them fall at the western Georgia.

Rivers very often damage coastal strips of river bed, and water mass, which overflows the banks creates serious danger for settlements, industry, agriculture, communications etc.

From the ancient times the mankind had fought against floods and negative effects caused by them and had used different approaches and methods for it. First stages of this fight according to chronology were based on descriptive and empirical studies and they lacked the opportunities of deep scientific solution. The latter became partially implementable only after that hydrology has transformed into science, which is able to quantitatively assess one or another phenomenon and to carry out its forecasting.

Despite the fact that at present we have data on lots of fundamental scientific studies related to forecasting of floods and freshets, nevertheless we can't assert that the issue is solved at desirable level, even results of verification of already performed best works in some cases are considerably deviated from reality.

Certain progress in use of modern machinery of random processes and field theories is mentioned recently in regard to hydrological forecasting.

The practice shows that water overtopping from water-bearing artery (river bed) of the river in most cases is related to damage of coastal strip by the flow and its malfunction as of water-retaining object. Remarkable example of this fact is well-known freshet at Rioni river on January 31, 1987, when intensive lateral erosion processes caused by powerful flow originated in river bed, washed off and knocked out of action coast-protection structures (dikes) almost in twenty places, as a result of which 2-meter high wave flooded human settlements, arable and crop areas, communication road network, a lot of houses has been destroyed, plenty of cattle was drowned and even human losses were registered [1,2].

The foregoing and other similar examples insistently require preliminary assessment of vulnerability of riverside.

DETERMINATION OF PROBABLE VALUE OF VULNERABILITY

By vulnerability is meant object feature, which reflects its ability to offer resistance to current load (influence) on it, i.e. it is a feature, inverse to resistance. Degree of vulnerability is depended both on intensity and duration of loading and on existing interrelation between component elements of the object. Critical limit of vulnerability determines the range of trouble-free performance of the object. It is desirable to assess vulnerability according to all the indicators, which characterize its critical value; however it is unrealizable due to restriction of precise analytical modeling of current processes. That's why we must select one basic determining (integral) factor among characteristic indicators of critical state, according to which will be implemented the analysis of vulnerable state of the object [3].

After selection of determining factor it is possible to use well known procedures of establishment of reliability for assessment of vulnerability. Model "load-strength" is frequently used for this purpose in the theory of reliability.

In our case a bottom velocity of water flow (v_b) can be considered as determining factor in regard to "load". Determination of approximate values of bottom velocity for any cross-section can be carried out by taking into account the values of morphometrical characteristics, hydrological and hydraulic elements of river bed, precise definition of which in case of necessity will be implemented according to direct measurements, while in regard to riverside as determining factor will be used integral characteristic of soil compaction, which determines permissible (non-washing out) speed of water flow (v_p). The latter is the maximal value of water flow, which doesn't cause washing-out of given soil.

Let's consider a short, straight-line stretch of river bed, which can be taken as prismatic one with uniform riverside soils. Under this assumption we may be able to formalize at some level the problem of determination of riverside vulnerability. Let's assume that in certain time period (decade) river movement at the stretch under review is steady and bottom velocity (v_b) experiences relatively insignificant changes. Under these conditions bottom velocity of the flow can be taken as random value v_b distribution density of which is $f_1(v_b)$, mathematical expectation is m_{v_b} and mean square deviation is δ_{v_b}.

In the same way we consider as random values a permissible speed of water flow v_p, distribution density of which is $f_2(v_p)$, mathematical expectation is m_{v_p} and mean square deviation is δ_{v_p}. It is

natural that if v_b will exceed v_p, riverside washing-off will take place, i.e. mutual consideration of random values v_b and v_p as of system gives us an opportunity of forecasting of riverside vulnerability. With this end we input new random value – Z, which is related to our start random values via general functional dependence:

$$Z = \phi(V_b - V_p). \quad (1)$$

Let's suppose as already known the probability density $f(V_b - V_p)$ of the system of random values $(V_b - V_p)$ and determine the distribution law for value Z. Therefore the problem of forecasting of vulnerability is considerably simplified, since we are moving from the system of two random values to one random value Z.

As far as the dependence (1) represents certain surface in $V_b 0 V_p Z$ system, distribution function G(z) of random value Z will be written as follows [5,6]

$$G(z) = P(Z < z) = P\left(\varphi(V_{\text{ბ}}, V_p) < z\right), \quad (2)$$

where z is a distance from cutting plane H to coordinate plane $V_b 0 V_p$, which is drawn in parallel to it secant line K, points of which satisfy the equality $\varphi(v_b, v_p) = Z$, during project onto the coordinate plane $v_b 0 v_p$ will divide the latter into two areas, and points of one of them (let us denote it as D) satisfy the condition $\phi(v_{\text{b}}, v_{\text{p}}) < Z$. Then for fulfillment of (2) a random point $(V_{\text{b}}, V_{\text{p}})$ must get into D area, proceeding from this fact we can write down

$$G(z) = P\left((v_b, v_p) \subset D\right) = \iint_{(D)} f(v_b, v_p) dv_b dv_p. \quad (3)$$

In this mathematical expression the parameter z implicitly enters into integration limits, after differentiation of *g*(z) on z we will get distribution density for random value Z

$$g(z) = G'(z). \quad (4)$$

Knowing concrete form of function $Z = \phi(v_{\text{b}}, v_{\text{p}})$, we can take z as integration limits and write down expression for g(z) in an explicit form. As far as the difference between v_{p} and v_{b} is significant for forecasting of riverside vulnerability, we can consider functional dependence $Z = \phi(v_{\text{p}}, v_{\text{b}})$ in the form of difference between random values

$$Z = (v_{\text{p}} - v_{\text{b}}). \quad (5)$$

In this case D area will be represented as semi-plane of coordinate plane $(v_{\text{b}} 0 v_{\text{p}})$, which is laid below straight line $v_{\text{p}} - v_{\text{b}} = Z$. This line cuts coordinate axes into Z congruent segments (in positive and negative directions)

Random points, which got into this area, satisfy the condition $v_{\text{p}} - v_{\text{b}} < Z$. In this case distribution function (3) will be as follows:

$$G(z) = \iint_{(D)} f(v_{\text{b}}, v_{\text{p}}) dv_{\text{b}} dv_{\text{p}} = \int_{-\infty}^{+\infty} \left\{ \int_{-\infty}^{z+v_{\text{b}}} f(v_{\text{b}}, v_{\text{p}}) dv_{\text{p}} \right\} dv_{\text{b}}. \quad (6)$$

After differentiation of this expression on z we will get distribution density for random value Z

$$g(z) = \int_{-\infty}^{+\infty} f(v_b, z + v_p) dv_p \ . \quad (7)$$

As far as V_b and V_p are independent random values, $f(v_b, v_p) = f_1(v_b) \cdot f_2(v_p)$.

Thus distribution density (7) for random value Z will be

$$g(z) = \int_{-\infty}^{+\infty} f_1(v_p) f_2(z + v_p) dv_p \ . \quad (8)$$

In this case it may be said that takes place composition of two laws, which will be written down as follows:

$$g = f_1 * f_2 . \quad (9)$$

In general cases distribution laws for f_1 and f_2 can be of any form, while in our case V_b and V_p represent random value of normal distribution that is testified by statistical data of long-term observations.

In these case distribution densities f_1 and f_2 will be written in following form:

$$f_1(v_f) = \frac{1}{\delta_{v_b}\sqrt{2\pi}} e^{-\frac{(v_b - m_{v_b})^2}{2\delta_b^2}} , \quad (10)$$

$$f_2(v_b) = \frac{1}{\delta_{v_b}\sqrt{2\pi}} e^{-\frac{(v_d - m_{v_b})^2}{2\delta_b^2}} . \quad (11)$$

It is known that composition of two normal distribution laws provides normal distribution law [6, 7], at the same time mathematical expectation of new random value is an algebraic sum of start random values, while dispersion is a sum of dispersions.

In our case we will have:

$$m_z = m_{v_p} - m_{v_b} , \ \delta_z = \sqrt{\delta_{v_p} + \delta_{v_b}} . \quad (12)$$

Distribution density of random value Z will be as follows:

$$g(z) = \frac{1}{\sqrt{\delta_{v_d} + \delta_{v_f}}\sqrt{2\pi}} \cdot e^{-\frac{[z-(m_{vd} - m_{vf})]^2}{2(\delta_{vd}^2 - \delta_{vf}^2)}} , \quad (13)$$

while function of its distribution will be:

$$G(z) = \int_{-\infty}^{z} g(z) dz \quad (14)$$

As far as there is no risk of riverside washing-off for random value Z > 0, vulnerability (r) will be assessed according to equation

$$r = P(Z < 0) = G(0) = \int_{-\infty}^{0} g(z) dz \quad (15)$$

Analysis of obtained formulas shows that increase of v_b causes reduction of m_z, that in its turn increases the area below the curve in the negative area of axis z and, therefore, assessment of riverside vulnerability at one or another section increases, too.

As far as distribution function $G(z)$ (15) with parameters (m_z, δ_z) can be expressed in the following form by normal distribution function Φ^* of random value with parameters (0,1)

$$G(z) = \Phi^*\left(\frac{z - m_z}{\delta_z}\right), \qquad (16)$$

then the value of riverside vulnerability can be calculated by following formula

$$r = G(0) = \Phi^*\left(-\frac{m_z}{\delta_z}\right). \qquad (17)$$

CONCLUSIONS

1. Among natural processes freshets represent such phenomenon, which was, is and will be the reason of biggest damage for population of any country. At present there is no methodology, which makes possible forecasting of risks related to river bed coastal degradation with permissible accuracy in order to timely take measures for getting rid of expected damage. That's why a mentioned phenomenon will remain so far the research subject for appropriate field of science.
2. Mechanism of riverside destruction by water flow is considered in the presented work as random process, which is depended both on influence of flow speed and riverside resistance. As the indicator of this process against such influence is taken riverside characteristic – vulnerability, for determination of which is used a well-known model of the theory of reliability, called "load-strength" model. Proceeding from this fact a result obtained via theoretical formalization in the form of represented formula has to be considered as rough approximation and it can't claim the high accuracy.
3. Within the frameworks of initiated researches is scheduled a follow-up of works with the end of removal of current disadvantages, namely determination of limits for approximate value of vulnerability with predefined accuracy and taking into account time factor in the modeling process that will be a step forward in relation to current reality.

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Amelioration

AGROCHEMICAL RECLAMATION METHODS OF DEGRADED AND TECHNOGENICALLY POLLUTED SOILS

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ABSTRACT: The content of heavy metals in the soils of the Ryazan region was studied and the grading of soils according to their gross content was developed, taking into account the total index of contained pollutants. There were proposed the methods of control, protection and detoxification of technogenically polluted soils in order to produce environmentally friendly agricultural products. The most effective fertilizer system was identified. The research also covered the migratory ability of heavy metals in soils.

KEYWORDS: environmental monitoring, heavy metals, manmade load, detoxification of soils, migration.

Мелиорация

АГРОХИМИЧЕСКИЕ ПРИЕМЫ МЕЛИОРАЦИЙ ДЕГРАДИРОВАННЫХ И ТЕХНОГЕННО ЗАГРЯЗНЕННЫХ ПОЧВ

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Ежегодно в биосферу поступает огромное количество различных веществ из атмосферы, в т.ч. тяжелые металлы (ТМ), за счет промышленного и сельскохозяйственного производства и других источников. Загрязнение ТМ внешне незаметно, поэтому важное экологическое значение приобретает наблюдения за концентрацией ТМ в атмосферных осадках в проведении почвенного мониторинга. Почвенно-экологический мониторинг на региональном уровне нами проводится с 1993 года.

Концентрирование металлов в атмосферных осадках как теплого, так и холодного периодов различаются по периодам и по годам [1]. Поступившие из атмосферы ТМ включаются в биогенную, водную миграцию, аккумулируются в почвенном покрове, включаются в большой геологический круговорот.

Валовое содержание ТМ в естественных незагрязненных почвах обусловлено их концентрацией в почвообразующих породах и определяется генезисом, петрохимией, минералогическим

составом тонкодисперсных фракций, фациальными различиями материнского субстрата и процессами почвообразования [2]. Почва наследует свой минералогический состав (геохимический фон) от почвообразующей породы.

Региональные почвообразующие породы концентрировали: Pb 8–16 мг/кг, Cd 0,15–0,29 мг/кг, Zn 33–46 мг/кг, Cu 20,9–27,0 мг/кг и т.д. [3].

Для проведения регионального экологического мониторинга в 90-ые годы прошлого столетия были организованы полигоны и определены точки типичных хозяйств, где проводились исследования. Пробоотбор осуществлялся в 1995 и 2006 годах в конце вегетационного периода в соответствии с требованиями ГОСТов и методических указаний.

В образцах определялось валовое содержание химических элементов спектральным методом по методике ЦИНАО с использованием 5н HNO_3 в качестве экстрагента. Количественное определение проведено в лаборатории геолого-геохимической экспедиции (г. Бронницы). При этом использовался масс-спектрометр с индуктивно связанной плазмой Elan-6100 (“PerkinElmer”, США); атомно-эмиссионного спектрометра Optima-4300 (“PerkinElmer”, США). Результаты обрабатывались статистически – на основе анализа вариационного ряда вычислялся на компьютере достоверный интервал с помощью программ Excel.

Поступающие из атмосферы металлы в той или иной мере фиксируются почвой. Скорость закрепления металлов, их подвижность зависит в основном от окислительно-восстановительных условий, преобладающих в почвах. Динамика поведения загрязняющих веществ в почве в конечном итоге приводит к накоплению или выносу их из профиля почв.

Основные типы исследуемых почв региона: черноземы, серые лесные, дерново-подзолистые и аллювиальные почвы. Исследования позволили уточнить и подтвердить статистическими расчетами представления об ассоциации химических элементов-загрязнителей. Из 42 выявленных элементов остановились на 13. При этом для As, Hg за фоновые критерии приняты их кларки в земной коре.

Большое влияние на интенсивность загрязнения почв оказывает близость расположения промышленных предприятий. В аллювиальных, дерново-подзолистых почвах, расположенных в 5–20 км от г. Рязани отмечено накопление Zn, V, Pb, Cd, As до уровней повышенной, средней и низкой загрязненности. В среднем в данном районе, почвы имеют низкий уровень загрязнения и убывают в ряду Pb = Zn > Cd > Cu > Mo + Sn > Mn > V (*табл. 1*).

Буферность почв и всей экосистемы по отношению к воздействию техногенных потоков зависит от совокупности процессов, выводящих избыточные диструкционно активные продукты техногенеза из биологического круговорота [4]. По буферной способности лучшими почвами региона являются черноземы, серые лесные тяжелого гранулометрического состава, образованные на покровных суглинках. Менее всего устойчивы к промышленным выбросам дерново-подзолистые почвы на флювиогляциальных отложениях.

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С 2002 г. по 2008 г. проводили лизиметрические опыты по детоксикации повышенного загрязнения (Pb – 40 мг/кг, Cd – 0,6, Zn – 110, Cu – 90 мг/кг) дерново-подзолистой супесчаной почвы, а с 2006 г. по 2008 г. – чернозема оподзоленного. Использовались лизиметры конструкции ВНИИГиМ.

Таблица 1

Интенсивность загрязнения почв тяжелыми металлами в Рязанском регионе

Элементы	Региональный фон	Среднее содержание, мг/кг			
		Почвы Рязанского района	Дерново-подзолистые	Черноземы	Серые лесные
Pb	12	30,3±5	16,2±2,6	18,8±2,0	23,2±3,2
Cd	0,18	0,43±0,09	0,21±0,08	0,31±0,03	0,26±0,04
Zn	35	86,4±17	35,3±5,1	55,6±5,1	46,9±5,0
Cu	27	53,4±10	38,8±6,0	44,9±6,0	50,6±5,9
As	5,0*	4,73±0,84	2,4±0,93	4,1±0,3	3,07±0,48
Hg	0,07*	0,08±0,008	0,05±0,008	0,06±0,006	0,05±0,008
Mo	0,7	1,31±0,40	0,96±0,11	1,14±0,27	0,84±0,07
Mn	400	700±95	587±110	621±98	737±94
B	27	39,2±6,6	29,3±3,5	39,0±5,4	37,2±4,5
Co	9	11±1,9	7,2±1,1	12,8±1,3	11,3±1,1
Ni	20	26,6±4,4	18,4±2,5	31,3±2,9	25,8±2,4
V	83	133±47	80,2±13,9	165±23	156±39
Sn	2,6	5,0±0,9	2,92±0,65	2,57±0,56	2,80±0,40

Концепция исследований состоит в том, что в агроландшафтах, как правило, наблюдается наличие не одного, а нескольких фитотоксикантов. Теоретически, в таких случаях, возможны как усиления, так и ослабления сил негативного воздействия отдельных ТМ на растения. Научно обоснованная система удобрений в севообороте бесспорно оказывает влияние на более полное использование питательных веществ почвы и удобрений разными культурами и его фитосанитарной роли.

Исследуемая дерново-подзолистая почва, в гранулометрическом составе которой преобладает физический песок, обладает слабыми экологическими функциями. Она имеет неглубокий гумусовый (20–39 см), слабомощный иллювиальный (17–30 см) горизонты и близко расположенные глеевые горизонты. Оподзоленный чернозем с тяжелым гранулометрическим составом обладает более высокими буферными свойствами.

До закладки опытов проведено фоновое известкование и почвы имели реакцию близкую к нейтральной, pH > 6,0. Содержание гумуса около 2% в дерново-подзолистой почве, около 4% в черноземе. Обеспеченность подвижными фосфором и калием определена как средняя и повышенная.

В опытах исследовались органическая, органо-минеральная и минеральная системы удобрений. Они несколько различались в схемах опытов. Анализ многолетних исследований продуктивности повышено загрязненной дерново-подзолистой почвы представлен в таблице 2.

Схема опыта предполагает исследования продуктивности загрязненной почвы (вариант 1). Варианты 2, 3, 4, 5 навоз КРС (Н40) вносили только 2 раза за севооборот (под пропашные). Минеральные удобрения (оптимальные дозы N1-60-90, P1-120, K160-120(N1P1K1) во втором варианте использовались ежегодно, кроме клевера. В 3 и 4 вариантах на фоне Н40 т/га N1K1 использовали двойную (Р2) и четверную (Р4) дозы фосфора. На 5 варианте использовали навоз (Н80), а на 6 –

N1K1 (ежегодно) P480 – 2 раза за севооборот. Применение навоза 40 т/га и одновременное запасное использование P240 в виде суперфосфата (вариант 4) обеспечили максимальную продуктивность, прибавка составила 43,9 ц/га корм. ед. (249%). Другие системы удобрений обеспечили прирост продуктивности севооборота на 21,2–27 ц/га корм. ед. (120–153%).

Таблица 2

Влияние систем удобрений на продуктивность загрязненной тяжелыми металлами дерново-подзолистой почвы, ц/га корм. ед.

Варианты опыта	Картофель (клубни)	Ячмень (зерно)	Сено клевера 1 г.п.	Сено клевера 2 г.п.	Биомасса рожь + ячмень	Свекла кормовая (корнеплоды)	Овес (зерно)	Средняя продуктивность
	2002 г.	2003 г.	2004 г.	2005 г.	2006 г.	2007 г.	2008 г.	
1. Без удобрений	29,7	29,0	8,1	8,3	12,2	14,2	21,7	17,6
2. H40 N1P1K1	67,8	48,6	25,3	12,3	44,4	44,12	67,9	44,3
3. H40 P1K1 P2	75,9	54,0	25,9	10,8	46,2	52,8	67,4	44,6
4. H40 P1K1 P4	88,8	65,2	47,2	20,8	71,2	56,0	81,2	61,5
5. H80	75,6	39,6	30,1	11,2	30,6	36,0	71,0	42,0
6. P480 N1K1	56,8	57,7	21,3	13,6	40,0	44,8	37,2	38,8

Схема опыта на повышено загрязненном черноземе несколько отличалась (табл. 3).

Таблица 3

Влияние систем удобрений на продуктивность загрязненного чернозема

Варианты опыта	Урожай основной продукции, ц/га			Кормовые единицы, ц/га	
	Ячмень	Свекла кормовая	Овес	Средняя продуктивность	Прибавки
	2006 г.	2007 г.	2008 г.	2006–2008 гг.	
1. Без удобрений	15,7	293	22,2	73,1	–
2. H100	32,1	573	27,7	128,6	55,5
3. H100 N1P1K1	36,9	675	34,6	152,5	79,4
4. P2 N1K1	24,2	375	34,0	103,2	30,1
5. P4 N1K1	30,8	333	27,2	98,0	27,9
6. P120N1K1	26,5	452	34,7	115,4	42,3
$НСР_{0,95}$	4,8	39,6	3,6	–	–

Органическая система представлена навозом КРС в дозе 100 т/га (вариант 2). Органо-минеральная – на фоне H100 ежегодно вносилось полное минеральное удобрение (N1P1K1, вариант 3). В вариантах 4 и 5 исследовались периодические дозы фосфора P2, P4. В варианте 6 применялась ежегодная доза P120. В последних трех вариантах использовались минеральные удобрения ежегодно N1K1. В звене исследуемого севооборота все агрохимические приемы детоксикации имели положительную закономерность. Вместе с тем высокая эффективность 109% получена от использования органо-минеральной системы (вариант 3).

Оценку агрохимических приемов детоксикации загрязненных почв проводили на основе изучения состава гумуса и качества внутрипочвенных вод.

Гумусообразование играет значительную роль в формировании почвы и ее важнейших свойств и признаков. Насыщенность 1 га посевной площади органикой несколько отличалась в опытах, но интенсивность накопления гумуса от различных агрохимических средств практически не различалась. Эти увеличения укладывались на черноземе в 6–25%, на дерново-подзолистой почве в 6–28%. В дерново-подзолистой почве процесс гумусообразования более интенсивно проходил при запасном внесении Р480 на фоне N1K1. Практически одинаковое влияние оказали органическая (Н80) и органо-минеральная (Н40 Р240 N1K1) системы. Процесс гумификации обусловлен факторами почвообразования, а фракционный состав гумуса – минералогическим составом. ГК позволили выявить, что наиболее ценная ГК-2, связанная кальцием, повышалась только в черноземе под влиянием систем удобрений. В дерново-подзолистой почве увеличивались концентрации ГК 1-ой и 3-ей фракциями. На них заметное влияние оказывали варианты Р480, Н40 на фоне N1K1. Сравнивая действия систем удобрений на качество гумуса в загрязненных почвах, удобрения в черноземе увеличивают содержание ГК на 10–45%, ФК – 8–51%, в дерново-подзолистой повышается концентрация ГК на 19–42%, ФК остается без изменений.

Общую загрязненность почвы поллютантами характеризует валовое содержание ТМ. Отрицательное влияние высоких концентраций ТМ на биосферу зависит от их подвижности. Пока элементы прочно связаны с составными частями почвы, они труднодоступны растениям, слабо выражена их миграция в биосфере. На повышено загрязненных почвах (вариант 1) проявляется выраженная зависимость содержания ТМ от типа почвы. В дерново-подзолистой почве концентрация ацетатно-аммонийных форм Pb и Cd выделена меньше на вариантах без удобрений, Zn и Cu – больше по сравнению с черноземом (табл. 4).

Таблица 4

Среднее содержание подвижных форм тяжелых металлов в почвах (экстрагент ацетатно-аммонийный буфер pH 4,8)

Варианты опыта	Оподзоленный чернозем тяжелосуглинистый				Дерново-подзолистая супесчаная			
	Pb	Cd	Zn	Cu	Pb	Cd	Zn	Cu
1. Б/у	19,2	0,25	53,6	33,2	24,1	0,44	37,1	14,3
	40	42	49	37	54	73	34	17
2. Н40N1P1K1	23,4	0,25	68,1	39,1	15,5	0,35	26,5	10,1
	59	42	62	43	39	58	24	11
3. Н40Р120N1K1	20,9	0,26	65,4	37,6	10,2	0,35	29,3	8,5
	52	43	59	34	26	58	27	9
4. Н40Р240 N1K1	21,0	0,26	73,7	42,1	10,3	0,33	40,1	11,2
	53	43	67	47	26	55	36	12
5. Н80	20,7	0,23	72,9	37,6	8,6	0,34	59,3	9,6
	52	38	66	34	22	57	54	11
6. Р480N1K1	19,0	0,24	67,4	38,0	13,7	0,23	48,3	7,8
	48	40	61	42	34	38	44	7
$НСР_{0,95}$	3,4	0,06	10,0	6,9	3,8	0,1	12,1	4,2

Примечание: В знаменателе содержание в мг/кг, в числителе – подвижность ТМ в %.

Рассматривая интенсивность образования подвижных форм элементов, следует отметить, что Cd наиболее интенсивно переходил в подвижную форму на черноземе, но при P120 на фоне N1K1 этот процесс резко снижался. В дерново-подзолистой почве вариант 6 (P480N1K1) имел ту же тенденцию.

Миграционная способность ТМ зависит от совокупности свойств почвы, химических загрязнителей, ландшафтной обстановки. Инфильтрация их через почвенный профиль сопровождается выведением органического вещества и связанных с ним ТМ. Изучаемые системы удобрений на дерново-подзолистой почве уменьшают в основном вынос Pb, Zn, Cu за пределы почвенного профиля и увеличивают Cd. В черноземе удобрения повысили миграцию Pb и снизили – Cd. Корреляционные исследования по влиянию качества гумуса (групп, фракций) на содержание ТМ во внутрипочвенных водах показали, что миграция Pb в почвенно-грунтовые воды в основном обусловлена 3-ей фракцией ГК в дерново-подзолистой почве (r = 0,59) и ФК-3 – в черноземе (r = 0,69). Поступление Cd в лизиметрические воды с ФК-3 в дерново-подзолистой почве имеет высокую степень зависимости (r = 0,77). В черноземе группа ФК, фракции ГК-2, ГК-3 и сумма фракций ГК имели отрицательные корреляции (r = -0,75, -0,78, -0,57, -0,74), но в данной почве обнаружена высокая миграционная способность Cd с фракцией ГК-1 (r = 0,81). Cu мигрирует преимущественно в виде комплексных соединений во фракциях ГК-2 и ФК-2 в дерново-подзолистой почве. Миграционная способность Zn в большей степени обнаружена в черноземе в виде фракций ФК-3 (r= 0,83) и ГК-2 (r= 0,65).

ВЫВОДЫ

1. В Рязанском регионе наибольшее атмотехногенное поступление относится к свинцу.
2. Результаты почвенно-экологического мониторинга показывают, что на интенсивность загрязнения почв ТМ оказывает близость расположения промышленных предприятий. В основном наблюдается низкое, среднее загрязнение почв, хотя отмечаются точки мониторинга, где определены повышенный и высокий уровень загрязнения Pb, V, Cu, Cd.
3. При детоксикации повышенного уровня загрязнения почв комплексом металлов (Cd, Pb, Zn, Cu) выявлена наиболее эффективная органо-минеральная система удобрений.
4. Системы удобрений в основном уменьшают вынос Pb, Zn, Cu за пределы почвенного профиля в дерново-подзолистой почве, но увеличивали – Cd. В черноземе снизили миграцию Cd, но повысили – Pb. Миграция обусловлена в первую очередь фульвокислотами фракцией 3.

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Safety and risk of hydraulic structures

THE ORGANISATION OF THE OBSERVATION SYSTEM IN DAMS AS THE MAIN PART OF SAFETY OF RESERVUARS EXPLOTATION (On the example of Gekhi dam)

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ABSTRACT: The Geghi dam of hydraulic complex is the highest soil dam in the Republic of Armenia. The hydraulic complex consists of the dam and auxiliary structures such as a catastrophic spillway, discharge tunnel etc.

The paper describes development of equipment location diagram and grounding of their necessity for measurement of deposits and deformations of the dam. Proceeding from specific characteristics of the structure special measurement instruments of safe operation and provide high accuracy of measurement.

KEYWORDS: dam, wastewater, diameter, dynamometer, measurement unit.

INTRODUCTION

The Geghi reservoir is located on the Gekhi River in Syunik region of the Republic of Armenia, on 4km higher and merges to the river Vokhchi. Construction of the Gekhi Dam was almost completed in 1990, but wasn't put into operation waiting for project data verification after the 1988 Spitak earthquake. Since 2004 a reconstruction project has been under way by efforts of the molybdenum industrial complex. After successful completion of the project review and reconstruction the Gekhi Dam will be placed into operation.

The dam is rock-fill; its height at the reservoir is 70 m and has an inclined clay core with a single layer of a filter from upstream reach and downstream reach. The core is placed on a concrete plate built on bedrock foundation. The grout cover of depth ranging from 20 to 23 m has been built under the dam.

The catastrophic spillway located at the right bank pier consists of a trench spillway with a 70 m length of the spillway deck front which passes to inclined shaft of a 5×4 m horseshoe section, which is connected to the derivational tunnel in its lower part. The entire spillway path has been designed as free-flow.

The water intake design is simple, has two intakes on each a removable rough trash rack is mounted. Double openings are narrowing to a steel coated single tunnel the diameter of which is 1.32 m. The tunnel then is branched at the entrance to the shaft to mine to the access of the valves drives. The initial pressure section of the tunnel is of 73 m length. At the end of the tunnel an underground room for gates arranged. The control system consists of the vertical shaft of 40 м depth, the underground chamber of gates where four gates with hydraulic drives are located.

On each of the branches an emergency and working gates are mounted. Behind the gates there is a stilling basin of 11.7 m length made by erecting in the tunnel a spillway concrete wall of 2 m height.

Further, there is a small transitional 12 m-long section is arranged from which water enters the free-flow tunnel of horseshoe 2.5×2.5 m section. The tunnel length is 88 м, and then it is connected to the inclined tunnel of a waterwaste path in its middle flow.

In 2004 the additional bottom water outlet, on the left board of the dam was designed and built. The bottom water outlet consists of a bottom tower with two reception openings. The first opening of a rectangular outline is made with a bottom, on elevation of 1342m and is intended for full discharge of the reservoir. The second opening is made in the form of three oblong "windows", with the bottom intake elevation mark of 1348m. Openings are equipped with trashracks. Further, water gets to the pressure head tunnel of round section with the diameter of 2.2m and length of 335m. At its end the tunnel forks, with transition to two openings of round section with the diameters of 2m and 1.22m. The first pipeline is designed for water evacuation from the reservoir. At the tunnel exit to the day surface, the stilling well is built by erecting water drain concrete wall then water by the channel of rectangular section moves to the stilling basin arranged on a waterwaste path.

The second pipeline feeds water to the assumed building of SHPP and up to its end remains pressure conduit. The main technical characteristics of the reservoir and structures are given in the Table 1.

Table 1

The reservoir technical characteristics

№	Main characteristics	Measurement unit	Meanings
1	2	3	4
General data			
1	Name		Gekhi
2	Region		Syuik
3	River		Gekhi
4	Construction data		1990/2013
5	The population in a flooding zone	People	4300
6	Water accumulated area	км^2	280.8
7	Purpose		Water supply
8	Subordination	Kadjaran copper molybdenum factory	
Water basin			
10	Volume at NPU	Mil.м³	15
11	Net volume	Mil.м³	12
12	Dead volume	Mil.м³	3
13	NPU mark	м	1402.00
14	FPU mark	м	1403.4
15	MG mark	м	1371.5
16	Mirror area		
Dam			
17	Type	Stone covered	
18	Dam class		1
19	Ant filtration actions		Core
20	Material of a body of the ant filtration device		Loam
21	Height	м	70
22	Crest mark	м	1405.00

Table 1 (Continuation)

1	2	3	4
23	Crest width	м	10
24	Length on a crest	м	744
26	Material of a body of a dam		Riprap
27	Basis		Rock
28	Basis of a riding slope		1:2.25-1:2.75
29	Basis of a local slope		1:1.5
30	Fastening of a riding slope		Concrete facing
31	Fastening of a local slope		Stone sketch
Catastrophic spillway			
33	General expense	$м^3$/sec.	264
34	Type ogolovka		trench
35	Length of the water drain front	м	70
36	Coefficient of an expense of a spillway		0.46
37	Type of waterwaste path		Tunnel
Water outlet			
40	Amount of water outlet	piece	1
41	General expense	$м^3$/sec.	6
42	The type of water outlet		Ground
46	Constructing device		Rough lattice
47	Working locks		Flat lock
48	Emergency locks		Flat lock

According to the project, on the dam control instrumentation in particular – piezoelectric load measuring element/transducer and soil dynamometers of the Soviet production was installed. However, during temporary preservation of the dam, all cables of devices were cut off so all control equipment has irrevocably been lost. Therefore, creation of a new observation network before filling the dam became one of actual problems of a re-conservation of structures.

Proceeding from design decisions and an actual state of structures, it is supposed to carry out the following program of supervision on the dam and structures of the Gekhi reservoir. Supervision will be conducted:

On the dam

1. Filtration mode of the dam,
2. Precipitation and horizontal deformations of the dam body,
3. Fracturing on the dam crest,
4. Contact of a core with a concrete wall,
5. Seismic loads.

On the Catastrophic spillway:

1. Trench and tunnel joints opening,
2. Tunnel lining deformations,
3. Filtration and erosive leakage regime of water behind the lining.

On the right-bank water outlet:

1. Tunnel joints opening,
2. Tunnel lining deformations,

3. Filtration and erosive leakage regime of water behind the lining,
4. Lists of the water outlet shaft.

It is planned to install Sisegeo (Italy) instrumentation on the dam. Total quantity is presented in table 2.

Table 2

The quantity and location of the monitoring system

N	Name	PK 0+00	PK 0+78	PK 1+23	PK 1+50	PK 1+78	PK 2+23	PK 2+83	PK 3+15	Water outlet	Total
1	Fundamental benchmark	1	0	0	0	0	0	1	0	0	2
2	Surface mark	0	3	4	0	4	3	0	0	0	14
3	Seismometer	0	0	0	2	0	0	0	0	0	2
4	Inner piezometer	0	2	2	0	2	2	0	0	0	8
5	Sinking piezometer	0	2	3	0	3	2	0	0	0	10
6	Inclinometer	0	2	2	0	2	2	0	0	0	8
7	Extensometer	0	4	4	0	4	4	0	0	0	16
8	Water level sensor	0	0	0	0	0	0	0	0	1	1
9	Seismometer	0	0	0	3	0	0	0	0	0	3

1. DAM

SUPERVISION OVER FILTRATION MODE

Filtration researches are one of the main objectives of monitoring of dams built using local materials. Depressions surface observation is one of the main problems of filtration control. In the upstream shoulder the organization of supervision doesn't make sense as there water level in the reservoir practically is established. The organization of supervision over a depression in a core of already erected dam technically is not feasible. Supervision are supposed to be conducted by installation of three piezometers in the central sections and – two piezometers in lateral sections. The scheme of the equipment installation in the central section of the dam is shown in Fig. 1. For automation of supervision an installation of P252R pressure sensors is suggested. The sensor is installed in a well, with a piezoelectric dynamometer column of diameter 38мм from special punched plastic filter and a column of the same diameter. The mouth of the well is equipped with standard tip and protection against excessive stress. That is obligatory for this type of converters is established.

DEPOSITS AND HORIZONTAL DEFORMATIONS

It is well-known that high rock-fill dams are subject to considerable vertical deformations. For measurement of vertical and horizontal deformations of the dam a complex of measuring equipment is foreseen.

On the surface of the dam the network consisting of two fundamental reference points and signs along the crest of the dam and downstream berm has been foreseen.

For measurement of deposit and horizontal shifts of the downstream shoulder installation of S242SV3000 extensor-inclinometers has been foreseen. For measurement of vertical deformations T-REX the REX4510000 extensometer is used. Measuring instruments work in wells surrounded with special section pipes, for deviation control.

Both measuring instruments are hand-hold and are not connected to the central console. Such solution was accepted because the automatic inclinometer involves a chain of measuring instruments mounted along the entire length of the well. This equipment is very expensive. Manual measurement will be carried out during two years after the reservoir fillup. According to measurement data the zone of active deformations of the dam's body will be localized. Now automation of the system of observations is possible by setting a chain of measuring instruments only in the localized zone. Installation diagram of inclinometers is shown in Fig.1.

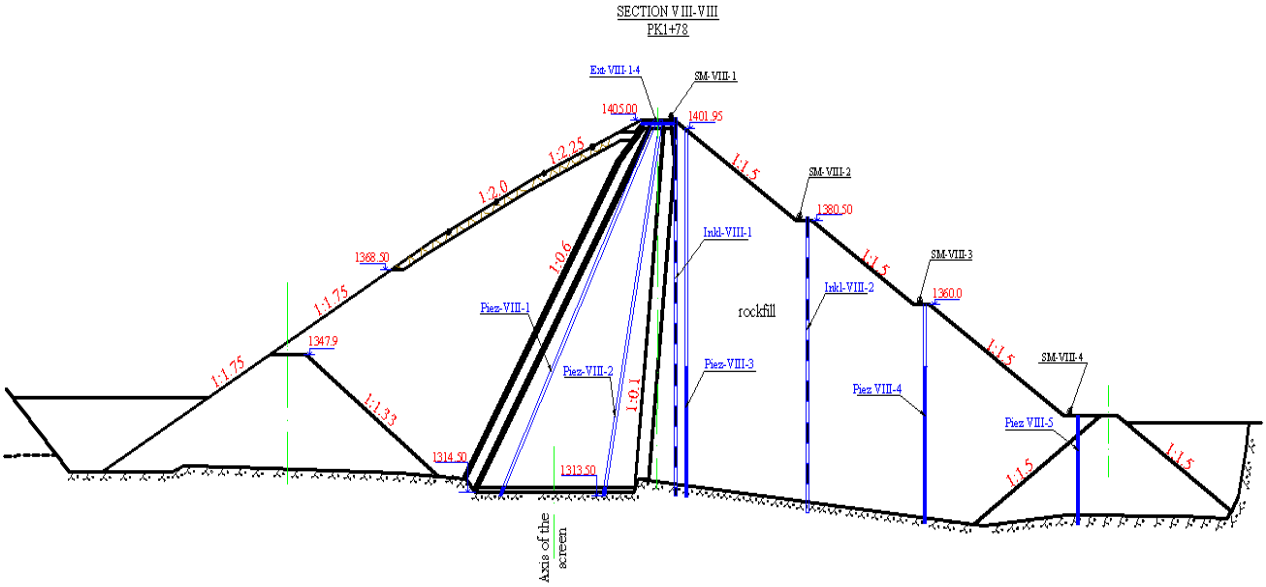


Fig. 1. Arrangement of monitoring systems along the dam's central cross section

FRACTURING ALONG THE CREST

In connection with that that longitudinal cracks were detected at the crest of the dam after completion of construction, it is very important to organize observations of fracturing at the dam's crest. Such observations are implemented by installation of the chain of D232 ground extensometers on the crest (lower the depth of frost penetration).

In each section four extensometers, connected in a common chain, are installed. Anchor plates are installed in such a way in order to cover contacts "upstream shoulder-filters", "filters-core", "filters-downstream shoulder". Cables from extensometers are tapped to switching cabinet units and further to data recorder.

CONTACT BETWEEN THE DAM AND CONCRETE WALL

The most important, from the filtration point of view, is the contact of the dam core with the cement-grout curtain. To control the state in the section under study, it is enough to install piezometers before and after cement-grout curtain with filters immediately on the contact. As far as these piezometers can not be replaces from now on, it is assumed installation more reliable and long-term string measuring PK45A devices.

Piezometers are installed immediately at the core contact with a base before and after cement-grout curtain at 5 m distant from the curtain axis.

SEISMIC MONITORING

It is assumed to carry out seismic monitoring only in the central dam site. It is suggested to install three MR2002 accelerometers on the crest, banked earth, and at the base in the downstream reach. The

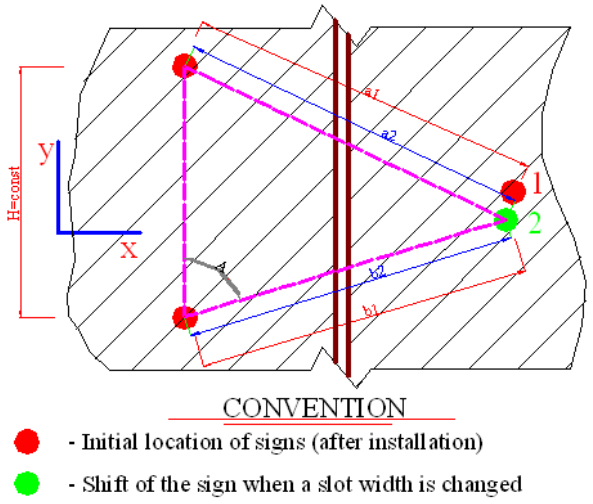
accelerometer on the crest will serve as the main, and the other two – secondary. All accelerometers will be connected with ones installed on the crest, which is equipped with standard RS232 port. The supply will content a special program designed for processing observation data.

2. CATASTROPHIC SPILLWAY, RIGHT BANK AND LEFT BANK TUNNELS TRENCH AND TUNNEL JOINTS OPENING

In order to measure joints opening of trench spillway and horizontal section of the discharge tunnel, installation of overlay biaxial slot width gauges is foreseen.

The main problem here consists in measuring the distant between three points, fastened at both sides of the joint. Fig.2 shows the diagram of measurement and deformation calculation methodology. In the capacity of measuring points special anchor bolts are installed. Measurements are carried out by portable DF250 deform meters.

SETTING OF SLOT WIDTH GAUGE SIGNS



OBSERVATIONS OF THE TUNNEL DEFORMATIONS

Deformations of the tunnel lining are determined by accurate measurement of distances between fixed points on the lining in the measured dam site. Fixation of points is carried out by installing anchor bolts in the vault and walls of the tunnel by a diagram shown in Fig.3. The distance between points is determined by measurements using DNP0 tape extensometer. The measuring tape is made of stainless steel. The measuring device is equipped with a compressor providing equal tape tension at different measurements which provides results accuracy.

The difference of distance measurements between fixed points in different time testifies on the lining deformations. On the basis of the measurement results deformations can be calculated in the direction of interest. Measurements are made manually upon the tunnel emptying.

OBSERVATIONS OF FILTRATION AND EROSIVE LEAKAGE REGIME

Vertical walls of galleries and tunnels often are reason of erosive leakage initiation along the contact with the rock. To control erosive leakage phenomena occurring with the tunnel lining the pair of the tunnel piezometer and sample taker is installed.

The tunnel piezometer is a tube having a filter tip. The sample taker is a tube having a protective net at the tip. In the orifice of the tube a cock for a sample taking is installed in

CROSS SECTION 2–2

Diagram of extensometer signs settings

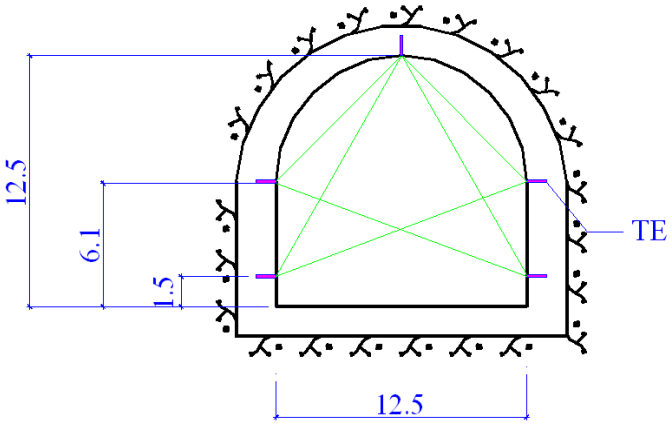


Fig. 3. Diagram of the tunnel lining deformations

order to determine presence of mechanical and chemical internal erosion.

In case both of the devices are installed in existing tunnels, the tube is equipped with a rubber wad enabling quick localization of the drill cutting. In the orifice of the piezometer a cock is installed for air tap and manometer as shown in Fig.4.

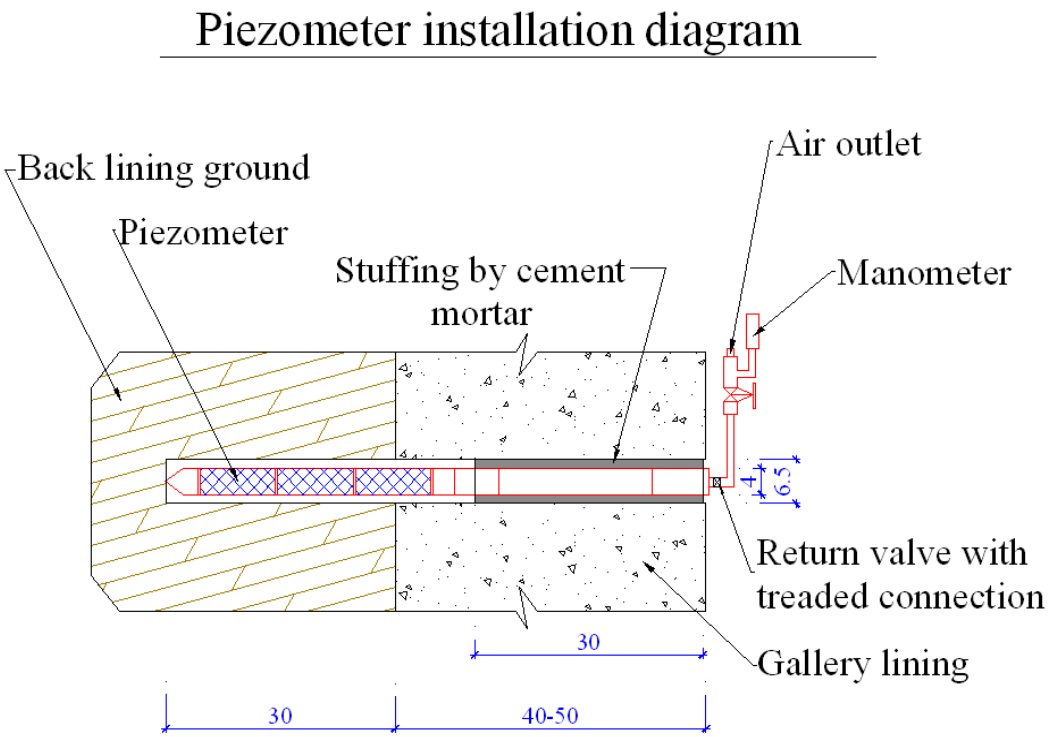


Fig. 4. Tunnel piezometer setting draft

OBSERVATIONS OF THE DISCHARGE OUTLET SHAFT TILT

The shaft access to the water discharge outlet is located at the immediate vicinity to the reservoir right side at the end of the trench discharge outlet. The shaft higher left wall involves a retaining wall under reservoir water immediate pressure. Closeness of the shaft to the reservoir doesn't except deformation and tilt of its hole under water pressure. Therefore, it is suggested to organize observations of the groove deformation.

Surface displacements of the shaft platform will be carried out by geodetic methods using electronic tachometer.

It is suggested to implement measurements of the shaft tilt using surface S521clinometers installed in the shaft groove. It is supposed to install clinometers at the left and right wall along the axis of the tunnel. It also is suggested to set three observation points at the left wall. The first clinometer is installed at the midway of the retaining wall, the second and third divide the rest of the shaft groove nearly to three equal parts. Along the right wall installation of two observation points dividing the shaft wall approximately to three equal parts will do. It is suggested to install magneto resistor clinometers (Fig. 5).

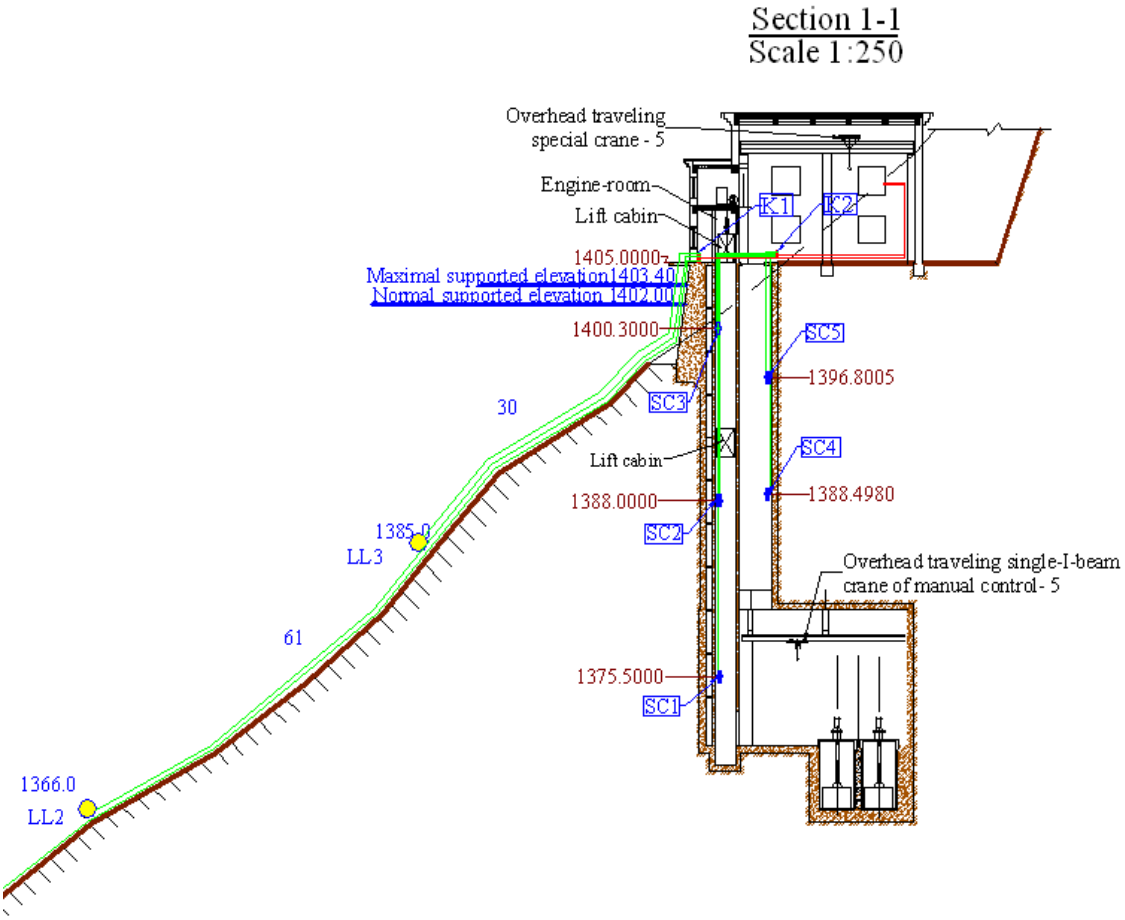


Fig. 5. Clinometer installation for the shaft control

3. DATA GATHERING AND PROCESSING

To automatically register and preprocess data incoming from all instruments cable lines from each sensor individually are connected to switching devices and then to ADK100 data register. The latter is a multifunctional recorder of data, developed especially for the system monitoring. Multifunctional operational system enables executing measuring communication functions concurrently. In the recorder three 16/32CH multiplexers are installed separately.

The recorder automatically conducts inquiry at the entire system of instruments and implements data transfer by an in-built GSM modem. Data as a client desires, via Internet, will be accessible to people having respective access.

The recorder also can provide a system of alarm annunciation for all threshold quantities incoming from connected devices. Also, in the recorder there is a built-in chargeable battery providing power for interconnected devices.

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Hydraulic engineering and irrigation

ABOUT RECULTIVATION OF LAND POLLUTED WITH OIL AND OIL PRODUCTS ON APSHERON PENINSULA

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ABSTRACT: In the article they give information of the state of polluted land and areas of its spreading on Apsheron peninsula having a long history of oil output.

They analyse methods and technology of recultivation work to renew land polluted with oil and oil product in the Azerbaijan (specifically on Apsheron peninsula) comparing with the experience of developed countries.

Besides, they present the data of criteria (norms) of evaluating pollution in order to use optimum way of recultivation.

KEYWORDS: polluted land, criteria of pollution, oil product, recultivation.

Гидротехника и мелиорация

О РЕКУЛЬТИВАЦИИ ЗЕМЕЛЬ ЗАГРЯЗНЕННЫХ НЕФТЬЮ И НЕФТЕ-ПРОДУКТАМИ НА АПШЕРОНСКОМ ПОЛУОСТРОВЕ АЗЕРБАЙДЖАНА

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АКТУАЛЬНОСТЬ РАБОТЫ

Добыча нефти в Азербайджане, в частности на Апшеронском полуострове имеет очень давнюю историю и исчисляется несколькими веками. Следует отметить, что на Апшеронском полуострове только промышленным способом нефть добывается с 1870 года. Здесь за длительное время нефть добывали разными способами, в основном, глубинно-насосным и добыча всегда сопровождалась большими потерями нефти, загрязнением и нарушением плодородного почвенного слоя, а также окружающей среды. Интенсивное добывание нефти особенно в период существования бывшего СССР, помимо загрязнения нефтью почвогрунтов, были загрязнены и многие естественные озера и пруды Апшеронского полуострова нефтью и нефтепродуктами, буровыми водами и отходами, фитотоксичными канцерогенными веществами, увеличены все их морфометрические характеристики, в том числе и площади их водной поверхности (зеркала).

Все эти процессы значительно уменьшили площади плодородных земель, во многих местах привели к подъему уровня грунтовых вод и к вторичному засолению почв, ухудшили экологическое состояние полуострова и санитарно-гигиенические условия жителей многих населенных

пунктов находящихся в непосредственной близости с нефтезагрязненными землями, озер и прудов. Поэтому рекультивация и восстановление земель загрязненных нефтью и нефтепродуктами на Апшеронском полуострове очень актуальная проблема.

ЦЕЛЬ ИССЛЕДОВАНИЯ

Целью исследования является анализ проведенных работ по рекультивации и восстановлению земель загрязненных нефтью и нефтепродуктами на Апшеронском полуострове для выявления более приемлемых методов.

ОБЪЕКТ ИССЛЕДОВАНИЯ

Объектом исследования являются нефтезагрязненные земли на Апшеронском полуострове. По данным Управления Экологии Государственной Нефтяной Компании Азербайджанской Республики (ГНКАР) земли загрязненные нефтью и нефтепродуктами на Апшеронском полуострове требующие рекультивации составляют 7500 гектаров. Эти земли в основном расположены около нефтяных месторождений Сабунчи, Сураханы, Маштаги, Бузовны, Гала, Пираллахи, Гарадаг и др. Помимо загрязненных на этих территориях в определенной степени ухудшили и водно-солевой режим почво-грунтов, имеются отдельные участки подверженные вторичному засолению.

МЕТОДЫ ИССЛЕДОВАНИЯ

Ознакомление и анализ методов, технологий и принципов проведенных работ по рекультивации и восстановлению земель загрязненных нефтью и нефтепродуктами в Азербайджане, сравнительно с опытом других стран для установления оптимальных вариантов. С научно-практической точки зрения различные мероприятия по рекультивации почв, загрязненных нефтью и нефтепродуктами необходимо принимать с учетом санитарно-гигиенических норм и оценки экологической обстановки территорий. Поскольку в Азербайджане, как и во многих нефтедобывающих республиках комовые входили в состав бывшего Советского Союза утвержденных норм предельно допустимых концентраций нефтепродуктов в почве, то необходимость проведения рекультивации загрязненных земель должна быть обоснована как по уровню загрязнения, так и по последствиям на окружающую среду. Кроме того методы рекультивации, также необходимо определять с учетом характера загрязнения, водно- физического свойства почв и природных условий, обуславливающих самоочищающуюся способность компонентов геосистемы.

Исходя из вышеизложенных требований нами проведены анализы принятых критерий по оценке загрязнения почв нефтепродуктами как в Азербайджане, в частности на Апшеронском полуострове, так и в других странах с целью рекомендации оптимальных уровней рекультивации с соответствующими технологиями.

СОДЕРЖАНИЕ ИССЛЕДОВАНИЙ И ПОЛУЧЕННЫЕ РЕЗУЛЬТАТЫ

В управление Экологии (ГНКАР) более десяти лет проводятся большие работы по рекультивации и восстановлению земель загрязненных нефтью и нефтепродуктами на Апшеронском полуострове с целью исполнения экологической государственной программы. На основании утвержденных договорам между Управлением Экологии (ГНКАР) и Азербайджанским Архитектурно-Строительным Университетом за это время сложилась нормальное сотрудничество. Поэтому студенты,

подготовленные по специальности "Мелиорация, рекультивация и охрана почвы" на кафедре "Гидротехнической мелиорации и гидрологии", под руководством назначенных сотрудников кафедры и Управлении Экологии проходят свою производственную практику на местах, где проводится рекультивации земель, загрязненных нефтью и нефтепродуктами, особенно где применяются сложные рекультивационные технологии. А также проводится обмен опытом между сотрудниками ААСУ и ГНКАР по данным проблемам и подготовке специалистов.

Как правило сложные рекультивационные технологии с применением земле очистительных установок различной конструкции используются для восстановления высоко нефтезагрязненных почв. А для рекультивации низко и средне нефтезагрязненных почв применятся и другие более простые способы не требующие больших затрат. К этим способам можно отнести простые технические, биологические, химические, биотехнологические и др.

На основание своих исследований Г.Ш. Мамедовым, Г.Ш. Ягубовым, В.А. Ахмедовым, Н.М. Исмаиловым и другими учеными предложены различные способы и мероприятия по рекультивации земель с учетом оценки и характера загрязнении на Апшеронском полуострове.

Оценки загрязнения в целях рекультивации и применяемые ее методы в разных странах мира отличаются и имеют разные критерии. Например в Нидерландах для оценки загрязнения почв применяются три уровня: 1 – фоновый с содержанием нефтепродуктов 50 мг/кг; 2 – повышенное загрязнение-1000 мг/кг, при котором организовывается мониторинг, выявляются и устраняются причины загрязнения; 3 – высокое загрязнение – 5000 мг/кг – служит основанием проведения рекультивации почв и грунтовых вод.

В Германии допустимые концентрации нефтепродуктов в почве приурочены к участкам, имеющим разную геоморфологию: водоохранные зоны и заповедники – 300 мг/кг; водоразделы – 5000 мг/кг. Многие страны Западной Европы за верхний безопасный уровень содержания нефти в почве принимают 1000 мг/кг. Для Российской Федерации с исключением Татарстана и Москвы за нижний безопасный уровень загрязнения почв принимается 1000 мг/кг, рекультивационные работы рекомендуют начинать при содержании нефтепродуктов- 1500 мг/кг, а для условий Москвы – 300 мг/кг. Кроме того в России для оценки загрязнения применяют следующие три уровня:

а) Для земель сельскохозяйственного назначения: 1 – низкий уровень загрязнения – (300-1000 мг/кг); 2 – средний и высокий уровень – (1000-5000 мг/кг); 3 – очень высокий уровень – выше 5000 мг/кг;

б) Для земель несельскохозяйственного назначения: 1 – низкий уровень загрязнения – (1000-5000 мг/кг); 2 – средний и высокий уровень – (5000-10000 мг/кг); 3 – очень высокий уровень – выше 10000 мг/кг;

Ввиду того, что в Азербайджане и в частности для условий Апшерона пока не разработан фоновый уровень с содержанием нефтепродуктов и ее критерии, с целью оценки применяют различные нормы. Например в Управлении Экологии и в системе ГНКАР целом для оценки загрязнения почв принимают следующие градации:

1. Слабо загрязненные почвы – 300 мг/кг
2. Мало загрязненные почвы – 3000-6000 мг/кг
3. Средне загрязненные почвы – 6000-25000 мг/кг
4. Очень сильно загрязненные почвы – свыше 25000 мг/кг

Учитывая трудности и сложности разработки стандартов по оценке фонового уровня и его критерий содержанием нефтепродуктов в рамках одной страны, в том числе Азербайджана, то для выбора оптимального метода рекультивации, существующие национальные нормы должны быть увязаны с системами международных стандартов с учетом способности самоочищения почвы.

Для условий Азербайджана Н.М.Исмаилов – предлагает приблизительно допустимый уровень загрязнения для легких нефтепродуктов в зависимости от способности самоочищения почвы в следующих пределах:

– для почв с низкой способностью самоочищения – 2000 мг/кг;

– для почв со средней способностью самоочищения – 4000 мг/кг;

– для почв с высокой способностью самоочищения – 8000 мг/кг.

А для тяжелых нефтепродуктов при высокой способности самоочищения почв допустимый уровень загрязнения предлагается 4000 мг/кг.

Учитывая предложения Н.М. Исмаилова в увязке с принятыми фоновыми уровнями загрязнения нефтепродуктами в Нидерландах и Российской Федерации и основываясь критериями оценки загрязнения предложенными управлением экологии (ГНКАР) повышения эффективности восстановления нефтезагрязненных почв нами рекомендуются принять следующие оптимальные уровни рекультивационных мероприятий:

1. Для слабо и мало загрязненных почв 300 мг/кг и 3000-6000 мг/кг первый уровень рекультивационных работ;

2. Для средне загрязненных почв 6000-25000 мг/кг второй уровень рекультивационных работ;

3. Для очень сильно загрязненных почв >25000 мг/кг третий уровень рекультивационных работ.

Рекультивационными работами первого уровня активизируются почвенные микроорганизмы по деструкции углеводородов. Сюда входят рыхление почвы, внесение извести, гипса, высоких доз органических и минеральных удобрений с последующей запашкой, создание мульчированной поверхности из высокопитательных смесей, посев нефтетолетарнтных растений с повышенными нормами, а также возможно применение сложных мелиорантов и т.д.

При рекультивационных работах второго уровня проводят замену загрязненного слоя путем удаления его, создают рекультивационный слой способом смешивания замазочных и чистых слоев почвы, вносят органо-минеральные и бактериальные активаторы (керамзитовые окатыши, навоз, биодеструкаторы), устраивают поглотительно-экранирующие слои под загрязненном слоем из минеральных грунтов и извести. При очистки почв от нефтепродуктов с использованием биодеструкторов эффективность обеспечивается активностью микроорганизмов по отношению к углеводородам в условиях хорошей аэрации почв, благоприятного водного, температурного ($5^{\circ}\div30^{\circ}C$) и питательного режимов почв.

Почвы с высоким уровнем загрязнения требуют применения сложной технико-термической рекультивационной технологии с использованием нефтеочистительных устройств. Для этого загрязненные слои почвы вывозятся машинами к стационарному нефтеочистительному цеху. В цеху в начальной стадии почва в приемном вибрационном бункере очищается от крупных отходов в размерах 120-150 мм и оставшаяся основная масса конвеером подается в смесительную камеру на промывку. Туда же подается чистая вода вместе с активно поверхностным средством, проводится водно-паровая системная промывка, где в процессе используются разные блоки конвейеров, насосных устройств, вибросито, гидроциклонов, паровых устройств, осаждающих емкостей, емкостей для воды и нефти и т.д. Как указано в технических характеристиках нефтеочистительных устройств эксплуатируемых в управлении экологии (ГНКАР) в результате их применения уровень загрязнения снижается до одного процента. Потом эти почвы перевозятся обратно на вывозные участки и эксплуатируются. А для сельскохозяйственных земель было бы целесообразным проводить и второй этап – применяя мероприятия первого уровня рекультивации с целью ускорения сроков восстановительных процессов.

Для рекультивации очень сильно загрязненных почв, соответствующей третьему уровню помимо использования нефтеочистительных устройств с последующим применением мероприятий по первому уровню рекультивации считаем что, необходимо применение и инженерно-экологического бедствия. Основы системы могут составлять такие инженерные сооружения, как дамба обвалования, стена в грунте, нагнетательные скважины, горизонтальный и вертикальный дренажи, добывающие скважины и т.д.

ВЫВОДЫ И ПРЕДЛОЖЕНИЯ

1. Анализируя предложения и опыт национальных и зарубежных ученых исследователей для повышения эффективности восстановления нефтезагрязененых почв рекомендуется принять оптимальные уровни рекультивационных мероприятий в зависимости указанных выше пределах загрязнения.

2. После снижения уровня высоко загрязненных почв в нефтеочистительных цехах до одного процента предлагается целесообразным проведение мероприятий первого уровня рекультивации с целью ускорения сроков допустимого восстановления.

3. Для рекультивации очень сильно нефтезагрязненных почв соответствующего применению третьего уровня рекультивации помимо выполнения требующих рекультивационных мероприятий второго уровня считается необходимым применение и инженерно-экологической системы для предотвращения экологического бедствия.

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Earth sciences

COMPOSING METHODS OF THE MAP OF ANTHROPOGENIC TRANSFORMATION OF NATURAL LANDSCAPES OF THE AZERBAIJAN REPUBLIC

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ABSTRACT: The present Landscapes of the republic are the naturally–anthropogenic complexes, which are being regulated and managed by men. Constantly or periodically controlled their structural-functional specificities and the productivity. The systematic way of these complexes analysis plays major role in socio-economical progress of our country. At the made up by us the maps the Landscapes, being functioned with in the participation of a man and regulated by him one can notice various natural complex on their backgrounds.

KEYWORDS: landscape, anthropogenic transformation, natural landscapes, socio-economical progress, indication elements, landscape categories.

The map of the anthropogenic transformation of natural landscapes of the Azerbaijan Republic with the range 1:600000 is a result of systematic landscapes of researches, carried out in the period of 1985 to 2010 years. The basis of this map makes up the landscape maps drown up by us for separate regions of the republic (Greater Caucasus, Minor Caucasus, The Kur Lowlands Nakhchivan Autonomous Republic, Lenkoran province, The Mughan-Salyan massif, the Shirvan and the Mil-Garabagh plains). These maps were being joined together on the basis of the unique legends and the range, were being innovated in 2007-2010s.with necessary supplementary field researches, and as well as the information obtained with in the deciphering of cosmic photographs. While making up the maps there used the programs of MAPINFO, GIS, COREL DRAW, etc.

The present Landscapes of the republic are the naturally–anthropogenic complexes, which are being regulated and managed by men, and constantly or periodically controlled their structural-functional specificities and the productivity. The systematic way of these complexes analysis plays major role in socio-economical progress of our country. At the made up by us the maps the Landscapes, being functioned within the participation of a man and regulated by him one can notice various natural complex on their backgrounds.

At the map were being marked out more than 3000 contours which were distributed in 12 (twelve) landscape categories, 18 subcategories and 138 landscape versions.

The map of the present landscapes can reflect the structure and the transformations of the contemporary landscapes of the Republic. On the basis of Cosmic photographs deciphering were exposing some indication elements of natural and the anthropogenic complexes, on a natural landscapes put the natural habitats with the economic load, which have got various configuration and measure of course.

One of the main features of this map is that when choosing the landscape unit the degree of their anthropogenization were being taken into the consideration.

Deciphering of aero and the cosmic photographs with the aim of learning of the anthropogenic transformation of contemporary landscapes is an actual question of the modern landscape learning. A number of investigators (Smirnov, 1975; Vinogradov, 1981; Kvartsova, 1977, 2000; Alizadeh, 2000-2010 and the others) paid much attention for the working out of the methods of learning of the contemporary state of natural complexes, and as well as their anthropogenic transformations. The anthropogenic complexes were being deciphered on cosmic photographs more clearly than the natural landscapes. While deciphering the anthropogenic complexes of lower autonomic ranges side by side with the photo tone and color of a picture where the major role plays the drawing of a picture as well.

In agro-irrigational complexes as the reliable indication signs can be accepted the peculiarities of a relief, drainage sets, drawings, the size and forms of a field, the salty areas of grounds and the others. With certainty were being deciphered the agro-complexes alluvial the seas and seaplanes, the complexes of alluvial, alluvial-proalluvial plains with a collector-drainage and the irrigation system, and as well as the fields having rectangular forms .On the autumn-time and the black-and-white cosmic photographs the cotton fields were being attracted in dark-grey photocolor but on a spring-time photographs in light-grey photocolor, and on a color-photographs-with tint red color photographs. In autumn time the grain-crops are usually described in grey photocolour; ploughed but not sowed fields in white color; gardens, plantations and the personal plots described in orange-red color and fine-grained picture; non-irrigated complexes are being deciphered in light-brown colour. In the process of irrigational landscapes mapping have been taken into consideration not only the degree of the anthropogenization of a concrete landscape unit and the other factors, like natural and artificial breakdown of a relief, hydrogeological conditions, the level of mineralization of ground waters and their seasonal dynamics , thickness of the agro-irrigational layers in a topsoil, the features of the cultivated crops, type amount of vegetation, vegetation period, productivity and the others.

The relief, soil, climatic conditions, vegetable kingdom, surface and the underground waters, hydrogeological and the agro-ecological conditions were being analyzed with the help of necessary information obtained from the cosmic photographs and some special maps, of reserved and literary materials.

Such kind of information allows us to make a conclusion that the numerous modifications of the anthropogenic origin could stipulate to a strong breakdown of natural landscapes and distributing them to not a great natural habitats. And these natural habitats are able to attract various aspects of anthropogenic transformations, and with their help it is possible to determine the degree of landscape degradations.

Taking into account of this fact the compiled up map can be used in landscape planning, realization of land reclamation measures and in preparation of ecological programs as well.

Landscape categories change each other from plains up to mountains. Intensively used, greatly transformed agro-irrigational landscape plains are changed with not irrigated agro-landscapes of sub-mountainous ones being regularly irrigated and in indifferently transformed, intensively used with selitebnic, secondary-technogenic, and artificial-wood complexes. Here are given irregularly used pastures , wood-bushes, wood-grasslands-bushes complexes, being transformed in some degree of subalpine and alpine grasslands and as well as practically unchanged and subjected to some episodic anthropogenic influences of sub-nival and the nival complexes of the high mountains.

The results of the research state of modern landscapes and the scales of economic loads, and as well as the data obtained with the help of aero-and the cosmic materials underlay in a large scale maps of anthropogenic transformations of natural landscapes of the Azerbaijan and also the maps of some separate regions of the Republic (Nakhchivan AR, with the scale of 1:240000, Greater and the Minor Caucasus 1:280000, Kur-Araz plains 1:200; Lenkoran region 1:240000). There were given the categories, groups and

variations, which distinctly attract present state of landscapes, the correlation between the anthropogenic and the natural types of Landscapes and the degree of the anthropogenization of the concrete territories. For the first time with the usage of GIS of modern landscapes of the Azerbaijan Republic were being grouped on the degree of the anthropogenic transformations with the distribution of seven categories, twelve subcategories and twenty two landscape variations.

The grouped maps of natural landscapes of Azerbaijan Republic on the degree of the iranthropogenic changes were composed in 1:60000 scale on the basis of cosmic photographs deciphering. The landscape map besides various aspects of the anthropogenic transformations of natural complexes is also reflecting the level of degradation.

The categories of landscapes were determined on the basis of conformity of vertical differentiations of natural complexes but subcategories on the basis of the amount of economic loads. The versions of not large landscapes reflect the peculiarities of the anthropogenic natural complexes and play major role in estimation of the ecological conditions (***drawing 1***).

On the map the transformations of modern landscape structures of the mountainous and the flat regions are presented. To natural habitats of landscapes, reflecting some indication elements, the configuration of natural and anthropogenic complexes put necessary economical load, and cultivating of the territorial units .As a result of existing information obtained from cosmic photographs there done the analysis being characteristic for some concrete landscape units the peculiarities of the relief, vegetable cover, climatic condition, surface and underground waters, hydraulic conditions, as well as done necessary estimation of the agro-ecological conditions of a region.

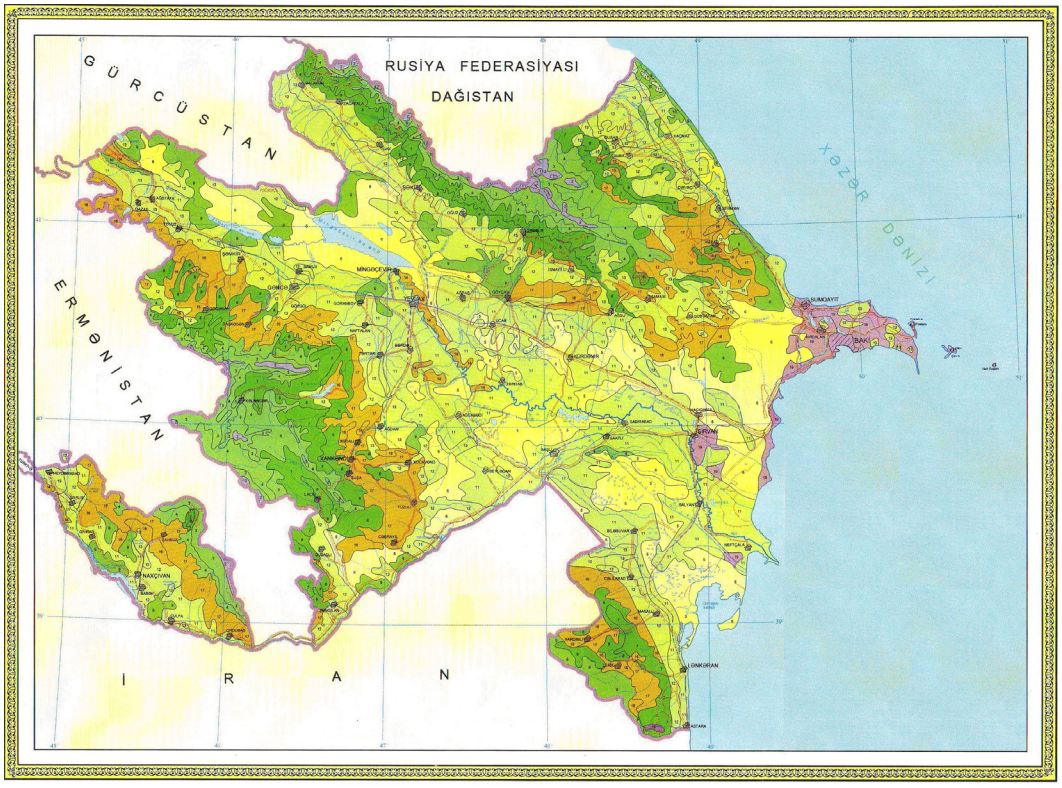

Fig. 1. The map of the grouped of natural landscapes of the Republic of Azerbaijan on the degree of the given anthropogenic transformations.
Scale: 1:600000; compiler Y. A. Garibov

Conventional-signs (drawing 1)

I. Practically unchanged landscapes saving natural peculiarities.

I. Nivally-glacial complexes greatly broken down into the Alpine peak and the watersheds. 2. Sub-nival complexes greatly broken down into the Alpine watershed, crystalline

II. A. Weakly changed, irregularly used summer pastures and the hay-mowing. 3. Subalpine and alpine meadows used as a summer pastures heavily broken down mountainous slopes of peaty and turf-meadow soils. 4. Subalpine and alpine meadows used as hay-mowing and summer pastures heavily broken down slopes, watersheds of turf- meadow soils changed, irregularly used.

B. Weakly wintry pastures. 5. Wintry semi-desert pastures of wavy-beddy plains with salty grey meadow soils. 6. Wintry partly-plain euphemernic-shrubby pastures heavily broken down arid-denudative low-mountainous with grey soils brown, salty, grey-brownish, bright-grey-brownish soils. Changed, episodically subjected.

C. Weakly to the influences the mountain woods. 7. Weakly and average broken down mountain slopes, low mountain and average-mountain with beechen and hornbeam forests with brown-forestry soils. 8. Weak and average broken down low-mountain, pre-mountain and the inter-mountainous hollows with oak hornbeam forests, shrubs with mountainous brownish forestry soils.

III. Average changed irregularly used and partly regularly used complexes. 9. Pastures and hay mowing accompanied small-areal ploughed field instead of arid rare forestry and the post forestry shrubs. 10. Small areal pastures and the hay mowing accompanied with oak-hornbeam, forestry-shrubby complexes of plains.

IV. Heavily transformed, regularly used complexes.11. Agro-irrigational landscapes of the accumulated plains instead of semi deserts, dry steppes and the intrazonal complexes with grey soil, grey soil-meadows, forestry-meadow, and bright grey soil-meadow soils.12. Agro-irrigational and dry land agricultural complexes of low mountain, foot hill plains, intra-mountain hollows instead of semi-desert, dry steppes, forestry-steppes and forestry–shrubs with grey-brown, grey soily-meadow, grey-brown ,brown-forestry soils. 13. Garden, garden-plantation selitebnic, selitebnogarden complexes of lowlands, intra-mountain hollows, pre-mountain plains instead of semi-desert, dry steppes, forestry-steppes, forestry-shrubby with grey soil–meadow, grey-brown, saline land, meadow-grey land, bright grey–brownish soils, transformed, irregularly used

B. Heavily complexes 14.Tugay forests, low place-forestry-shrubby, meadow-forestry shrubby complexes wavy, long-manned, hilly plains, with alluvial-meadow, forestry-meadow, forestry brownish soils.15. Recreational forests inclined wary, hilly, high plains with forestry-brownish, forestry-meadow soils. 16. Meadow-shrubby, shrubby complexes of inclined plains, lowland, gently sloping of mountainous slopes instead of oak-hornbeam, oaky, oaky-shrubby forests with mountainous-forestry brownish, post-forestry brown, forestry-meadow soils, accompanied by hay-mowing, small-areal plowing. 17. Hay moving and the pastures of the lowlands and the pre-mountainous plains with post forestry brown and forestry-brown.

V. Soils cardinal changing, functioning technogenic modifications. 18. Technogenic-urbanized selitebnic complexes. 19. Industrially technogenic modifications (terricones, quarries, oil wells, the infrastructures connected with industry). 20. Water anthropogenic complexes-canals, collectors, drainages, reservoirs, ponds, distributers, dykes and the others. 21. Road-technogenic modifications-automobiles, railway routes, roads with firm covering. 22. Pipelines and other technogenic modifications of oil pipelines, gas pipelines, water pipelines, sewerages, electricity transmission, telecommunications etc

Natural way of rehabilitation, self-regulation, stability of landscapes, and the same time degree of changing of some separate components were taken into consideration on the map. In practically unchanged irregularly used complexes mentioned peculiarities can partly be changed, however in intensively used radically transformed complexes all the components have been changed and controlled by men.

1. Intensively used post-wood cordially changed dry deserts, the deserts, forestry deserts of Greater and the Minor Caucasus and the other foothill alluvial-proalluvial, proalluvial-dealluvial plains. The majority these complexes can be differed by major. Areas in the form of agro-irrigational, dry land - agricultural, and the selitebnic units of course.
2. Irregularly used forestry deserts, the deserts, arid sparse growth of trees of low hill and inter-mountainous depression. To mainly dry land and episodic irrigated agriculture, intensive cattle pasture, enlargement of the populated area could stipulate for the washing out, uncovering, breaking down of the mountain slopes and increasing of areas of the arid complexes. Main complexes were shown in the form of large areas.
3. Irregularly used semi-deserts, dry deserts, arid rare forestry, shrubs and other pastures and the hay mowing (Diridagh, Tydagh. Ziyarat, Valley of Akarih, Gobustan, Absheron) and irregularly used pastures and hey-moving of subalpine and alpine meadows of highlands (Shahdagh, Tufandagh, Babadagh, Kam yaylag, Bok mountain range, Shahnabad, Shahduzih, Eastern Geychah, Murov dagh, the Garabagh volcanic plateau etc.). An intensive pasture of cattle could intensive anthropogenic degradation, within the forestry-meadow, meadow complexes made some small, but not numerous areas of weak-stable units, washed mountain slopes ravine-gully system increased surface break-downs, strengthened the process of meadow aridization .
4. Second naturally-anthropogenic landscape modifications were being developed in the forms of areas complexes in all the landscape units of mountainous territories of the republic. These complexes introduce themselves as indicator degradation. To them one can refer some mudflow centers, not large areas, shrubs, stony, rock waste, exposed territories, rocks, etc.
5. Technogenic modifications cover some huge selitebnic complexes, urbanized territorial units which were being polluted, violated in connection with the mining industry, road-building, pipe laying and other infrastructural works of course.

The compiled landscape map can be used in the program of socio-economical development of the regions, ecological programs, and landscape planning works and in realization of various types of ameliorative measures.

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Environmental Protection

EVALUATION AND ANALYSIS OF THE ENVIRONMENTAL PROJECT ON THE EREKLE II STREET IN THE CITY OF SIGHNAGHI (GEORGIA)

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ABSTRACT: The environmental project in Erekle II Street in the city of Sighnaghi envisages developing the storm-water and anti-landslide measures. For this purpose, the landslide section in Erekle II Street in the city of Sighnaghi was subject to the topographic survey. With the purpose of the engineering-geological evaluation of the object, 3 boreholes with the total length of 20 m were made. Ground and water samples were taken from the boreholes and were subject to the laboratory analysis. In addition, the hydrogeological and hydrological evaluation and hydraulic calculations of the area were done.

In order to ensure the stability of the landslide slope in Erekle II Street in the city of Sighnaghi, a drainage system to discharge the ground waters was designed, and a ditch by considering the calculations of the relevant hydrological and hydraulic properties was also designed.

KEYWORDS: landslide area, drainage system, storm channel, ditch, branch pipe.

1. INTRODUCTION

Under Agreement No 76/1 on State Acquisitions of May 10, 2013 concluded with Sighnaghi municipality, jointly with the scientific workers of the Ecological Center of the Environmental Protection Department, in May of 2013, the field and studies in Erekle II street in the city of Sighnaghi were accomplished. Ph.D. Iveta Skotnicova, professor, head of the department at Ostrava Technological University in Czech Republic and Scientist – Olesia Kapezina Meshchersky Science-Technology Center for Ryazan (Russia) among other workers, was engaged in the scientific-research activities of the project [1].

The environmental project envisages designing the storm-water and anti-landslide measures. In particular, the landslide area in Erekle II street in the city of Sighnaghi and its adjacent territory were subject to 1:500 topographic survey and the landslide area was subject to the engineering-geological and hydrogeological studies, by making 3 respective boreholes (with the total length of 20 m). Aiming at arranging the drainage system and storm-water channels across the landslide area in village Anaga, Sighnaghi region, the conglomerates and inert construction materials in the ground borrow pits in Mtavarangelozi gully were subject to the geological survey and samples were taken to be studied at the laboratory.

2. BRIEF THOROUGH ASSESSMENT OF THE DESIGN AREA

The main artery of Sighnaghi municipality is the river Alazani and river Iori. Within the limits of the municipality, a Georgian-Azerbaijani border runs along the lower section of the river Alazani (See Fig. 1). The river Alazani is flown only by some minor gullies from the territory of Signagi municipality. These gullies are dry for a long time of the year. The major tributaries of the river Alazani flow from the territory of Lagodekhi municipality.

Fig. 1. Map of the regions of Georgia

On the territory of Sighnaghi municipality, the river Iori is also flown by several minor gullies, which are dry for a long time of the year.

The territory of the study area has a dry continental climate, with relatively cold winter and hot summer. The average air temperature in the area is 12.6°C; the coldest month is January with the average temperature of 0.10°C. Frosty days are a rarity. The absolute minimum is –25.0°C. The warmest month of the year is July with the average temperature of 24.4°C. The absolute maximum is 40.0°C.

The direction of the prevailing wind is mostly western or north-western with the maximum velocity of 1.3/0.3 m/sec in January and 1.7/0.5 m/sec in July. The rated wind pressure values of 0.30 KPa is fixed once in 5 years and 0.38 KPa is fixed once in 15 years.

The modern geodynamic processes are widely spread on the territory of Sighnaghi municipality. They are promoted by a number of natural and technogenic factors, including: complex relief geology and climatic conditions augmented by the dense settlements of the regional center and adjacent villages with the associated communication constructions.

The modern geodynamic processes in Sighnaghi region mostly occur as erosive and landslide-mudflow phenomena. The spread of the erosive processes is clear in almost all big and small gullies. They are easily developed along the slopes of great inclinations and with the rocks of minor strength, while they are of a mudflow nature during the abundant rains and often cause damage to the infrastructure of the region and local population.

In recent years, the development of the landslide phenomena has been particular important. These processes cause a significant damage to the population, motor roads and different communication and medical structures and premises.

Activation of the above-said processes was also fixed in Erekle II Street in the city of Sighnaghi, and consequently, the present preliminary design was developed.

3. ACCOMPLISHING THE ENGINEERING-GEOLOGICAL AND HYDROGEOLOGICAL STUDIES ON THE EREKLE II STREET IN THE CITY OF SIGHNAGHI AND EVALUATING THEM

There were engineering-geological and hydrogeological studies accomplished in the study area. At first, reconnaissance was used to study the study area and borders, shapes and other peculiarities of the landslide-prone slope. As a result, it was established that the said area is densely populated and is subject to the impact of landslide processes. The relief is a stepped and wavy mainly as a result of the terraced private homestead lands and gardens and plots of field [2].

Most of the residential houses in the said area are damaged, with cracks and deformations (See Fig. 2).

Fig. 2. Damaged buildings and premises

In addition, the natural outcrops of the underground waters were studied. They come out as springs with minor outputs or seepage waters. These studies allowed fixing the optimal points to drill the boreholes. Three boreholes with the total depth of 20 m were drilled (See Fig. 3).

As a result of drilling, it was clear that the study area, to the depth of 5.0-6.0 m is built with delluvial deposits. For evaluation purposes, see the geological section of the boreholes (See Table 1), which is presented by light brown clay loams with clay layers and admixtures of clastic material. The filtration coefficient equals to 5.5-5.8 m/day (5,6 m/day) on average. These rocks along Erekle II street, are covered with a technogenic ground with the strength of 2.0 m, delivered at different times during the road construction. Below the depth of 6,0 m, the rocks are replaced by hard clays. The outcrops and levels of the underground waters were fixed in the boreholes: the water level was 1.7 m in borehole No 1. It should be noted that a perforated plastic pipe (piezometer) was submerged into borehole No 1 to fix the water level changes, as we think that the activity of the landslide phenomena mainly depends on the variation of the latter factor determining the strength of the constituent rocks.

Fig. 3. Drilling the first and third boreholes

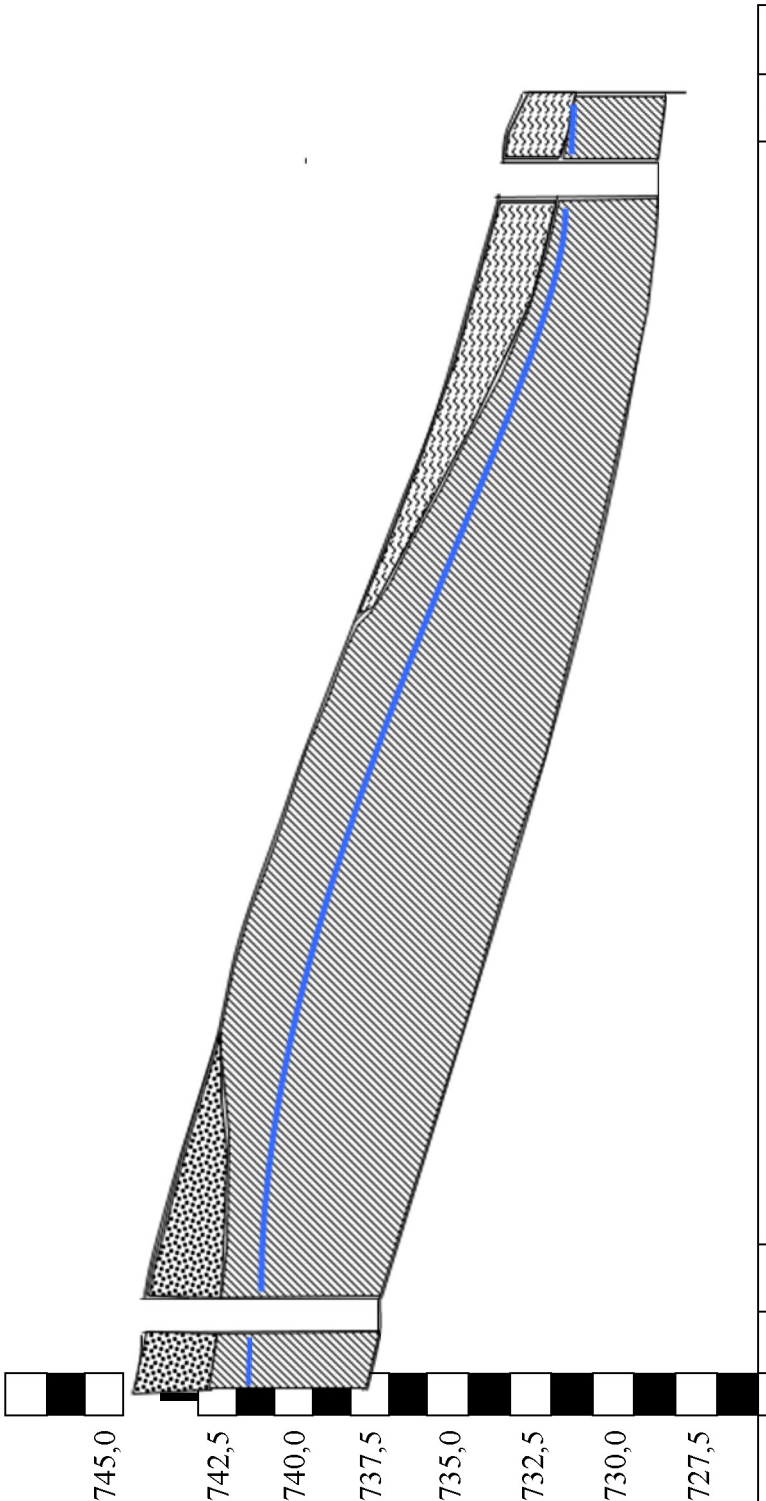
Table 3.1

Data of a lithological section of the first borehole

Coordinates of borehole No 1: X = 0576432; Y = 4607740 Absolute level above the sea, H = 735 m GPS (No 078)								
Geological index	**Layer No**	**Depth**		**Layer strength**	**Abs. foundation level**	**Lithological section**		**Ground-water level**
		From	**To**					
tQ_{IV}	1	0.0	1,2	1,2	733,8		**Fill**	733.3
dQ_{IV}	2	1,2	5,0	3,8	730,0		**Light brown clay loams with the admixtrures of sand layers and clastci materials (samples No 1 and No 2)**	

Figure 4 shows the lithological section in the middle part of the first borehole with the relevant geometry. We have taken different samples from the different depths of the boreholes (total of 5 samples) and tested them at the laboratory [5, 6].

Engineering-geological section 1-2
Horizontal scale: 1:500



Borehole No.		2		1	
Distance, m			75,0		
Surface level		743.2		732.3	
Foundation level		735.7		727.3	

745,0 742,5 740,0 737,5 735,0 732,5 730,0 727,5

Fig. 4. Geological section between the I and II holes

The percentages of the weight volumes of solid fractions remained after sieving the ground samples with the relevant diameters are given in Table 2.

Table 2

No	*Borehole #*	*Sample #*	*Depth*	*Total*	*>10.0*	*7.0-10.0*	*5.0-7.0*	*3.0-5.0*	*2.0-3.0*	*1.0-2.0*	*0.5-1.0*	*0.25-0.5*	*0.1-0.25*	*0.06-0.0-1*	*0.02-0.06*	*0.006-0.02*	*<0.006*
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1	1	1	2.0	100	0	0	2.1	1.3	2.0	1.1	0.9	15.2	12.4	12.3	19.6	16.4	16.7
2	1	2	5.0	100	0	0	1.6	2.5	2.1	1.4	1.6	15.3	10.1	9.3	19.2	17.6	19.3
3	2	3	2.5	100	0	0	0.7	0.5	1.7	4.7	4.4	9.2	11.7	18.8	17.3	18.6	12.4
4	2	4	6.0	100	0	0	0.6	0.7	1.8	4.2	7.5	11.2	7.3	18.6	21.4	16.3	10.4
5	3	5	4.5	100	0	0	0.5	1.9	5.4	4.3	5.1	13.2	14.7	12.1	16.4	14.3	12.1

By considering the above-described laboratory studies [6, 7], at the next stage, the integral curves of ground grain sizes are to be plotted, with the typical drawing for the first borehole given in Fig. 5.

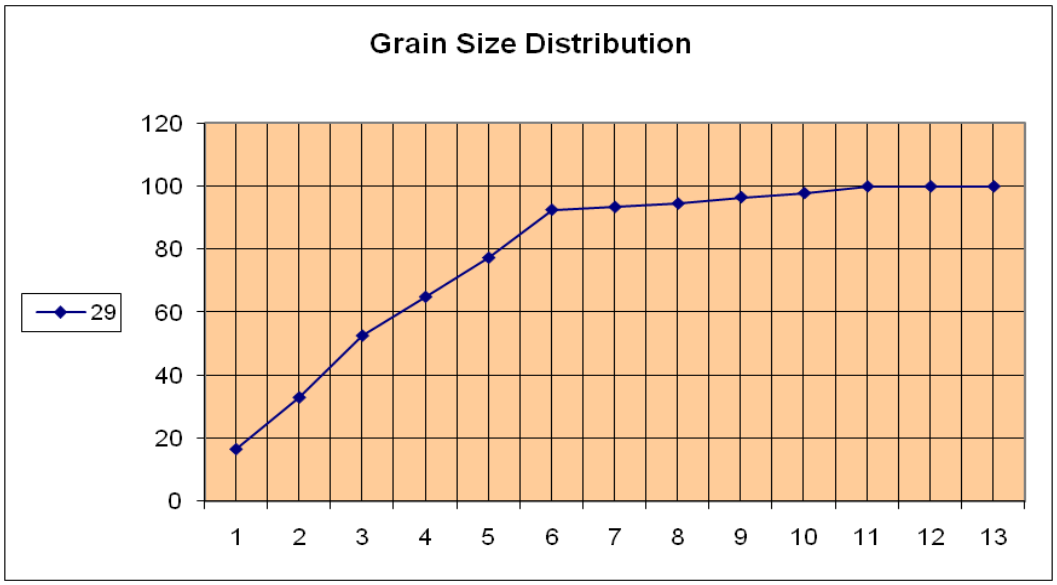


Fig. 5. Graph of the integral curves of the grain sizes of sample No 1 from the first borehole

By processing the gained data, it is also possible to calculate the value of the total average diameter [2,4] of the ground samples, which is $\overline{d} = 0.344$ (mm).

4. HYDROLOGICAL CALCULATION OF THE STUDY AREA

In order to calculate the surface runoff of the study area (design object), G.D. Rostomov empirical dependences universally recognized and included in the UNESCO Funds were used.

The following dependence was used to calculate the peak water discharges [1]:

$$Q = R\left[\frac{\Omega^{2/3} \cdot \mathrm{K}^{1,35} \cdot \tau^{0,38} \cdot \bar{\mathrm{I}}^{0,125}}{(\mathrm{L}+10)^{0,44}}\right]\Pi \cdot \sigma \cdot \lambda, \qquad (1)$$

where, Q is the peak water discharge, m^3/sec; R is the design area coefficient; Ω – is the area of the water catch basin, km^2 and is calculated based on a large-scale topographic map; K – is a climatic coefficient calculated based on the map; τ – is the recurrence period (provision in %); $\bar{I}$ – is the mean basin slope, and is calculated based on a large-scale topographic map; L – is the length of the water catch basin, km, and is calculated based on a large-scale topographic map; σ – is the form factor of the water catch basin, which is calculated by the following dependence:

$$\sigma = 0{,}25\frac{B_{\max}}{B_{ave}} + 0{,}75 = 0{,}25 \times \frac{0{,}006}{0{,}004} + 0{,}75 = 1{,}125\,, \tag{2}$$

where B_{max} – is the maximum width of the water catch basin, km; B_{ave} – is the average width of the water catch basin, km, and is calculated based on a large-scale topographic map. λ – is the dimensionless forestation value and is calculated by the following dependence:

$$\lambda = \frac{1}{1 + 0.2\frac{\Omega_{forest}}{\Omega}} = \frac{1}{1 + 0{,}2\frac{0{,}0009}{0{,}0022}} = 0{,}709\,, \tag{3}$$

where Ω_{forest} – is the area of the water catch basin covered with forest; Ω_{forest} = 0.0009 km^2; Π – is the soil parameter calculated based on the map and tables.

Finally, in order to fix the water discharge of a 0.5% provision in the first and second through boreholes in the study area, all the values in formula (1) were calculated: value of R is given in the Technical Reference and R = 1,15; Ω = 0,0022 km^2; K = 5; τ = 50 years (0,5 % provision); $\bar{I}$ = 0,176; L = 0,43 km; Π = 0,7; σ = 1.125; λ = 0.709; B_{max} = 0.006 km; Ω_{forest}= 0,0009 ჯმ²; B_{ave} = 0,004 km;

After relevant calculations, from (1) we receive:

$$Q^{I}{}_{0.5\%} = 1{,}15 \cdot \left[\frac{0{,}0022^{0{,}66} \cdot 5^{1{,}35} \cdot 50^{0{,}38} \cdot 0{,}176^{0{,}125}}{(0{,}43 + 10)^{0{,}44}}\right] \cdot 0{,}7 \cdot 1{,}125 \cdot 0{,}709 = 0{,}126 \ (m^3/sec) \tag{4}$$

The discharge of the surface water current formed along the main road at top of the drainage system in Erekle II Street in the city of Sighnaghi is also calculated by dependence (1). The initial measured data are as follows: R = 1,15; Ω = 0,000876 km^2; K = 5; τ = 50 years (0,5 % provision); $\bar{I}$ = 0,018; L = 0,146 km; Π = 0,7; σ = 1.125; λ = 0.709; B_{max} = 0.006 km; Ω_{forest}= 0,0009 km^2; B_{ave} = 0,004 km; we will have:

$$\sigma = 0{,}25\frac{B_{\max}}{B_{ave}} + 0{,}75 = 0{,}25 \times \frac{0{,}006}{0{,}004} + 0{,}75 = 1{,}125 \tag{5}$$

$$\lambda = \frac{1}{1 + 0.2\frac{\Omega_{forestt}}{\Omega}} = 0{,}971 \tag{6}$$

$$Q^{II}{}_{0.5\%} = 1{,}15 \cdot \left[\frac{0{,}000876^{0{,}66} \cdot 5^{1{,}35} \cdot 50^{0{,}38} \cdot 0{,}018^{0{,}125}}{(0{,}146 + 10)^{0{,}44}}\right] \cdot 0{,}7 \cdot 1{,}125 \cdot 0{,}971 = 0{,}072 \ (m^3/sec) \tag{7}$$

The peak estimate discharge for each ditch in Erekle II Street will be:

$$Q_3 = Q_4 = \frac{Q^{II}{}_{0.5\%}}{2} = \frac{0{,}072}{2} = 0{,}036 \tag{8}$$

Discharge of 1% provision water peak discharge formed in the study area must be considered when determining the parameters of a design ditch in the said area.

5. CONCLUSION

Thus, based on the gained data, aiming at regulating the surface water currents and ground waters to ensure the stability of the houses of the residents of Erekle II street, the storm-water premises (ditches) were designed and installed with proper branch pipes and boreholes, while the ground waters were regulated by constructing a drainage system, which has in fact attenuated the landslide body dynamics. The project also gives a local cost estimates with the calendar schedule, what is the confidential information.

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Environmental Protection

EVALUATION OF THE ECOLOGICAL PROCESSES IN THE CATCHMENT BASINS OF THE RIVERS INGURI (GEORGIA) AND YANGTZE (CHINA) AND NEW ENVIRONMENTAL PROTECTION MEASURES

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ABSTRACT: The article gives the evaluation of the ecological processes in the catch basins of the rivers Inguri (Georgia) and Yangtze (China) and new environmental protection measures to regulate the natural disasters (erosion, mudflow) with these rivers.

It is established that the ecological problems in the catch basins of the rivers Inguri and Yangtze, in the upstream wall of their dams, at their estuaries with the Black and Yellow Seas are almost similar and differ with their scales only.

The evaluation of the ecological problems in the catch basins of the rivers Inguri and Yangtze is proposed to do with the methods for carrying out the field and laboratory experiments in Georgia and China. These methods allow accurately predicting the erosive-mudflow and landslide processes.

By using the data gained through the experiments, the calculation methods to design the new environmental protective structures will be developed.

KEYWORDS: the rivers Inguri and Yangtze, catch basin, dam, environmental protective structures, erosion, mudflow.

1. INTRODUCTION

The river Inguri flows in West Georgia, along the southern slope of the main watershed ridge of the Caucasian and across Kolkheti plain. It heads from Inguri glacier, at 2614 m above sea level and flows into the Black Sea at village Anaklia. The length of the river is 213 km and the area of its basin is 4060 km^2 (See Fig. 1).

The sources of the river Inguri are different: 66% of the annual flow in the upper reaches is made formed with snow and glacier waters, 22% is the ground water and 12% is the rainwater, while in the lower

reaches, the same figures are 18%, 26% and 56%, respectively. Average annual discharge at village Khaishi is 109 m^3/sec, while it is 170 m^3/sec at the confluence. The river floods are common in spring and summer and low-water period is typical in winter. From village Lakhamuli to village Shamgona, the Inguri is used to transport timber, while in the lower reaches, the river is used for irrigation with the Inguri -Gali irrigation channel used for this purpose.

Fig. 1. Map of the river Inguri catchment basin

There is Inguri hydropower plant operating across the river Inguri (See Fig. 2) with its design capacity of 1640 thousand KW and total annual generation of 5.46 mlrd. Kw.h. The HPP includes a 271.5-metre-high arch dam creating a water reservoir at the city of Jvari (its volume is 1 mlrd. m^3 and its length is 30 km) and diversion tunnel (with the diameter of 9 m and length of 15 km) ending with the balance tank (with the diameter of 16 m and height of 167 m). The diversion tunnel delivers the water to the hydro-aggregates through five 451-metre-long pressure tunnels [2].

Fig. 2. General view of the Inguri arch dam

The cascade also includes an underground HPP with 5 hydro-aggregates. The water from its turbines, through the conductive tunnel (with the height of 13 m and length of 3.2 km), is directed to No 1 Vardnili HPP water reservoir. There is also Gali water reservoir constructed for Vardnili HPP with the volume of 1-1,9 mln. m^3. In 1972-1974, 9 aggregates of Vardnili HPP with the total output of 340 thousand KW (with the annual output of 1.13 mlrd. KW) were put to operation [4].

The river Yangtze is the fourth longest river in the world (with its length of 5.800 km) and the longest river in China. It is unique with its depth, flow and velocity creating ideal conditions to construct hydropower plants and dams across it [1].

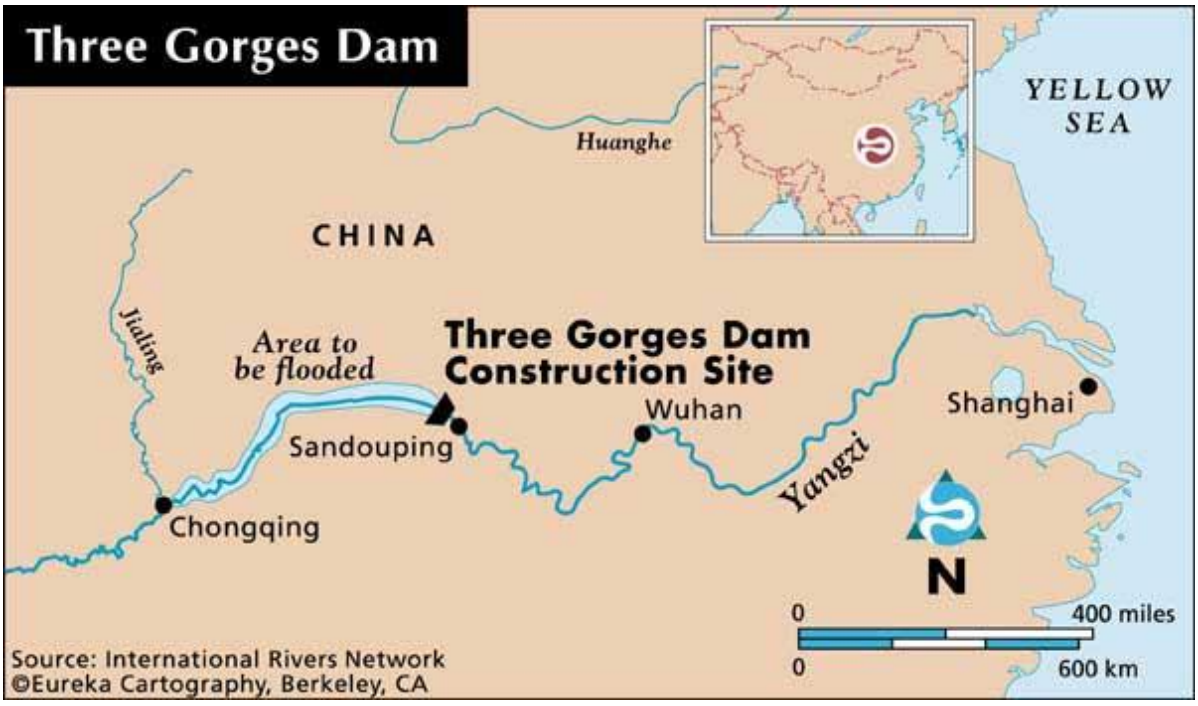

Fig. 3. Map of the river Yangtze catchment basin

Fig. 4. View of Three Gorges – Sanxia dam

The table below shows the statistical data of 10 longest rivers of the world, with the river Yangtze ranking the 3rd with its annual runoff of 1080 km^3 (See Table 1).

Table 1

Annual runoffs of the 10 largest rivers of the world

№	River	Annual runoff (km^3)
1	Amazon (South Africa)	6903
2	Congo (Africa)	1445
3	Yangtze (Asia)	1080
4	Orinoco (South America)	913
5	Yenisei (Asia)	624
6	Mississippi (North America)	598
7	Parana (South America)	551
8	Lena (Asia)	536
9	Tocantins (South Africa)	513
10	Zambezi (Africa)	504

The largest dam and HPP of the world are built across the river Yangtze by the town of Sandouping, located in Yichang, Hubei province, China. The dam capacity is 22.500 MW what equals to that of 15 nuclear power plants and is the first in the world. The construction of the dam completed in 2012 and the dam capacity is more than that of Itaipu Dam. Sanxia dam is a unique structure with its dikes built one by one and then combined into one structure. Each dike has 32 turbines and 2 small generators [11, 12].

Sanxia dam is used not only to generate the power, but also to increase the traffic volume across the river Yangtze and regulate freshets occurring on the river Yangtze in every 10 years.

The government of China assessed the project as a historical, engineering, social and economic success. The construction of the hydropower plant was not smooth, as the dam flooded the cultural and archeological monuments in the area, 1.3 million people were forced to resettle, ecological changes of the atmosphere were caused and landslide-prone areas appeared on the adjacent territories [13].

2. ECOLOGICAL PROBLEMS

Construction of a 271.5-metre arch dam across the river Inguri in Georgia not only significantly changed the ecological processes of the river, but also intensified the abrasive processes of the Black Sea Coast, and as a result, the village Anaklia and its adjacent settled areas have been put to the risk of floods and increased sea storms. At the same time, in order to expand the term of exploitation and increase the power capacity of the Inguri dam, it was decided to construct Khudoni arch dam in 3-5 km from it [3, 7].

The idea of Khudoni HPP first appeared in the 1970s, and the construction works started. However, due to the national movement, students' protest and locals' efforts, the works were stopped.

The issue to construct Khudoni HPP re-gained its actuality in the 2000s. In June of 2007, a Memorandum of Understanding was concluded between the government of Georgia and Indian Company "Continental Energy International" (now "Trans-Electrica" Ltd.). Khudoni HPP, after Inguri HPP, will be the second largest hydropower plants in Georgia (with the installed capacity of 1.320 MW and annual output of up to 3.8 KW·hr). The planned capacity is 702 MW and the average annual generation will be 1.5 mlrd. KW/h; the height of the reinforced concrete dam will be 202 m and the area of the water level in the

reservoir will be 526 ha.

After the dam is in place, the activation of the erosive processes over the mountain slopes in the water area of the reservoir strengthening the mudflow and landslide processes and activating the deflation processes in the Sea coastline at the river Inguri estuary with the Black Sea may be considered an ecological problem [5, 7].

The hydropower plant of so called Three Gorges across the river Yangtze in China contains two major risks: (1) the amount of particles deposited in the water reservoir and layers are not studied, and (2) the dam is constructed in a seismically unstable zone leading to the erosion of 80% of the adjacent area. This, on its turn, intensifies the mudflow processes and accelerates the transportation of the ground into the river and its deposition there.

The hydrologists state that now, the river Yangtze is incapable of transporting the talus material to the coastline resulting in the activation of the abrasive processes. The city of Shanghai, which is built on the coast of the Yangtze, is not protected against the impact of the sea. Construction of the water reservoir caused the activation of the landslides, and in 2009, 20.000 km^3 ground fell in the river gorges.

Important ecological problems are waste management and the inert, sewage and other hard waste fallen in the river Yangtze accumulated in the water reservoir contributing to the reduced HPP efficiency. In order to solve this problem, a treatment plant was installed in the upper reaches of the Sanxia water reservoir with 1.84 miln. tons of waste on average accumulated in it every day.

The construction of the water reservoir caused the "destruction" of 16.000 ha of forest cover around it. However, the government of China reacted swiftly and started growing an artificial forest, gaining a positive valuation of the UNO. The coasts of Yangtze and area of the water reservoir in particular, were distinguished for biodiversity with 6.388 plant species. The dam had a negative impact on ichtio fauna, as well. Many fish species disappeared as a result of the water temperature and regime change, and the turbine edges also endanger the fish. One of the most important functions of the Three Gorges water reservoir, making Mao Zedong support the project, was the avoidance of seasonal floods across the river Yangtze. Such important towns, as Wuhan, Nanjing and Shanghai in the lower reaches of the river Yangtze, are built on the coastline in the lower reaches of the current, and annual river floods were much hazardous for them. The capacity of the water reservoir is 22 km^3. The water reservoir with such a capacity is capable of avoiding the floods occurring once in 10 years and minimizing the floods occurring once in 100 years [11,12].

The flood over the river Yangtze in 1954 took away the lives of 33.169 people, while in August of 2009; the water reservoir of Three Gorges blocked 40.000 m^3/sec current. This time, the level of the water reservoir reached 145 m.

In the low-water periods, Sanxia water reservoir supplies the agricultural plots of field and industrial regions with clean fresh water. Since 2003, the water reservoir has supplied 11 km^3 of water in dry seasons [13].

Such analyses allow stating that the ecological problems of the catch basins of the rivers Enguri and Yangtze, in the upstream wall of their dams and at their estuaries with the Seas, are almost similar differing with their scales only.

3. METHODS OF EXPERIMENTS

Aiming at evaluating the ecological problems of the catch basins of the river Inguri and Yangtze, in particular, at arriving at the accurate forecasts of the erosive-mudflow and landslide processes and designing new engineering-ecological measures, we think the following scientific field and laboratory works are purposeful [7,10]:

- Identifying the sensitive sites in the catch basins of the rivers.
- Aerial photographing of the sensitive sites.
- Sampling soil and ground on the sites with further laboratory analyses in Georgia and China.
- Predicting the erosive processes taking place over the mountain slopes by using the methods developed in Georgia and China and by considering the method of R. Morgan, the English professor.
- Using the method of academician Tsotne Mirtskhulava to assess the erosive processes taking place in the riverbed, by considering the ground washing velocities, being a part of the former Soviet erosion standards.
- Large-scale laboratory modeling of structures in Georgia (at the Institute of Water Management) and China (at the Changjiang River Scientific Research Institute) with the aim of designing new anti-erosive and anti-mudflow measures by considering the following terms of similarity: dynamic similarity (Froude number: Fr = idem), gemoetric similarity (bed slope: i = idem), sediment movement (ratio between the water and sediment velocities: V/V_{sed} = idem) and similarity in resistance (Chez coefficient: C = idem);
- Generalizing the results of the field and laboratory experiments and developing the methods to be used to design new anti-erosive and anti-mudflow structures.

4. NEW ENVIRONMENTAL PROTECTION MEASURES

The analysis of the catch basins of the rivers Inguri and Yangtze has shown that in the upstream wall of the dams, in particular, in the water area of the reservoir, the water level changes are followed by erosive processes intensifying the landslide and mudflow processes at the following stage.

Due to the above-described problems, the Institute of Water Economy has developed the engineering-ecological measures (anti-erosive and anti-mudflow structures), with the priorities of their scientific-technical novelty proved with relevant patents.

A new mountain slope anti-erosive structure [3] ensures maintaining the ground particles on site, fights erosion over the mountain slopes, creates the environment suitable for plants and its construction and installation costs are low. The premise is made up of polyethylene bags (1) filled with local ground (2) (see Fig. 5).

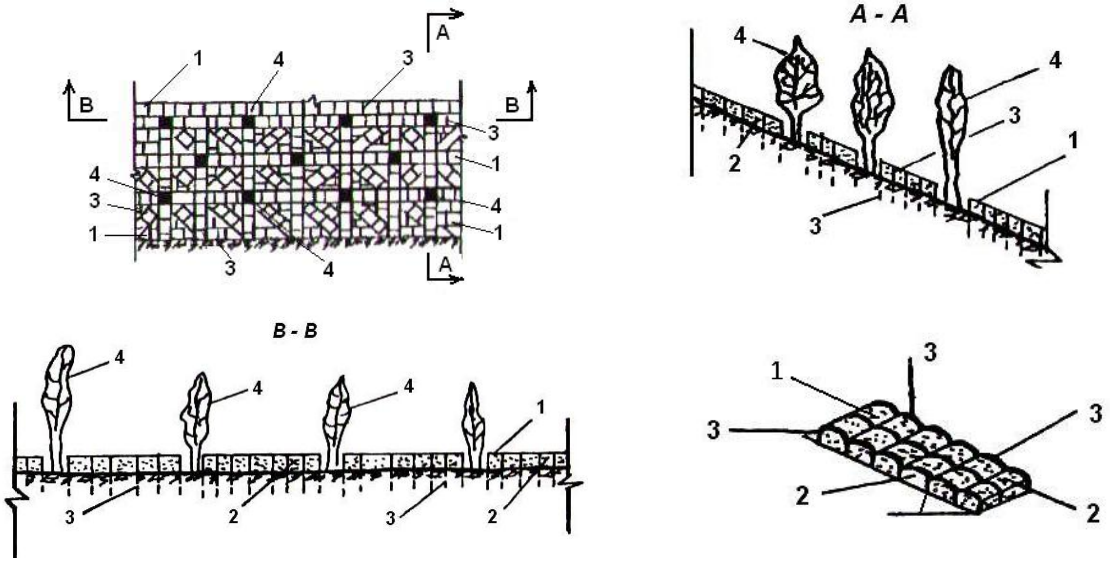

Fig. 5. Anti-erosive structure

The polyethylene bags (1) are fixed to the ground surface with metal clips (3), and free ground areas are occupied with green plantings planted in a staggered order (4). The polyethylene bags (1) on the ground are placed in a radial order around the plants and are connected to each other with a polyethylene material.

An anti-erosive device shown in Fig. 6 is made up of long bags made with a strong synthetic material (1), filled with local inert material (2). They are fixed to the mountain slope with strong clips (3), (see Georgian patent No. 925, Bulletin No 15(115), 2002, pp. 25÷26).

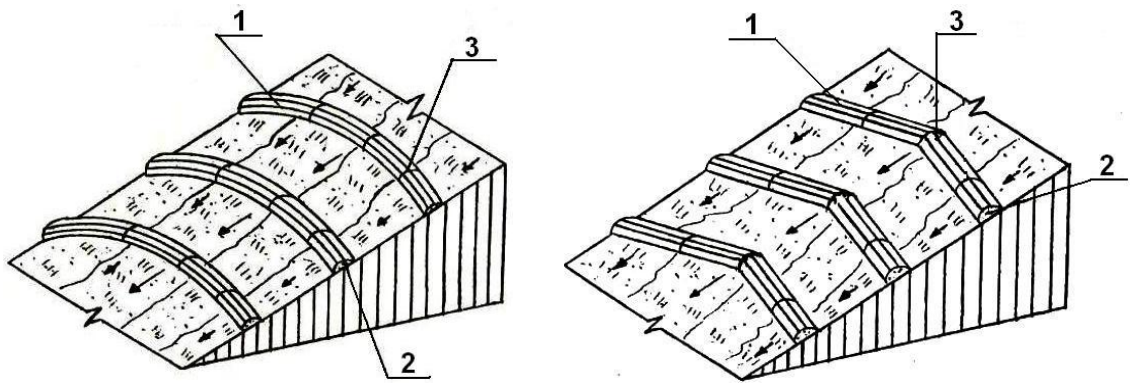

Fig. 6. Anti-erosive device

In order to extenuate the kinetic energy of the water currents caused by intense rains over the mountain slope, the long synthetic bags all over the width of the slope are located in parallel to one another, along a fractured or arching line reducing the velocity of the surface water current and origination of swaths and gullies between the bags and the ground in a longitudinal direction.

The Water Management Institute has developed a new construction to project various installations from debris flow and mud-rock flows (See fig 7).

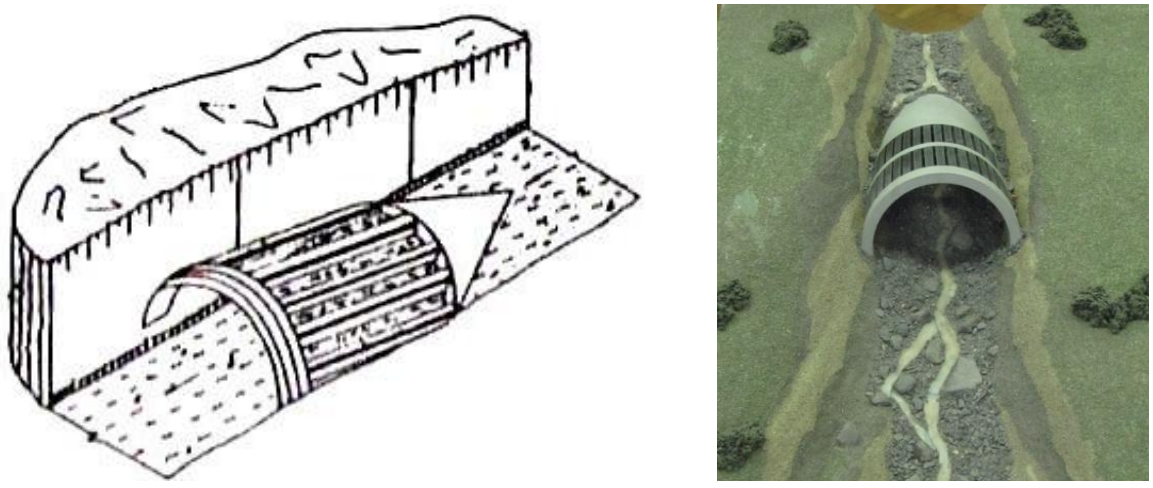

Fig. 7. Debris Flow Protection with a Spring-Board Type Structure

The structure is an arch-cylindrical framework with blind cone-shaped head, taper angle being 90-110^0. The structure operates as follows: the main destructive impact of the passing debris flow is taken by the cone-shaped head dampening most of the energy. Subsequent dampening of the energy in the cylindrical part of the structure occurs in a continuous fashion. Free cross-sectional area of rectangular

cells ensures optimum energy-dampening effect, i.e. it allows to eliminate heavy dynamic (frontal) impact of the debris flow, even catastrophic one, and to eliminate the threat of destruction of the structure which, therefore, may stand up to multiple debris flow impacts. The structure is erected by using the industrial waste, such as used rails, which amount to 70-80 % of the total volume of the building materials. Economic effect is 100-130 USD per running meter, as compared to the basic construction. The novelty of the structure is protected by an author's certificate.

An anti-mudflow structure of an arch-step-like shape [3] is a frame made with iron rails welded together or connected to one another with rivets. The iron frame is fixed in the riverbed with concrete (See Fig. 8).

The rectangular shape of the gaps of the structure allows efficiently dampening the mudflow energy and excludes the maximum force impact of the current on the structure. During the mudflow pass, the first step of the structure is subject to the principal (first) force impact with the initial destruction of the current structure; then, the current moves along the cylindrical steps of the structure, where the mudflow energy is evenly dampened.

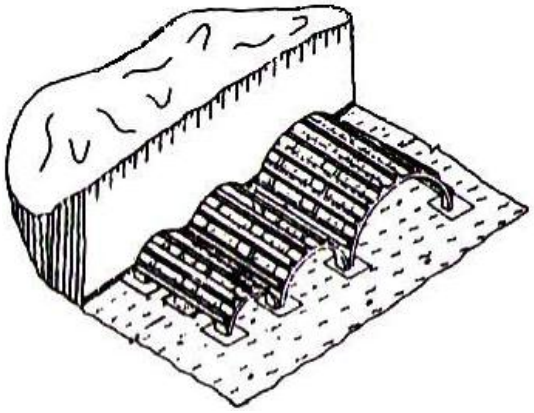

Fig. 8. Structure with an arch-step-like shape

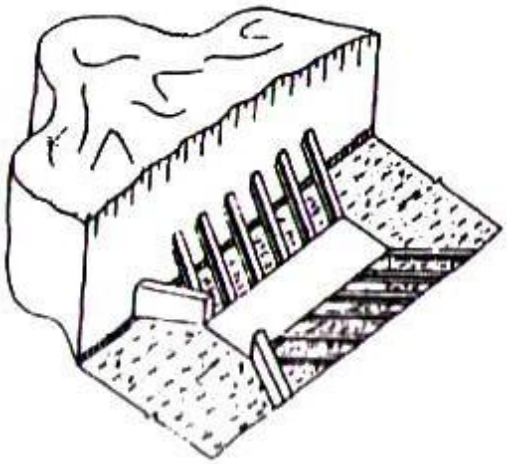

Fig. 9. Structure of a trapezoidal shape

The structure (6) given in Fig. 9 is a trapezoidal gutter with the reinforced concrete current-direction walls. The slopes of the structure are connected to the sides of the river bed (gorge), with their angles varying within the limits of 110-160°. The slopes of the structure are iron beams creating rectangular gaps between one another. There is a reinforced concrete foundation in the center of the structure of a spring-board shape, with the mudflow moving along it. The trapezoidal shape of the structure with its current-direction walls allows reducing the impact force of the current and gravitational (weight) pressure of the sediment or mudflow mass on the structure guaranteeing reliable operation of the structure.

4. CONCLUSION

The river Inguri in Georgia and the river Yangtze in China are one of the most water-bearing rivers in the two countries, and their water resources are used in many ways.

The evaluation of the ecological processes in the catch basins of the two rivers has made it clear that the ecological problems of the catch basins in the upstream wall of their dams, at their estuaries with the Black and Yellow Seas are almost similar and differ with their scales only.

Arriving at the accurate forecasts of the ecological processes taking place in the catch basins of the rivers Inguri and Yangtze and exploring the sedimentation taking place in the upstream wall of the dams, is

recommended by using the thorough scientific field and research laboratory studies (large-scale modeling) in Georgia and China and developing the methods to design new environmental protective structures.

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Reclamation

RESEARCH OF NEW ALTERNATIVE MEASURES OF DRAINAGE SYSTEMS FOR COLCHIS WETLAND SOILS ON THE THREE TIER DRAINAGE EXAMPLE *)

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ABSTRACT: In the article is considered issues of Colchis lowland problems and alternative ways for its solving. There is presented new three tier drainage systems installation works carried out by us in the village Didi Jikhaishi (Samtredia district). We continue observation and results analysis.

KEYWORDS: tier drainage.

1. INTRODUCTION

For Georgia, as small lands country especially important is use of modern science-technical achieves for Colchis lowlands soils reclamation and digestion. On the Colchis lowland is necessary using of complex reclamation works, in order to digest them.

As a result of reclamation and water industrial works, importance increase bio productivity. By practical use of scientifically recommendation of science may be received additional: crops – 293, meat – 65.7, milk – 189, tea – 22.5 thousand tones and etc. [1].

2. MAIN PART

It is known, that formation of swamped and wetland soils is a result of same time interacting factors influence: geological-hydrological, climate, soil, geo morphological and etc., which define necessity of difficult complex of reclamation works.

Without of implementation reforms in irrigation and drainage sector and without of its rehabilitation will be impossible launching of agricultural-food production in Georgia.

For digestion of Colchis lowland one of the most important measure is to use combined drainage system, which provide fast drainage of wetland areas. In the Water Management Institute of Georgian Technical University during many years running researches on the Colchis lowland drainage systems, but three tier drainages is the new measure and is necessary to study its characteristic.

Our aim was to arrange field test area for examine three tier drainage in field condition, which will increase drainage norm for Colchis lowland wetland soils. For this we installed 18 meter length drainage construction on the territory of the Didi Jilhaishi College.

On the territory of village Didi Jikhaishi (Samtredia district) is built 18 meter three tier drainage construction, it is running observation and results analysis.

*) Article is worked out by grant project of Shota Rustaveli National Science Foundation „Research of new alternative measures of drainage systems for Colchis wetland soils". Grant contract 40/35.

Photo. 1. Wetland soil in village Didi Jikhaishi

- First tier – regulation of run off water;
- Second tier – ellipse perforated polyethylene construction;
- Third tier – the intake pipe/collector channel.

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Environmental protection

ON RESEARCH ASPECTS OF A NEW-TYPE FLOATING WAVE DAMPING HYDRO-TECHNICAL COMPLEX FOR PROTECTION OF COASTAL LINE AND OPEN PORTS FROM STORM WAVES

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ABSTRACT: The main research aspects of the problem which is connected with the floating new type coast-protection. Breakwater (damper) functioning is presented.

Based on the Gvelesiani's analytical solution of the proper 2D boundary value problem and the processing of the obtained numerical results the relation between the damping degree of the wave maximum amplitude and the damper (barrier) submergence depth for the varied progressive wave length is developed.

KEYWORDS: floating damper, progressive wave, damping degree of wave amplitude, damper submergence depth, wave length, water basin depth.

INTRODUCTION

The purpose of our project which is connected with the development of the floating coast-protection new type breakwater structure complex is the creation of high technology, innovation-commercial product of practical application demanded at local and/or international markets for sea and ocean recreation coastal lines.

In order to achieve the purpose the realization of our project is planned on the basis of well-founded hydrodynamic and physical modeling of a new type breakwater hydro-technical structures (and their chain) by design of analogous models and their serial tests on a special laboratory wave generator according to the parameters characteristic to Black Sea coastal-recreation strip.

The economic wealth of any seaside country, organization of foreign transportations, development of cultural and economic relations, etc. significantly depends on smooth performance of open type sea (ocean) ports. Open ports, as well as, their water areas (water territories within port boundaries) in definite periods as a rule undergo undesirable action of sea storm waves, which hinders normal functioning of sea transport (maneuvering and settling of transport ships, etc.). Also, storm waves cause irreversible washing out of coastal lines adjacent to ports, hindering water sewer operation in storms and flooding of coastal territories.

Under the effect of waves and as a result of base soil wash-out and deformation the protecting wall dam (mole) of Poti port is failing, in the nearest future as a result of construction of high-rise dam "Deriner" on the territory of Turkey and blocking of the river Chorokhi solid drift, catastrophic washings are threatening the Achara Black Sea shelf. The coast adjacent to "Baku-Supsa" oil terminal is also

exposed to washings. The mentioned phenomena are connected with substantial economical and ecological losses. The similar phenomena are observed not only on coastal areas of Georgia, but also on sea and ocean coastal areas of many countries of the world.

In order to prevent harmful effects of storm waves, by the contemporary situation, protection works of selected coastal lines are executed (inert material heaping in selected coastal line, fencing of port area perimeter arranging different type traditional hydro-technical structures, etc.) which is quite expensive and requires regular works for restoration of the washed-out volume.

It may be said that the practice of using the existing storm resisting fencing structures on coastal line and a number of open ports of the world are morally, as well as, technologically outdated, while a number of facilities are obsolete and need renewing and rehabilitation according to the contemporary technologies.

MAIN PART

In the mentioned context, innovation proposition-technology developed in our project can be considered as one of the versions. The project will present both, model structures laboratory-testing research results and, in accordance with the obtained results, the methods of calculation of the complex composed of new type floating coast-protection fencing hydro-technical structures on the basis of 2D and 3D wave processes mathematical modeling (see Fig 1-3) [1-4].

The research tasks are:

- Development of methodology of theoretical and experimental research of floating wave damping structures and organizational problems;
- Choosing of provisional-testing shapes of a new type floating breakwater hydro-technical structures on the basis of hydrodynamic and physical modeling, design and construction of test models;
- Serial test of floating chain of selected constructions on laboratory wave generators in conditions of wave regime generation characteristic to the Black Sea;
- Hydrodynamic analysis of scientific-experimental research results, technological innovation and development of innovation commercial propositions for realization at local and international markets.

Based on the analytical hydrodynamic model and structural-functional analysis the essential principles and concrete issues concerning the process under study, the progressive waves interaction with the floating structure (damper) having a simple shape (as a wall-barrier) are studied [5].

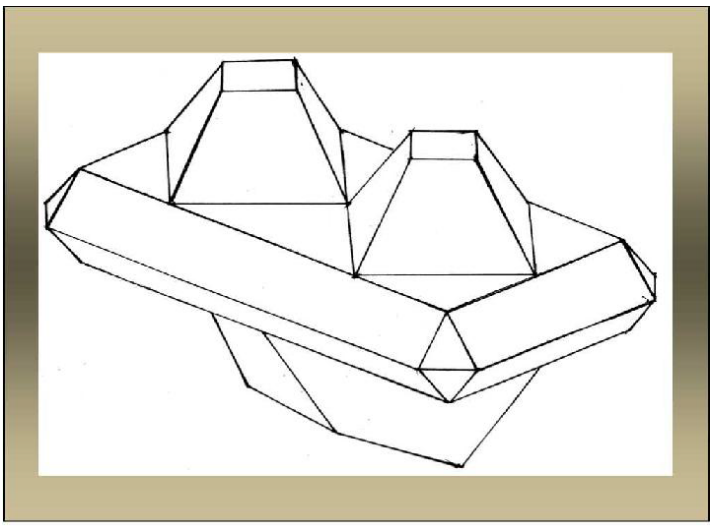

Fig.1. One of the floating waves damping structure proposed in the project (scheme)

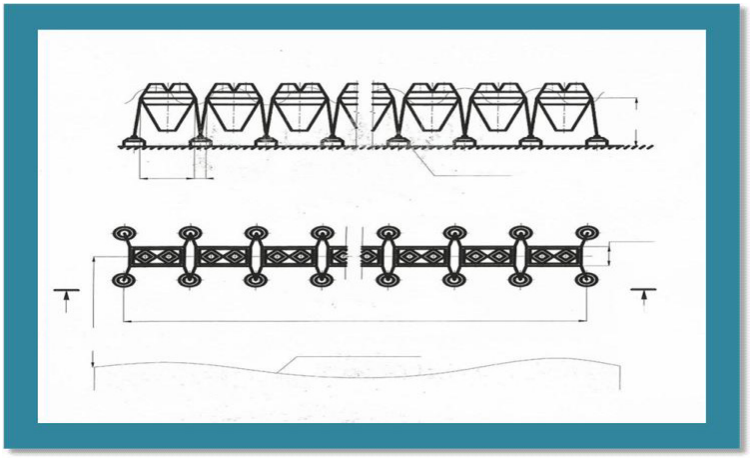

Fig. 2. Floating wave damping structures system (one of the models proposed).

Fig. 3. Preliminary experimental study of the wave damping structures system proposed in the project in hydraulic laboratory

Using the developed operative method the functional dependences characterizing the different wave parameters are derived. As a result, the average horizontal velocity of the wave flow under the damper is estimated and based on the Gvelesiani's analytical solution of the boundary value problem relative to the unsteady wave's generation, the maximum wave amplitude when it is moving after the section of barrier is determined.

The generalized diagram of the relation between the wave's amplitude damping degree and the damper submergence depth for the varied wave length are plotted.

These results shows that the relative maximum wave amplitude after it cross the damper (barrier) site (Fig.4) is the following function

$$e = \frac{\eta_{m,1} - \eta_{m,2}}{\eta_{m,1}} = \mathrm{f}\left(kh, \frac{H_1}{h}\right) \qquad (1)$$

where $\eta_{m,1}$ and $\eta_{m,2}$ = maximum wave amplitude before and after the barrier site, $k = \frac{2\pi}{\lambda}$, λ = progressive wave length, h = depth of the water basin at the barrier zone, H_1 = length of the barriers submerged in the water (depth of the barrier submergence under the water surface)

Based on the numerical results processing the following formula was obtained by T. Gvelesiani for assessment the maximum wave damping degree

$$e = 0.54H_1^* + \left[0.12 + 0.09\left(H_1^* - 0.2\right)\right]\left(kh - 0.4\right) \quad \left(\text{when } 0.75 \le kh < 2.2, \quad 0.2 \le H_1^* \le 0.6\right), \qquad (2)$$

where $H_1^* = \frac{H_1}{h}$.

The results of calculation using (2) for the *example* when $H_1^* = 0.4$ and h = 10 m are shown in the Table 1.

Table 1

λ, m	kh	e %
30	2.1	45
40	1.60	38
60	1.0	30
80	0.80	27

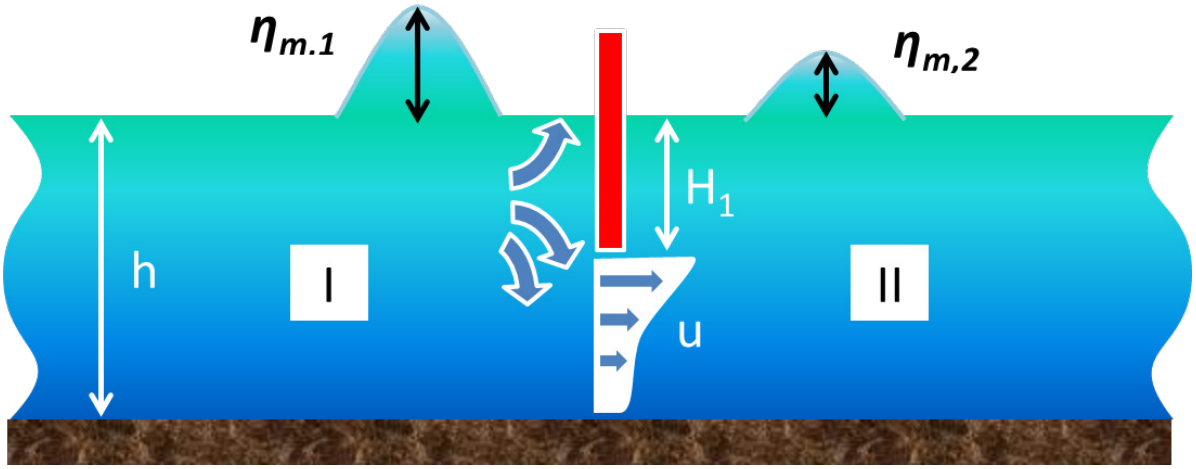

Fig. 4. The design scheme for study the wave damping character under the damper (barrier) action.

According to the proposed innovation project it will be possible to efficiently protect sea (or ocean) recreation coastal lines from washing and flooding, in rehabilitation (or newly built) ports construction widening-limiting of open port area territory space and effective protection from any whole gale (according to the demanded degree) so that in stormy weather be possible to let in and maneuver any size sea transport.

Unlike the existing ways of protection of open ports and recreation coastal lines (construction of capital protection walls, arrangement of metal construction structures and creation of other fencing measures) from storm waves the realization of the proposed project will be particularly effective and economically profitable owing to the following technical-economic indices: structure type and design sustainability, storm resistive required effect, use of contemporary light-weight noncorrosive material and comparative efficiency of structures complex arrangement, security of exploitation and repair capability, short time of structure assembly, convenience of work performance on sea, selection and design of structure facade esthetic forms.

The group of scientists working on the project plans to receive patent for the mentioned device in the form of intellectual property and commercial realization of the respective transfer for the interested investors and private persons who, with consideration of perspective development, intend building of international open ports and arrangement of coastal lines. Also, it is planned to develop recommendations on coastal line ecological-preventive protection (shore washing protection, uninterrupted operation of water sewage conduits in storm periods, increase of recreation and comfort level of holidaymakers, etc.) which in the given situation is urgent and timely for any populated places and towns in sea and ocean coastal line.

Taking into account the above enumerated characteristics the realization of the proposed innovation project will be possible with comparatively low expenses that will be the main factor for rehabilitation (or constructing) of ports and coastal line that will impart effectiveness and viability to execution of ecological and preventive measures on these objects.

For realization of this project, in the first place it will be necessary under the aegis of the Ministry of economy and sustainable development of Georgia to attract investors, collaborators and private persons interested in this problem and to inform them about the urgency of the proposed problem, high technological effectiveness and competitiveness of the innovation project.

CONCLUSION

Topicality of the problem, dealing with the wave damping structures complex effect, its research subject and objectives are determined.

The analytical relation between the wave maximum amplitude damping degree and the damper (barrier) submergence depth for the varied wave length is developed.

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Environmental protection

ON ASSESSMENT OF A DAM OVERTOPPING PROCESS DURATION CAUSED BY SEISMOGENIC WAVES IN RESERVOIRS

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ABSTRACT: The generation of long-period tsunami like impulse waves in a mountain reservoir of hydraulic works may be stipulated by a strong earthquake accompanying by seism tectonic (residual) deformations at the earth surface of the reservoir zone. The possible prolonged and repeated overtopping the embankment dam by these waves may cause the partial or complete scouring (failure) of the dam and catastrophic consequences at the downstream region.

The analysis of the computed cycle results based on the proper 2D hydrodynamic boundary value problem solution for the reservoir represented schematically as the rectangle, allowed to predict the possible dam overtopping accident and to assess the parameters of the wave oscillation process at dam site in particular such as the possible duration of the wave overtopping process.

KEYWORDS: wave maximum run-up height, water level rise, wave amplitude, wave length, duration of wave.

INTRODUCTION

The analysis [1, 4] showed that the amplitude of waves generated in reservoir due to an earthquake or the ground seismic movement of vibration type (when a seismic wave is propagated along the bottom of reservoir) are in general, smaller than wind-generated waves.

On the other hand the generation of long-period tsunami like (seismogenic) waves in a mountain reservoir of hydraulic works may be stipulated by a strong earthquake accompanying by seism tectonic (residual) displacement (STD) at the earth surface of the reservoir zone. These waves may be of considerable period and amplitude [2,4]. Therefore the possible prolonged and repeated overtopping of the embankment dam by these waves may cause the partial or complete scouring (failure) of the dam and catastrophic consequences at the downstream region [3].

It should be noted that reservoirs with high dams, situated usually in mountain areas with steep slopes and shallow water in river mouth near the initial site of a reservoir (where the backwater curve approaches the normal depth), should not be regarded as channels of unlimited length [2]. At this site, both the increase of the height of the wave and its reflection (caused by the intensive decreasing a depth and width of the reservoir) are occurred. That leads to the water level oscillation with relatively long periods [3]. As a first approximation to take account of the reflection factor we shall consider the process of wave-formation in a reservoir of limited length and average depth [4]. So the reservoir can be represented as a

rectangle (plane or 2D representation) or as a rectangular parallelepiped (3D representation); also it was assumed that the amplitude of residual displacement was negligible relatively to the reservoir height. Thus in the papers [1, 4] the author has solved (based on the small amplitude wave's theory) two and three dimensional (2D, 3D) problems on a linear oscillation of an ideal incompressible fluid in a reservoir during seismic disturbance at its bottom as the vertical velocity of displacement representing an arbitrary function of time and coordinates.

MAIN PART

According to the solution of the 2D problem of wave generation in reservoir due to the STD at its bottom [2, 3, 4], the wave maximum run-up height (or water level rise) $\eta_{d,m}$ at the dam site ($x = 0$) (Fig.1) can be expressed in a non-dimensional form as the function of the following parameters

$$\frac{\eta^*_{d,m}}{D^*_m} = \frac{1}{t^*_0} f\left(l^*, \frac{b}{l}, \frac{x_0}{l}, t^*_0\right) \qquad (1)$$

where $\eta^*_{d,m} = \frac{\eta_{d,m}}{h}$, $l^* = \frac{l}{h}$, $t^* = t\sqrt{\frac{g}{h}}$, $t^*_0 = t_0\sqrt{\frac{g}{h}}$, $D^*_m = \frac{D_m}{h}$, g = free fall acceleration, l = length and h = depth of the reservoir, t_0 = duration of the seismotectonical displacement, D_m and $2b$ = maximum amplitude and extent of seism tectonic displacement (up throw) at the reservoir bottom along x coordinate, x_0=corresponding coordinate of its center (count from dam site).

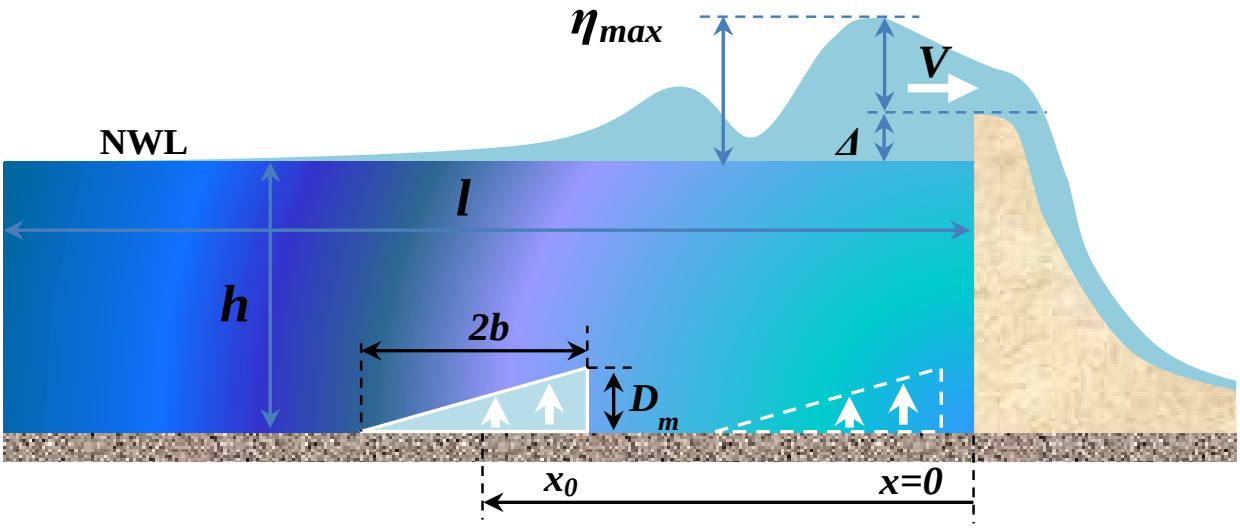

Fig. 1. Design scheme for study the seismogenic wave oscillation in reservoir due to STD at its bottom

For the estimation of the possibility and character of a dam overtopping event by tsunami type waves when the location and sizes of the STD approximately are known in advance, we have to answer on the following basic questions:

a) what will be the maximum amplitude of waves at the water surface in a reservoir and in particular, at the dam site?

b) how often the maximum water level rises (peaks) will be occurred at the dam during the water oscillation in a reservoir?

c) what will be the duration of the maximum level rises at a dam site?

Below we'll touch upon shortly the aspects c), as for the issues a) and b) they have been considered in [2].

We will consider the case (Fig.1) when the earth surface seism tectonic rise (up throw) occurs on one side of the fault (line) ignoring the deformations of the downthrown [2]. Obviously, it will be the extreme case with the most possible dam overtopping accidence with dangerous consequences at downstream.

Results of calculation examples based on the above mentioned 2D wave problem solution [4] are illustrated at figures 2 and 3 showing the following functional dependence for concrete values of design parameters

$$\frac{\eta_d}{D_m} = f(t)$$

where η_d = wave run-up height at the dam site (x = 0), (Δ = residual freeboard or height between the design water level and the elevation of the dam crest. (Fig. 1)

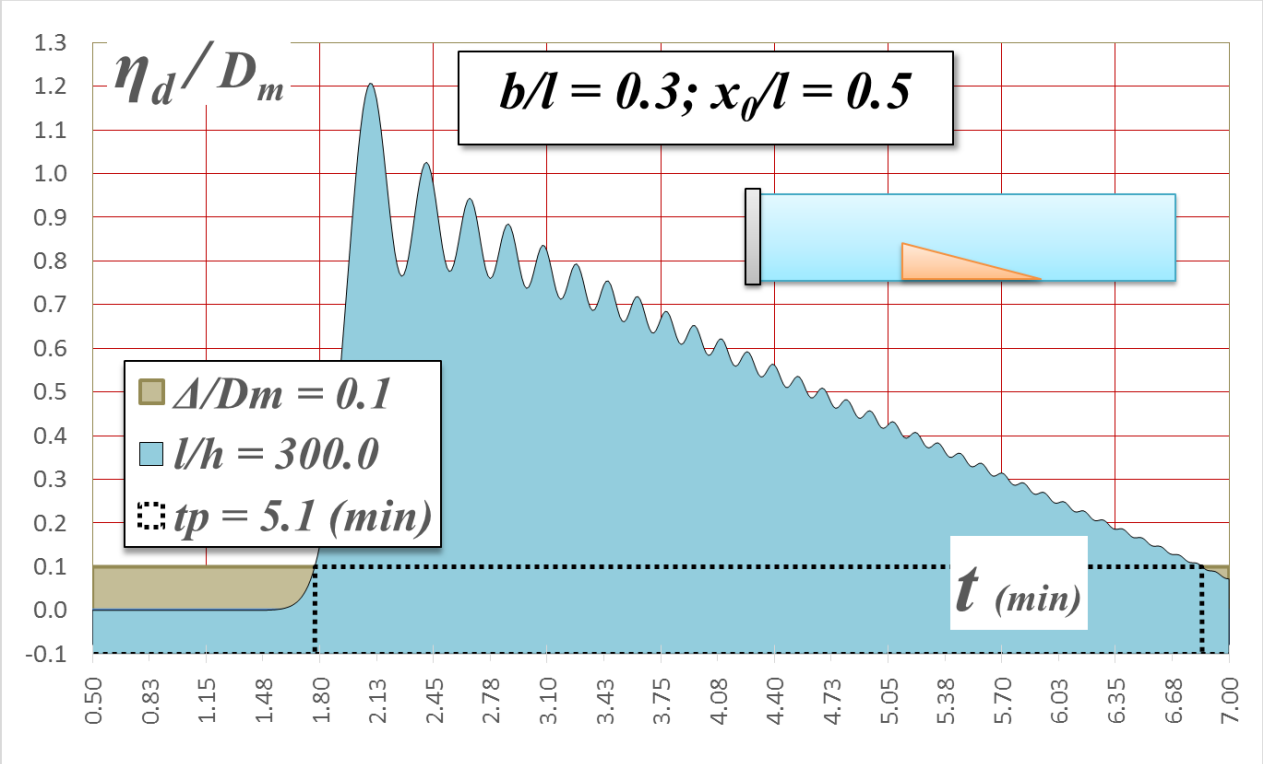

Fig. 2. The relation between the parameter η_d / D_m and time (t) (the proper value t_p is shown).

The dam overtopping process will begin when $\eta_d > \Delta$ and it will be continued during the time interval $T_{ov} \approx t_p$ where t_p = maximum limit of duration of the water level rise or "thickness of wave peak" at the Δ level (Fig. 2, Fig. 3).

So the value t_p can be used for assessment the duration period of the dam possible overtopping process by extreme seismogenic wave considering different freeboard height (Δ).

The parameter t_p mainly is dependent on: the shape of the STD at the reservoir bottom and its relative length (b/l), the shape of reservoir (or parameter l/h) and the relative freeboard value (Δ/D_m). The relationship t_p = f(l/h) for the concrete shape of the STD is shown at Figure 4.

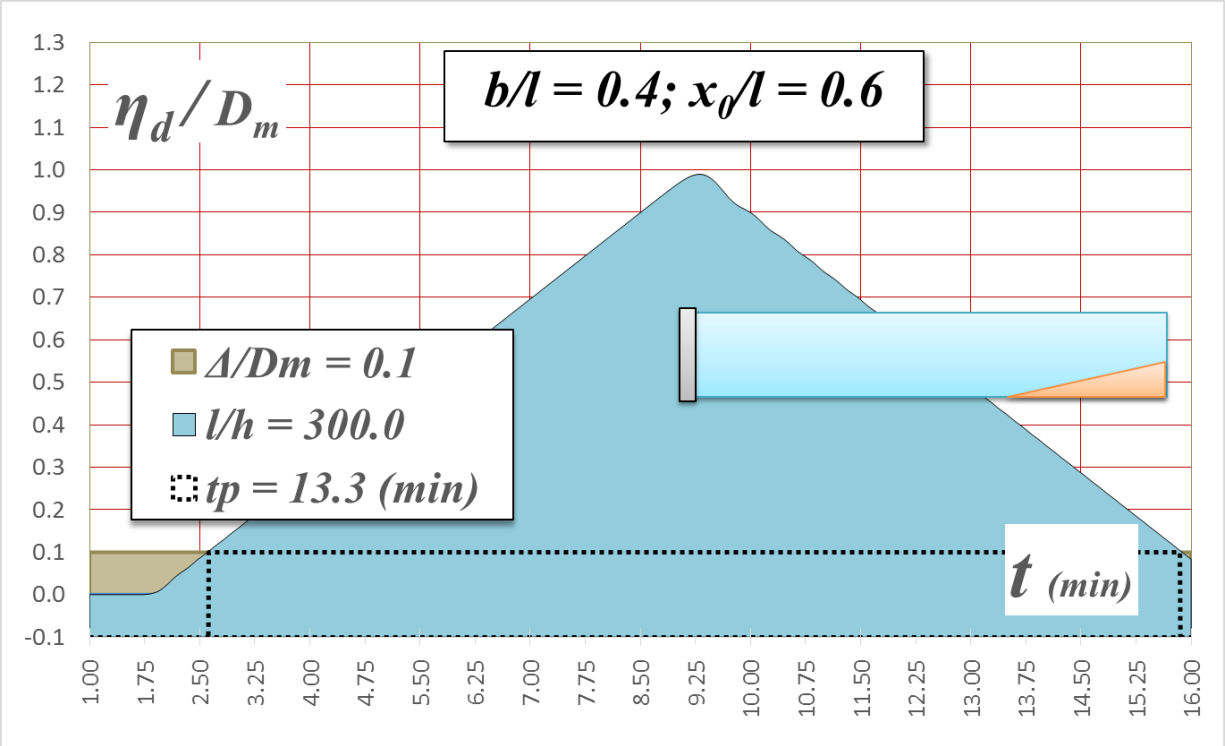

Fig. 3. The relation between the parameter η_d / D_m and time (*t*) (the proper value t_p is shown).

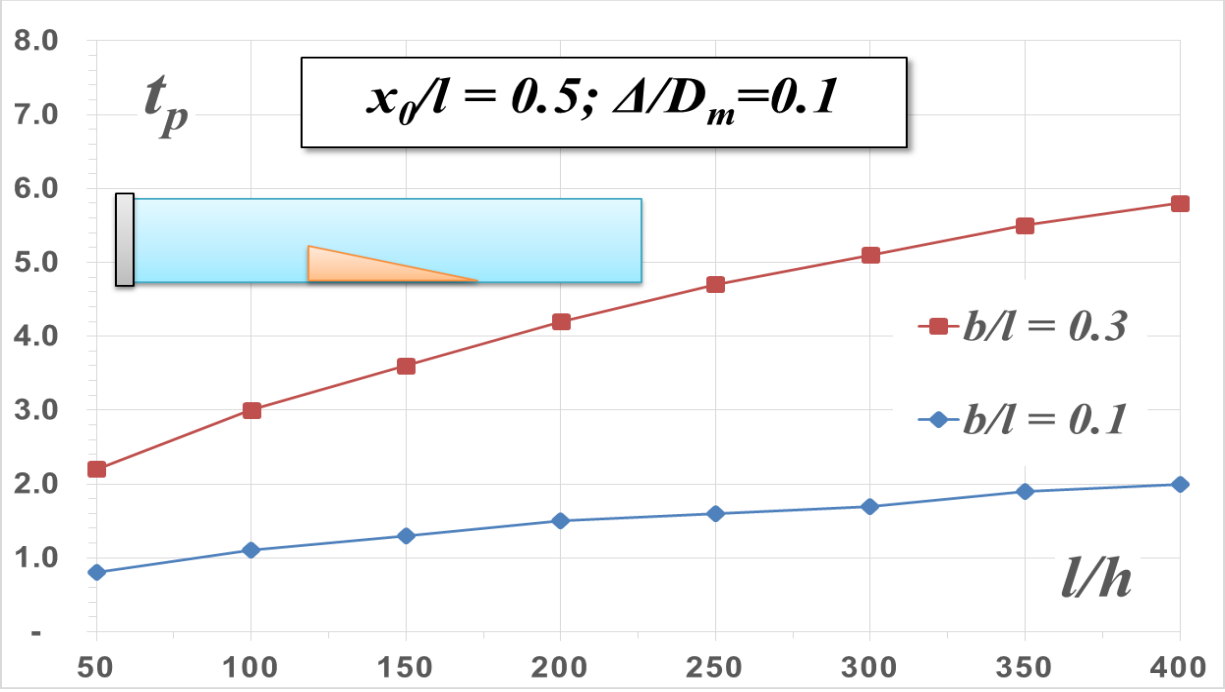

Fig. 4. The values t_p as a function of l/*h* when *b*/l = 0.3 and 0.1 (the concrete shape of the seismo-tectonical deformation at the reservoir bottom is shown).

Abovementioned computed data show that the possible duration period of the dam overtopping process by tsunami type waves in reservoirs amounts to the considerable values that increases to a great extent the risk of emergency due to the dam scouring and it eventual failure

CONCLUSION

The analytical solution of the proper 2D hydrodynamic (wave) problem have been obtained formerly by T. Gvelesiani using the potential waves motion theory (for the reservoir represented schematically as the rectangle) is used to describe mathematically the seismogenic waves oscillation character in the reservoir during an strong earthquake. The analysis of the computed results showed in particular, that value t_p assessing the period of dam overtopping process by seismogenic waves mainly is dependent on: the shape of the STD at the reservoir bottom and its relative length (b/l), the shape of reservoir (or parameter l/h) and the relative freeboard value (Δ/D_m). The duration of wave overtopping process can amount to the considerable values (more than 10 min).

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Environmental protection

QUALITY OF LIFE AND ENVIRONMENT

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ABSTRACT: The article considers the environmental economics as a synthesis of traditional neoclassical and Resource Economics in combination with an assessment of the environmental impact, on the one hand and environmental economics and traditional environment, on the other. It's shown that triune concept of sustainable development appeared as a result combining three main points of view: economic, social and environmental. It's shown that ecological economics gives us the key to change not only the mankind, but also the whole world, including inanimate, vegetable and animal nature. People – consumers are seen as an important component of the economic and environmental integrity of the system and not as a dominant and central force. Humanity is adopted as a part of the biosphere and affirms the need to transform the nature for the benefit of a person, there appears a number of new ideas that how people develop to a large extent under the influence of the environmental impact.

KEYWORDS: ecological economics, ecosystems, quality of life, human development.

INTRODUCTION

Interaction of nature and society is a key problem of political and socio-economic development of society. Environmental protection is a range of measures intended to limit the negative impact of human activity on the environment. However, as international experience shows, this problem is far from its solution.

Expanding and enhancing anthropogenic and technogenic pressure on nature, society often faces with reproduced "boomerang effect": destruction of nature causes to economic loss and social damage. Nature is not able to recover on its own the destroyed ecological balance, recreate withdrawn welfare in an appropriate volume. Ecological degradation processes acquires the character of a deep environmental crisis. Question of nature conservation turned into the question of mankind's survival. Economic growth based on traditional principles, becomes menacingly dangerous. If in all preceding steps society strived maximally to change the nature in order to fit their needs, now it should be adjusted itself to the changes of its vital activities and above all, social reproduction taking into account the need to maintain the ecological balance, achieving environmentally sustainable socio-economic development of society.

MAIN PART

Most of the ecological problems now crossed the boundaries of the national households and acquired global dimension. Solving them requires joint efforts of all countries of the world community. Countries don't immediately come to the necessity of understanding the radical restructuring at the relationship between man and nature. Effective methods were not immediately established for simulating the conservation efforts.

In the late 1980s, there is appeared interdisciplinary field of knowledge of ecological economics

studying the relationship between ecological systems (ecosystems) and economical systems in the broadest representation [1]. Ecological economics is a kind of synthesis of traditional neoclassical and resource economics in combination with an environmental impact assessment (EIA) on the one hand, and environmental economics with EIA and traditional ecology on the other hand. People – consumers are seen as an important component of the economic and environmental integrity of the system and not as a dominant and central force. Humanity is adopted as a part of the biosphere and affirms the need to transform the nature for the benefit of a person, there appears a number of new ideas that how people develop to a large extent under the influence of the environmental impact. Consumption is exposed not only in monetary budget limitations as it's in neo keynesian economics, but also natural limitations and physical rules. At the center of ecological economics stands sustainable management of the economical and environmental system, and time frames are usually considered more widely than in the traditional economy. The aim of ecological economics is to find the best ways to live on our planet – "economical society" based on the definition of frugality through economic efficiency and achievement of environmentally friendly economic development.

There are three concepts at the core of ecological economics: throughput/reprocessing capacity of ecological and economic systems, bearing capacity/ capacity of ecosystem and entropy. It's believed that contemporary economics and people's survival depend on throughput/reprocessing capacity of ecosystem. Second concept – is a bearing capacity or capacity. Under sustainable conditions ecosystem bearing capacity (capacity) can be determined with sufficient accuracy. What about entropy, costs of biological and economic sectors are always greater than the capacity of economic output. Regardless to the efficiency of production processes from the standpoint of minimizing or reducing the effects of external wastes, production will always contribute to the continued growth of entropy in the universe. Therefore, economic activities should strive to ensure the necessary level of goods for the society and minimize the entropy growth.

Specific research topics for the environmental economics (econology) include: environmentally sustainable ecological development, analysis of the ecological limits of economic growth, global climate changes, conservation of biodiversity, economic assessment of natural resources, ecological-economical modeling, ecological tax reform, etc.

Triune concept of sustainable development appeared as the result of combining three main points of view: economic, social and ecological.

Economical approach to the concept of sustainable development was based on the theory of maximum flow of aggregate income Hicks-Lindahl, which can be produced under the terms of, at least, saving the aggregate capital that with the help of it this revenue is produced. This concept implies the optimal use of limited resources and use of ecological – nature, – energy-, and material-saving technologies, including production and processing of raw materials, creation of environmentally friendly products, minimization, recycling and disposal of wastes. However, when deciding how much capital should be maintained (for example, physical or natural, or human capital) and to which extent the different types of capital are interchanged, as well as at the assessment of these assets, especially the ecological resources, proper interpretation and billing problems arouse. There are two kinds of sustainability - weak, when it's about the depletion of natural and produced capital, and strong – when the natural capital shouldn't be depleted (and part of the profits from the sale of non-renewable resources should be directed to the increase of the value of renewable natural capital) [2].

Social component of sustainability is focused on human rights and is directed to the maintaining the stability of social and cultural systems, as well as, to the reduction of number of damaging conflicts among people. An important aspect of this approach is a fair share of benefits. It's desirable to preserve the cultural capital and diversity on a global scale, as well as fuller use of sustainable development practices

not available in the dominant cultures. For achieving sustainable development, contemporary society will create a more efficient decision-making system taking into account historical experience and encouraged pluralism. Achievement is important not only inside, but also intergenerational justice. Within the concept of human development, man is not the object, but the subject of development. Based on the expansion of options of human choices as the main value, concept of sustainable development implies that people should be involved in the processes that form the scope of his life, encourage the adoption and fulfillment of decisions, and control their performance [3].

From an environmental perspective, sustainable development should ensure the integrity of natural biological and physical systems. Viability of ecosystem means special importance upon which global stability of entire biosphere depends. Moreover, the term of «natural» system and habitat reales can be understood broadly, including the man-made environment, such as, for example, cities. The main focus is paid to the conservation abilities to heal itself and dynamic adaptation of these systems towards changes, rather than keeping them in some "ideal" static state. Degradation of natural resources, environmental contamination and loss of biodiversity reduce the ability of ecosystems to heal itself.

Reconciling of these different perspectives and their translation into the language of particular practice which is a means of achieving sustainable development – is a task of enormous complexity, since all three pillars of sustainable development should be considered in a balanced manner. Mechanisms of interaction among these three concepts are also important. Economic and social elements interacting with each other generate new challenges such as achieving equity within one generation (E.g., in relation to the distribution of income) and targeted assistance to the poor. The mechanism of interaction of economic and environmental elements generated new ideas on valuation and internalization (accounts economic statements of enterprises) of external influences on the environment. Eventually, the relationship of social and environmental elements has sparked interest to issues such as intra-generational and intergenerational equity, including respect for the rights of future generations, and public participation in decision-making [4].

The emergence of the concept of sustainable development undermined the fundamental basis of the traditional economy – unlimited economic growth. In one of the basic documents of the UN Conference on Environment and Development (Rio de Janeiro, 1992) – "Agenda of the XXI Century", Chapter 4 (part 1) devoted to changes in the nature of production and consumption, traced the idea that we should go beyond the concept of sustainable development, when it is said that some economists «are questioning traditional concepts of economic growth», and suggests the search for "patterns of consumption and production that meet essential needs of mankind". Within the framework of ecological economics theoretical approaches are formulated towards the termination of the problem of economic growth without unacceptable social consequences. Center was established for the development of a stable economy in order to promote this concept in 2004 by the proponents of this approach. There was introduced the concept of "steady state economy" – physical components which are limited and do not change over time in the works of Herman Daly [5].

Progress of economic science led to an increasing integration of the natural factor. On the one hand, most of the traditional natural resources have become deficient. This applies not only to non-renewable resources, but also to so-called renewable resources – primarily to ecosystem resources (eco-system "goods" and "services") and biodiversity. One of the definitions of sustainable development is inexpensive development in the long, intergenerational terms.

Since nature is the basis of human life, its depletion and degradation under existing economic relations negatively affects social relations, the growth of poverty and patterns of production and consumption. On the other hand, it appears that many renewable natural benefits do not have the proper values that are the source of their depletion and degradation. Therefore, there was a shift to environmental

economics and sustainable development of the economy. At the same time, the interaction of social and environmental factors led to the consideration of another factor of production – social capital [6].

Canadian economist Peter Victor proposed interactive model allowing investigating the potential to achieve a stable, but not growing economy. The model demonstrates that even within the common approaches to the economy, there are opportunities to reach steady state [7].

Traditional economics argues that maximization of profits and customer satisfaction in the market system is compatible with the maximization of human well-being and that market failures can be corrected by the state policy. The second group believes that short-term maximization of profits and the satisfaction of individuals-consumers will eventually lead to the depletion of natural and social resources which rests on human well-being and survival of the species. To a large extent, it is about ensuring the quality of life.

Quality of life is a concept used in sociology, economics, politics, medicine and other fields, indicating the assessment of a certain set of conditions and characteristics of human life usually based on his own degree of satisfaction by these conditions and characteristics. It is wider concept than material security (standard of living) and also includes such objective and subjective factors as health, life expectancy, environmental conditions, food, household comfort, social environment, satisfaction with cultural and spiritual needs, psychological comfort, etc. Quality of life may depend on the state of health, communication in society, psychological and social status, freedom of action and choice, from stress and excessive concerns, organization of leisure time, level of education, access to cultural heritage, social, psychological and vocational self-assertion, psycho type and adequacy of communications and relationships [8].

In 2009 a report was issued by the International Commission on key indicators of economic performance and social progress under the guidance of Nobel laureate Joseph Stiglitz and A. Sena that justified the use of the quality of life indicator as a main criterion of economic development of society instead of gross domestic product (GDP) [9].

We can use the Human Development Index (HDI) of the United Nations with a certain approach like an indicator of the quality of life. Until 2013 HDI "Human Capacity Development Index "(HCDI) is an integral indicator calculated annually for inter-country comparison and measurement of living standards, literacy, education and longevity as the basic characteristics of human capacity in a researched area. It is a standard tool in the overall comparison of living standards of different countries and regions.

In the document "Environmental Performance Index", prepared by Yale and Columbia universities, Azerbaijan ranks second in the world for the activities over the past ten years in the field of environmental protection [10].

The document assessed 132 countries on two directions: the ecological situation in the country and the results of activities of the last ten years relating to the environmental protection.

According to the document, Azerbaijan ranks first in the area to reduce diseases associated with the environment.

The ground for this was set by work held to remove the environmental problems negatively affecting human health. Thus, such results were achieved due to changes in the management of hazardous wastes, including the complete neutralization at the modern ground of dangerous toxic waste, provision of population with clean drinking water meeting the requirements of the World Health Organization, the advance in the management of solid waste and wastewater, rehabilitation of oil-contaminated sites and other activities.

Azerbaijan also in the evaluation related to forests, on all three components – the situation of forest resources, changes in forest cover and forest loss, according to the index of the situation of the environment and ecological development indicators showed the highest score and ranked first among 132 countries.

This assessment took into account an increase from 11.4 to 11.8 per cent of forest in the total area, a ban on industrial waste, strengthening measures for the protection of forests, including the suppression of illegal logging, gasification of regions, a decrease from year to year of cases of felling through advocacy carried out by mass media in conjunction with the public.

Also in the "Environmental Performance Index" Azerbaijan ranked 45th for the protection of basic human settlements, development in the last decade of biodiversity, which is estimated on the basis of indicators of protected marine areas and protection of biomes and 100th on the actual situation. This development was due to the actions carried out to establish a network of especially protected areas, breeding of rare species, reintroduction of them into the places in which they have historically lived, the achievement of the natural growth of rare endangered species due to tighter security measures.

In the "Index of environmental performance", the situation in the environment and ecological environment has been evaluated on the basis of 22 indicators in ten areas.

One of the patterns of world development is the globalization of the economy. Globalization of the economy is a complex and contradictory process. On the one hand, it facilitates the economic interaction among the states, creates conditions for countries to access the advanced achievements of mankind, saves resources, and stimulates the world's progress. On the other hand, globalization leads to negative consequences: consolidation of peripheral economic model, loss of the resources of their country which is outside the ranks of developed countries. Globalization disseminates compete among all participants, including weak countries, which leads to the ruin of small business, reduction in the standard of living, etc.

Increasing globalization of the economy is reflected in a sharp increase of standards and capital movement rates in faster growth of international trade compared to GDP growth that people full-time working in real-time emerged in global financial markets. Information systems created over the last decade immeasurably intensified the ability of financial capital to the rapid movement that contains at least potentially, the capacity to destroy sustainable economic systems.

CONCLUSION

Thus, ecological economics gives us the key to change not only the mankind, but also the whole world, including inanimate, vegetable and animal nature. We can't talk about a specific image of the future society, because it will constantly change, transform. Making a positive impact of globalization available to the maximum number of countries, and thus mitigate the negative effects is one of the declared objectives of the international community.

How is it possible? It's necessary to improve our holistic representations in the relationship between environmental, social and economic systems and conformable actions aimed at the dissemination and application of existing knowledge to achieve harmony between nature and society, especially considering the interests of future generations. Organization of International conferences, research projects, publications and interaction with the public and governmental organizations in order to develop concepts of ecological economics and sustainable development is important for fulfilling this work.

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Hydrology and meteorology

ASSESSMENT OF CURRENT CHANGES IN THE ANNUAL DISTRIBUTION OF RUN-OFF OF THE AZERBAIJAN RIVERS

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ABSTRACT: The article describes the particularity of annual run-of distribution of rivers of Azerbaijan Republic. On the example of 20 main river located in different natural regions of the republic main particularities of change of monthly and seasonal run-off have been defined.

It was established that during the period of 1975-2012 compared to previous years flow in winter has increased and in summer reduced for majority of the assessed rivers. Possible reasons of these regularities have been described in the article.

KEYWORDS: monthly flow, seasonal flow, climate change, anthropogenic factors.

Climate factors play an important role in flow distribution during a year: including atmospheric precipitation, their seasonal distribution characters, temperature and humidity of air and possible evaporation. The changes in the performance of climate are also has influenced to the regimes of rivers. However the process of transformation of the precipitations fallen into the river basin to the flow is very complicated and significantly depends from the surface factors of basin. These factors are relief, soil and plant cover, hydrogeological condition, lake, glaciers and etc. The flow regime of river of one basin as result of impacts of surface factors may significantly differ from the regime of other rivers formed in similar climate condition. The hydrogeological condition of these basins is clearly observed in the hydrographs of Ganjachay and Zabukhchay rivers (Figure 1).

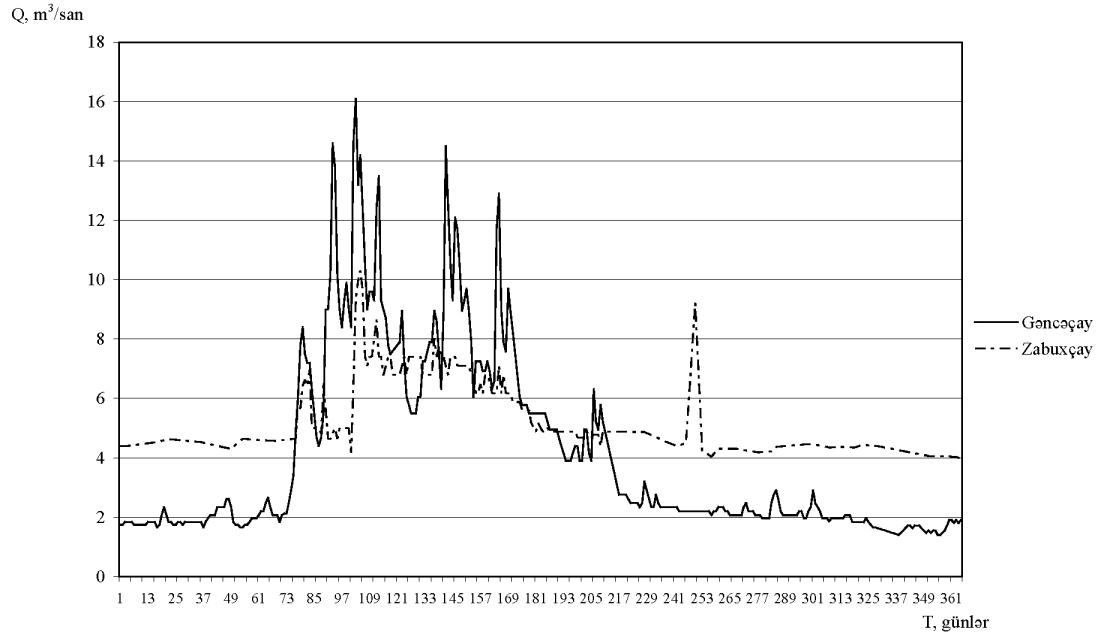

Fig. 1. Hydrographs of Ganjachay (Zurnabad point) and Zabukhchay rivers (Zabukh point) (1985)

Anthropogenic factors also strongly influence on annual flow distribution. The water reservoirs constructed for regulation of river stream are the most relevant examples (Figure 2).

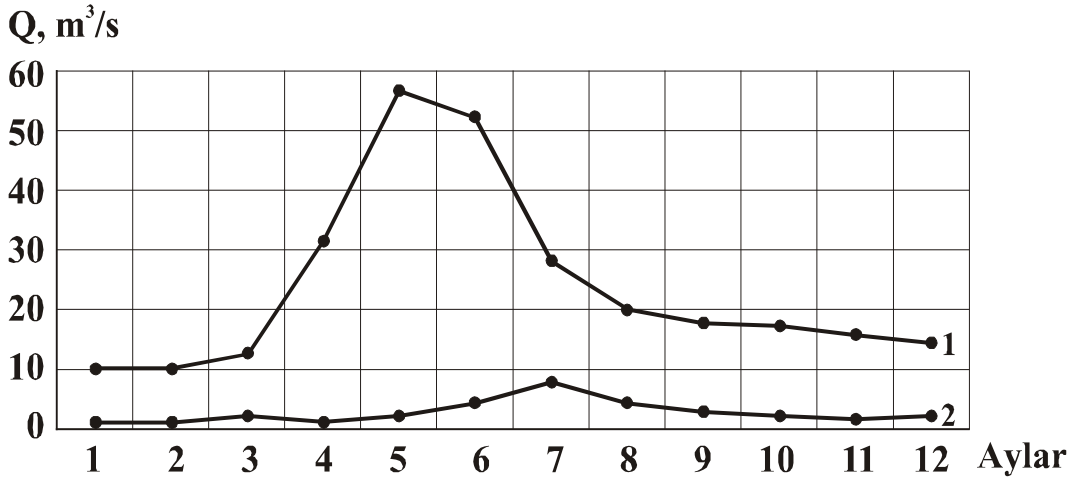

Fig. 2. The hydrographs of Tartar River (Madagiz point) for different periods
1 – Natural regime (1925-1973); 2 – Anthropogenic regime (1981-1991)

In fact, each river has individual water regime according to individual characters of its water storage. However in spite of all these differences there are general elements in water regimes of rivers and they are mainly based on climate factors. And it allows classify rivers according to annual distribution characters of flow.

Currently the rivers of Azerbaijan are divided into 5 types according to their water regimes S.H.Rustamov and R.M.Qashqay (Рустамов, Кашкай, 1989):

1. Rivers where there is high water during the summer months
2. Rivers with floods during a whole year
3. Rivers with floods during cold times of a year
4. Rivers where there is high water and floods during summer and spring
5. Rivers rich with high water and floods during autumn and spring

All such kind of types of annual distribution of run-off of rivers in Azerbaijan makes clear description of water regimes of rivers, especially characters reflecting impacts of climate factors. Even in some cases the rivers with same hydrological type could differ from each other with their monthly and yearly distribution characters of streams. The patterns of change of annual and seasonal performances of river streams according to height in different zones were defined by S.H. Rustamov and R.M. Qashqay (Рустамов, Кашкай, 1989). And it can be used in calculation of stream characteristics of the rivers without observation data.

R.H. Verdiyev developed new scheme to calculate annual distribution of rivers streams of Azerbaijan (Вердиев, 2002). The main advantage of this method is the consideration of water richness of a year in calculations.

Generally classification of rivers based on their water regimes, feeding sources, character of annual distribution of stream, and other indicators are developed according to the multiyear indicators of stream characteristics.

In fact monthly and seasonal calculation of streams based on the data covering last 20-30 years usually gives us concrete and sustainable information. Extended information on annual distribution of river streams in Azerbaijan is described in several published materials (Фатуллаев, 2002; Вердиев, 2002). But it must be noted that fundamental studies on annual distribution of streams were carried out several

decades ago, during 1960-1990 years. Regional impacts of global climate changes in recent periods are clearly reflected in the territories of Azerbaijan. Therefore it is very significant to study multiyear dynamics of monthly and seasonal streams of rivers using recent hydrological data.

Modern changes in annual distribution of flows of the rivers in the republic are assessed separately for seasonal and monthly run-off indicators. Therefore there has been used observation data of 22 rivers located in different physical-geographical regions. Observation period starts from the beginning of hydrological observations till 2010. Each observation sequence has been subdivided into 2 phases and corresponding flow quantities have been compared. The first phase covers the period till 1975, the second phase till 1976-2010 years. The reason of such timing is that the last assessment of annual distribution of flows of the water resources and rivers of Azerbaijan were developed based on the observation data of period till 1975 (Рустамов, Кашкай, 1989).

The main part of the territory of Azerbaijan Republic is located in the Basin of Kura River. The flow in the closure point (Salyan, in the distance of 85 km from the estuary) of the river (near mouth) has been decreased in all seasons. The strongest decrease (25,7 %) happened in the spring season.

As well as the flow in the closure point (Saatli) of Araz (Near its mouth) – the second biggest river of Azerbaijan went down in all seasons except winter. It must be noted that for the point in Saatli the data till 2005 has been used and therefore the capacity of water filled Khudaferin Water Reservoir has been considered in the calculations.

However there has been observed increase in winter flows of 16 of the remaining 20 rivers. The decrease in Alingachay (Erefse) is 2.4% and Velvelechay (Tengealti) is 0.6% which in the level of the accuracy of the flow registration.

The main reason of increase of winter flows is based on feeding of rivers with snowmelts in the result of increase of the temperature in winter season (Исмайлов, Иманов, 2010).

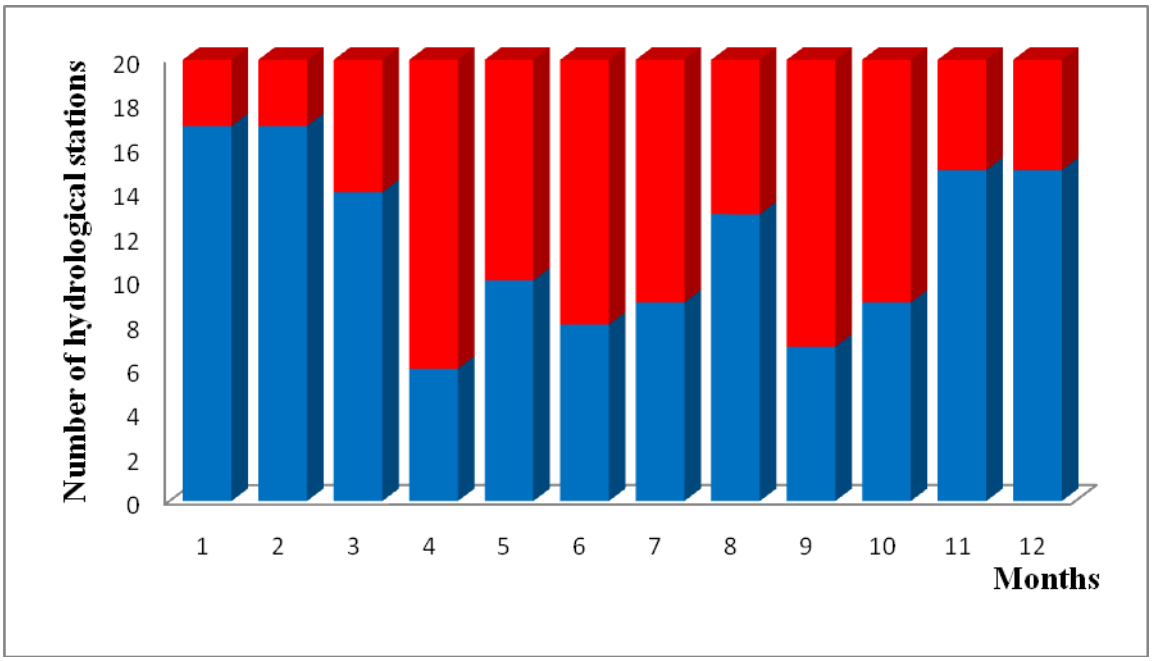

Figure 3. The number of increased and decreased average monthly runoff stations for Azerbaijan rivers
Note: total number of station is 20
– the number of decreased runoff station
– the number of increased runoff station

The flow in Ganikh (Alazani) river has been increased in all seasons. However the flow is increased and decreased in the tributaries (located in the territory of Azerbaijan) of the river. One of the reasons of increase of flow in Ganikh (Alazani) river may be snowmelts in the territory of Georgia.

The flow has been decreased in spring season in the most rivers of the Lesser Caucasus, Nakhchivan and Lankaran regions. However the flow o the rivers in the Greater Caucasus is increased. There is gap here. Thus the flow in Eyrichay (Bashdashagil) river has been increased 0.4% though the flow in Talachay (Zagatala) has been increased 91.6%.

The flow in the most rivers has been decreased in summer season. This is mainly based on extended use of river waters in irrigation. However it is difficult to explain that why the increase of flow in Tengerud river (Vago) is 68.0%, in Eyrichay (in estuary) is 50.0% and in Demiraparanchay (Gabala) is 29.8%.

Autumn flow in the most rivers has been decreased. However there has been observed increase in the flow of the rivers in he southern slope of the Greater Caucasus, especially in Ganikh (Alazani) basin.

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Safety and risk of hydraulic structures

MODELING PROCEDURE OF COASTAL PROTECTION SHAPED BLOCKS WITH HIGH WAVE SUPPRESSING AND INTERLOCKING CAPACITY

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ABSTRACT: On the basis of analysis of wave suppression efficiency and stability on the slope of more than one hundred existing shaped massives the new type of coast protecting reinforced concrete blocks – so called "Hexablock" characterized with higher wave suppression properties, interlocking capacity, stability on the slope and longer life time is proposed. The procedure of "Hexablock" modeling is worked out by the laboratory of the Institute of Water Management of Georgian Technical University.

KEYWORDS: shaped blocks, new type of coast protection "Hexablock".

INTRODUCTION

The study of waves and coast protecting structures interaction processes is getting more important every year. However, consideration of many factors stipulating development of the process is so difficult that the problem of modeling the real wave streams and their interaction with the coast protecting structures is not fully studied yet.

The analysis of many works dedicated to the problem shows considerable difference of ideas and opinions.

According to the world practice of reservoirs bank protection methods the most efficient one is with shaped concrete blocks.

THE KEYNOTES

According to the analysis of more than one hundred relevant research works it has been determined that among the used shaped blocks the most popular are: Tetrapod, Dolos and Dipod types, fig. 1.

Tetrapod **Dolos** **Dipod.**

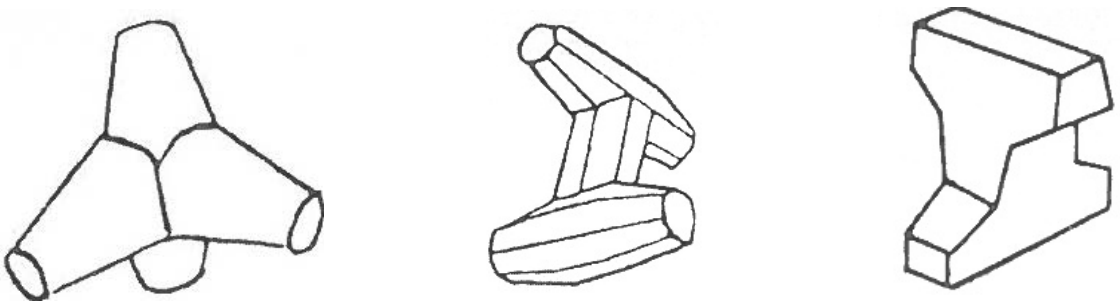

Fig. 1. The most efficient types of shaped blocks

With a view to rise wave suppressing capacity of shaped blocks, their interlocking properties, stability at the shore line and the longer service lifetime the new type of shaped block the "Hexablock" in particular is proposed, fig. 2.

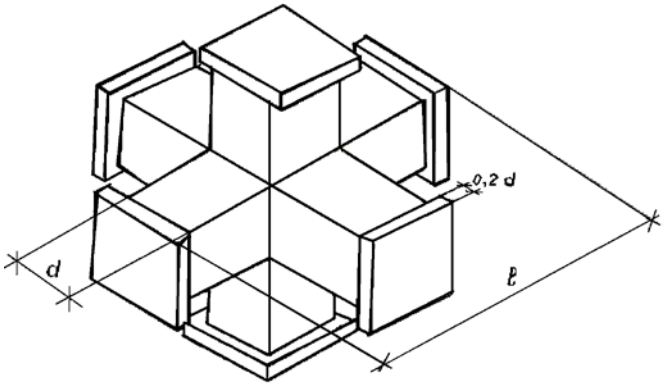

Fig. 2. The diagram of new type shaped massif – "Hexablock"

CALCULATION OF "HEXABLOCK" STABILITY

The "Hexablock" weight that will ensure its limit equilibrium at the slope is determined by the approbated universal dependence [Iordanishvili I.K., 2010]:

$$M = \frac{0{,}0165\rho_b h_{1\%}^3}{(\rho_b - 1{,}02)^3 ctg\alpha}\sqrt{\frac{\lambda_{1\%}}{h_{1\%}}} \qquad (1)$$

where ρ_b is the density of block material (t/m^3), $h_{1\%}$, $\lambda_{1\%}$ are the height and the length of 1% provision wave (m); α – is the bank slope angle; $\rho = 1.02$ is the density of the Black Sea water (t/m^3).

If to assume for a first approximation that the height of natural scale "Hexablock" $l_{nat} \approx \frac{h_{1\%}}{3}$ (that opinion is based on many studies) where $h_{1\%}$ is the height of 1% provision wave at the Caucasian coast line when ρ_b = 2.4 (t/m^3), $\frac{\lambda}{h} = 10$, ctgα = 3(α = 18^0), then the true weight (P_{nat}) of "Hexablock", the weight securing its stability on the slope (M_{nat}) and the model values (h_{mod} P_{mod}, M_{mod}) will be summarized in Tables 1, 2, 3 and fig. 3 below. The said values were received by the hydro-technical laboratory of Water Management Institute of Georgian Technical University at the following installations: the large hydro-wave chute 50.0 m long, 0.75 m wide, 1.5 m deep; the small hydro-wave chute with dimensions 10.0×0.3 x 0.7 m; the small wave basin 7.0×7.5×1.1 m and large wave basin 30.0×40.0×2.0 m.

Table 1

The values of "Hexablock" actual (natural scale) and model design characteristics (for small chute 10.0×0.3×0.7 m; a_{L1}=30)

$H_{nat,m}/h_{mod,m}$	5.00/0.16	5.70/0.19	6.90/0.23	7.50/0.25	8.10/0.27	8.40/0.28	9.00/0.30
$P_{nat,t}/P_{mod,kg}$	1.70/0.06	2.10/0.08	4.50/0.17	5.50/0.21	7.10/0.26	7.80/0.29	8.00/0.30
$M_{nat,t}/M_{mod,kg}$	1.80/0.07	2.20/0.08	4.60/0.17	5.90/0.22	7.40/0.27	8.00/0.30	8.30/0.31
$D_{nat,\ m}/d_{mod,m}$	0.40/0.01	0.45/0.015	0.55/0.018	0.60/0.02	0.65/0.022	0.68/0.023	0.73/0.024
$S_{nat,\ m}/S_{mod,m}$	0.52/0.017	0.63/0.021	0.75/0.025	0.83/0.028	0.90/0.031	0.95/0.032	1.0/0.033
$L_{nat,\ m}/l_{mod,m}$	1.69/0.05	1.90/0.06	2.30/0.075	2.50/0.08	2.70/0.09	2.80/0.09	3.00/0.10

Table 2

The values of "Hexablock" actual (natural scale) and model design characteristics (for large chute 50,0×0,75×1,5м; a_{L2}=13)

$H_{nat,m}/h_{mod,m}$	5.00/0.39	5.70/0.44	6.90/0.53	7.50/0.58	8.10/0.62	8.40/0.64	9.00/0.70
$P_{nat,t}/P_{mod,kg}$	1.70/0.77	2.10/0.96	4.50/2.0	5.50/2.5	7.10/3.2	7.80/3.5	8.00/3.64
$M_{nat,t}/M_{mod,kg}$	1.80/0.8	2.20/1.00	4.60/2.1	5.90/2.7	7.40/3.4	8.00/3.64	8.30/3.8
$D_{nat,\ m}/d_{mod,m}$	0.40/0.03	0.45/0.031	0.55/0.042	0.60/0.046	0.65/0.05	0.68/0.052	0.73/0.056
$S_{nat,\ m}/S_{mod,m}$	0.52/0.04	0.63/0.05	0.75/0.06	0.83/0.07	0.90/0.07	0.95/0.073	1.0/0.077
$L_{nat,\ m}/l_{mod,m}$	1.69/0.13	1.90/0.15	2.30/0.18	2.50/0.19	2.70/0.21	2.80/0.22	3.00/0.23

Table 3

Values of "Hexablock" actual (a_{L1}scale) and model design characteristics (for spatial basin 7,0×7,5×1,1м; a_{L3}=l7)

$H_{nat,m}/h_{mod,m}$	5.00/0.29	5.70/0.34	6.90/0.41	7.50/0.44	810/0.48	8.40/0.49	9.00/0.53
$P_{nat,t}/P_{mod,kg}$	1.70/0.35	2.10/0.43	4.50/0.92	5.50/1.12	7.10/1.44	7.80/1.58	8.00/1.63
$M_{nat,t}/M_{mod,kg}$	1.80/0.37	2.20/0.46	4.60/0.94	5.90/1.21	7.40/1.51	8.00/1.62	8.30/1.70
$D_{nat,\ m}/d_{mod,m}$	0.40/0.02	0.45/0.03	0.55/0.03	0.60/0.035	0.65/0.038	0.68/0.04	0.73/0.043
$S_{nat,\ m}/S_{mod,m}$	0.52/0.03	0.63/0.04	0.75/0.045	0.83/0.048	0.90/0.05	0.95/0.06	1.0/0.061
$L_{nat,\ m}/l_{mod,m}$	1.69/0.09	1.90/0.11	2.30/0.132	2.50/0.15	2.70/0.16	2.80/0.17	3.00/0.18

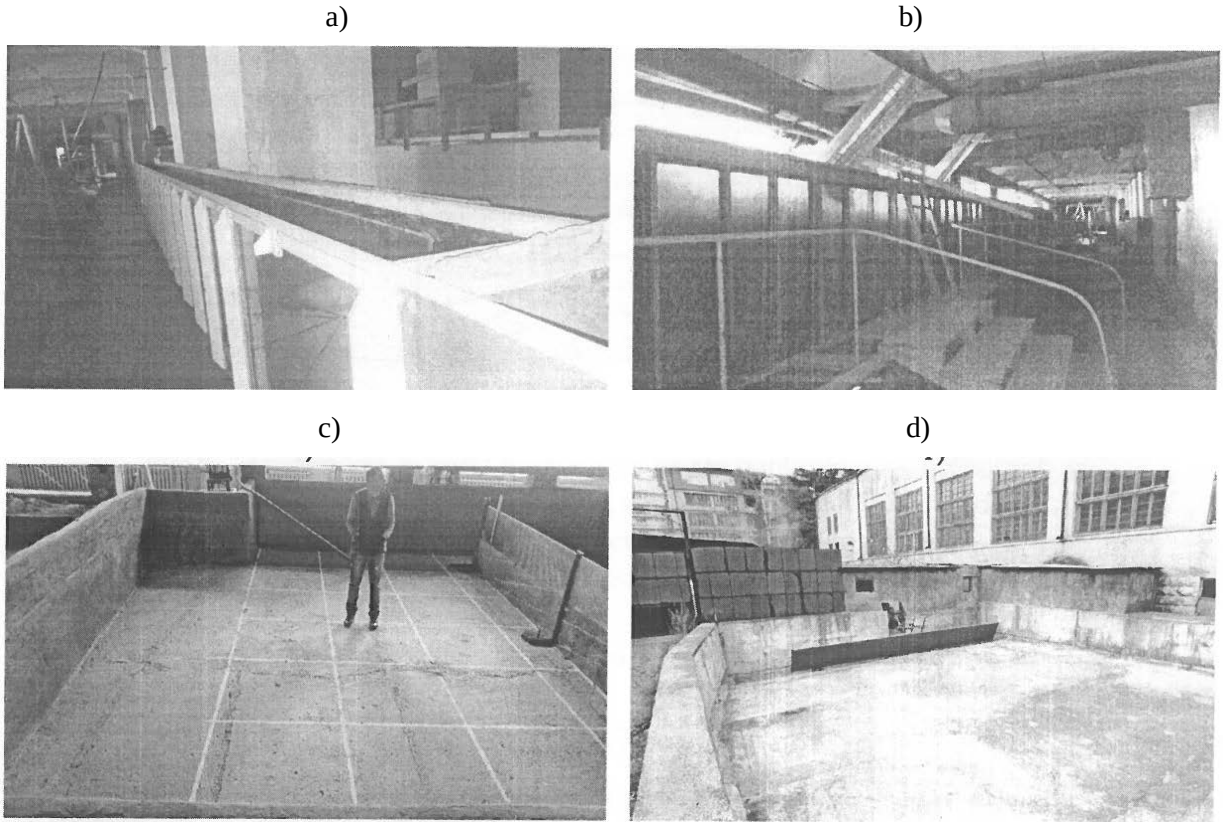

Fig. 3. General views of a) small chute (10.0×0.3×0.7 m); b) large chute (50.0×0.75×1.5 m); c) small wave basin (7.0×7.5×1.1 m); d) large wave basin (30.0×40.0×2.0 m)

Under equal values of factors appeared in the stability equation of "Hexablock" (1), its stability parameter (M) is of higher importance in comparison with dolos and tetrapod, fig. 4.

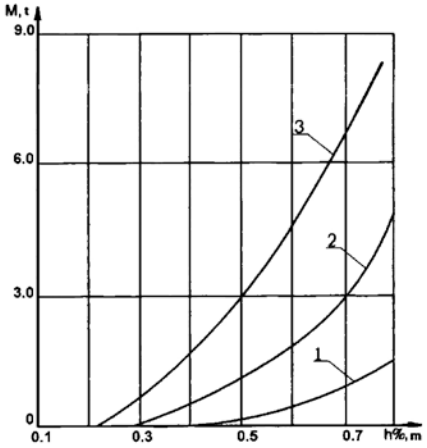

Fig. 4. Dependence of stability parameter (M) on the wave height for different blocks: 1 –Tetrapod, 2 – Dolos, 3 – "Hexablock" (by formula 1)

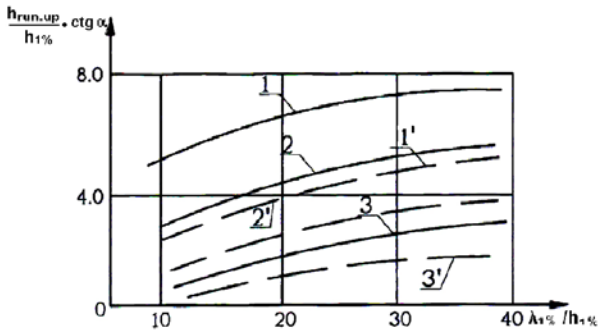

Fig. 5. Dependence of waves run up height on the smooth slope and hexablocks filling on the angle of waves, slope gradient and height of waves: Smooth slope1) $\alpha=5^o$ (ctgα=11); 2) Universal curve; 3) $\alpha=30^0$ (ctgα =1.7); 1^1, 2^1, 3^1, - ditto with hexablocks filling

CALCULATION OF "HEXABLOCK'S" WAVE SUPPRESSING EFFECT

With a view to determine wave suppressing effect of hexablock the height of waves rolled up the smooth slopes was compared with the fill of hexablocks (see fig. 5).

Thus, dependence of waves height rolled up on the slope with hexablocks filling is as:

$$h_{run.up.hex} = h_{1\%}\sqrt[3]{\lambda_{1\%} / h_{1\%} m^{-1}} \qquad (2)$$

So, the comparison of numerical values of waves height rolled up on the smooth slope and the slope with hexablocks filling has proved considerable wave suppressing property of the latter, fig. 5.

Except stability of the block massifs on the slope and their wave suppression properties it is necessary to study their displacement and failure characteristics, such as the number of shifted blocks, influence of waves collapse sites, methods of shaped massives placement, waves impact on the piling, interlocking between massifs that ensures engagement between the "caps" at the tops of hexablocks.

For the laboratory study of hexablock being under influence of regular waves it is necessary to observe the law of mechanic similarity that assumes presence of geometric, kinematic and dynamic similarities and similar boundary and initial conditions as well.

According to the dimensional analysis (Nogid L.M., 1967; Sedov L.I.. 1967) the characteristic parameters that determine physics of the process will be:

– Parameters describing mechanical system: L (m) – geometric dimensions, M (kg·sec^2·m^{-1}) – mass, K (kg·m^{-1}) – factor of rigidity;
– Parameters describing the medium: ρ (kg·sec^{2}m^{-4}) – mass density; g (m·sec^{-2}) – acceleration of gravity force; ν (m^{2}sec^{-1}) – kinematic viscosity coefficient; H_W (m) – depth of water;
– Parameters describing disturbance: t (sec) – the period of disturbing force, δA (m) – linear amplitudes of constrained oscillations, v (m·sec^{-1}) – the maximum velocities of liquid particles in troubled water.

According to "π" theorem the dimensionless quantities sought will depend on dimensionless combinations by: Froude $Fr = \frac{\upsilon}{\sqrt{gL}} = idem$; Reynolds $\mathrm{Re} = \frac{\upsilon}{\gamma} = idem$; Newton $Ne = \frac{K}{\rho\upsilon^2 L} = idem$;

Strohal $Sh = \frac{\upsilon t}{L} = idem$; Koshi $Ch = \frac{m}{\rho L^3} = \frac{\rho \upsilon^2}{E} = idem$; Eiler $E_u = p/\rho\upsilon^2 = idem$, where Eu (kg·cm^{-2}) is modulus of material elasticity, ρ (kg/cm^{-2}) is the pressure drop.

Among the said six dimensionless criterions the determinant is Froude criterion, which is stipulated by identity of gravitation forces at the model and in nature (Iordanishvili I.K., 2011).

Recalculation of hydrodynamic laboratory characteristics to natural up *to the zone of waves collapse*, when the process runs in auto model zone, is made under consideration of the linear scale of modeling ($\alpha_L = L_{nat}/L_{mod}$). *After the zone of waves collapse* where auto modeling is not detected)) the height of run up waves and pressure are calculated with the scale correction factor ($K = 0.75$) [Iordanishvili I.K. 2011] (see table 4).

Table 4

Recalculation of natural hydrodynamic characteristics to the lab ones needed under study of hexablock according to Froude criterion ($Fr = \frac{v}{\sqrt{gL}}$, q = idem, p = idem)

Physical quantity	Scale linear factor $\alpha_L = L_H/L_M$ (H– natural M – model)	Model quantities before the zone of waves failure	Model quantities in waves run up and failure zone with allowance for scale factor K=0.75
h (wave height)	$a_h = a_L = h_{nat}/h_{\text{mod}}$	$h_{\text{mod}} = h_{nat}/a_L$	$h_{\text{mod}} = h_{nat}/a_L$
λ (wave length)	$a_\lambda = a_L = \lambda_{nat}/\lambda_{\text{mod}}$	$\lambda_{\text{mod}} = \lambda_{nat}/a_L$	$\lambda_{\text{mod}} = \lambda_{nat}/a_L$
H_b (Water depth	$a_b = a_L = H_{nat,b}/H_{\text{mod},b}$	$H_{\text{mod},b} = H_{nat,b}/a_L$	$H_{\text{mod},b} = H_{nat,b}/a_L$
l =`3.0S* (hexablock height)	$a_n = a_L = l_{nat}/l_{\text{mod}}$	$l_{\text{mod}} = l_{nat}/a_L$	$l_{\text{mod}} = l_{nat}/a_L$
Ω (area)	$a_\Omega = a_{L3}^2$	$\omega_{\text{mod}} = \omega_{nat}/a_L^2$	$\omega_{\text{mod}} = \omega_{nat}/a_L^2$
W (volume)	$a_W = a_L^3$	$W_{\text{mod}} = W_{nat}/a_L^3$	$W_{\text{mod}} = W_{nat}/a_L^3$
$h_{\text{run up}}$ (wave run up height)	$a_{run\ up} = a_L$	$h_{run\ up,мод} = h_{run\ up,nat}/a_L$	$h_{run\ up,мод} = h_{run\ up,nat}/a_L$
t (time, period)	$a_t = a_L^{1/2}$	$t_{\text{mod}} = V_{nat}/\sqrt{a_L}$	$t_{\text{mod}} = V_{nat}/\sqrt{a_L}$
φ (linear velocity)	$a_V = a_L^{1/2}$	$V_{\text{mod}} = V_{nat}/\sqrt{a_L}$	$V_{\text{mod}} = V_{nat}/\sqrt{a_L}$
α (angles)	$\alpha_\alpha = 1$	$a^0_{\text{mod}} = a^0_{nat}$	$a^0_{\text{mod}} = a^0_{nat}$
M (mass)	$a_M = a_L^3$	$M_{\text{mod}} = M_{nat}/a_L^3$	$M_{\text{mod}} = M_{nat}/a_L^3$
F (force)	$a_F = a_L^3$	$F_{\text{mod}} = F_{nat}/a_L^3$	$F_{\text{mod}} = F_{nat}/a_L^3$
ε_{por} (porosity)	$a_{nop} = 1$	$\varepsilon_{por\ \text{mod}} = \varepsilon_{por\ nat}$	$\varepsilon_{nop\ \text{mod}} = \varepsilon_{nop\ nat}$
P (pressure)	$a_p = a_L$	$P_{\text{mod}} = P_{nat}/a_L$	$P_{\text{mod}} = P_{nat}/a_L \cdot K$

* *$l = 3.0 \cdot S$ – the most efficient dimensions of hexablock from the point of view of wave suppression, block stability on the slope and simplicity of construction, fig.2.*

Selection of model and natural parameters of waves depends on their maximum possible values in model or observed in nature. In the small chute (10.0×0.3×0.7 m) wave parameters were changing –

h = 0.05÷0.2 m, λ = 0.4÷1.2 m; In the large chute (50.0×0.75×1.5 m) wave parameters were changing h = 0.05÷0.45 m, λ = 0.4÷3.1 m, t = 0.5÷7.5 sec; In the spatial 3 dimensional basin (7.0×7.5×1.1 m) wave parameters were changing – h = 0.15÷0.35 m, λ = 1.2÷3.0 m, t = 1.8÷2.4 sec.

According to the maximum values of natural and model wave characteristics the following scales were assumed: for small chute a_L= 30, for large chute a_L= 13 and for the spatial basin – a_L= 17.

So, under the maximum height of waves observed at the Caucasian Black Sea coastline h_{nat} = 6.0 m the maximum model value of waves height *in small chute* (dims: 10.0×0.3×0.7 m) h_{mod1} = 0.2 m with corresponding scale factor α_{L1} = 6:0.2 ≈ 30. *In large chute* (dims: 50.0×0.75×1.5 m) h_{mod2} = 0.45 m, scale factor α_{L2} = 6:0.45 ≈ 13. In *spatial basin* (dims: 7.0×7.5×1.1 m) h_{mod3} = 0.35 m, scale factor α_{L3} = 6:0.35 ≈ 17. Then the efficient height of hexablock in small chute l_{mod1} = 20:3 ≈ 7 cm, in large chute l_{mod2} = 45:3 ≈ 15 cm, in spatial basin l_{mod3}= 35:3≈ 12 cm, (According to the world practice it is assumed that the minimum height of hexablock in first approximation equals one third of the wave height). So, to specify the efficient height value of hexablock corresponding model studies must be carried out.

The procedure of experimental studies in wave chutes and basin was conditioned by the following considerations:

a) Conditions of tests under recalculation of parameters to the natural ones according to Froude criterion under selected scale of model must correspond to natural conditions, where the shaped massives are used in different wave zones;
b) Conditions of tests on the wave stands must be as different as possible to estimate conditions of the waves spectrum transformation without connection with the design of structures with shaped massives;
c) In experiments all parameters of waves must be determined as far as possible: the profiles of disturbed surface at the ranges under study, quantity of wave run up, quantity of the mean depth velocity;
d) The meter ranges must be located as near as possible to each other and the measurements in all ranges must be synchronized.

CONCLUSIONS

On the basis of study of different shape massives used for protection of washed out banks of reservoirs the procedure of experiments carried out in the hydraulic chutes of various dimensions was worked out at the Institute of Water Management of the Georgian Technical University. The new type of "Hexablock" the efficient wave suppressing reinforced concrete shaped massif that is stable at the slopes is proposed.

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Environmental protection

ANTHROPOGENIC AND GEOCHEMISTRY OF BIOSPHERE

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ABSTRACT: The problem about anthropogenic impact of human society on geochemistry of biosphere is discussed in this article. It also shows the vigorous natural geochemical flows on the surface of the ground causing dangerous rotation of components.

KEYWORDS: biosphere, techno genesis, geochemical processes, intensity, ecology.

Impetuous acceleration of geochemical activity of human society became comparable with natural processes. At the beginning of our century its results – pollution of natural object with radioactive isotopes, plumbum, acceleration of CO_2 concentration in atmosphere etc. – got worldwide character, endangering world's ecological crisis in the perspective. However, even now, we cannot even imagine what portion of majority chemical components of anthropogenic streams are in global flow of biosphere substance and what is its intensively in comparison with natural geotechnical streams. Necessary objectionable ecological consequence forecasts of anthropogenic geochemical activity, and even more, the possibility of geochemical flow regulation of biosphere, assume quantitative evaluation of natural and anthropogenic components of global geochemical substance streams.

Most powerful natural geochemical flows on the ground surface – water circulation between the land and ocean, with its significant section – stream flow, and also the rotation of elements, are associated with living material activity [1].

The indicator of element involvement intensively in cycle in the result of anthropogenic al human activity can be considered as the measure of annual world extraction of useful fossils. Especially, the liberation of chemical elements during the burning of combustible fossils, especially coals must be marked out [1].

In order to calculate the chemical elements' mass, annually drawn into natural and anthropogenic al streams, materials were used from the literature about the global riverine flow size and the average chemical structure of river waters, also the initial mass of biological land products and the average chemical element content in vegetation, the size of annual world chemical elements extraction in the beginning of 80 –ies of the past year , and the average content of the ashes of fossil coals [2, 3, 4, 5, 6].

The resume of V.I. Vernadski is that the action of humanity became comparable with natural processes, often mentioned in literature, but still at heart we hope that main natural biochemical processes will quantitatively prevail over the human activity. However, calculations and comparisons concern other. Already in 80-ies of the last century, humanity annually retrieved from subsoil more than it is carried out in one year by the stream flow: lead – almost 70 times, chrome – 35 times, copper – almost 30 times, phosphorus – almost 20 times, iron, manganese – 10 times, carbon – 6 times, zinc – almost 5 times, aluminum – 3 times, titanium 2.5 times, nickel – 2 times, vanadium, barium – 1.7 times, molybdenum – 1.3 times.

Humanity retrieves from subsoil more chemical elements than whole land vegetation. According to this, annually more is obtained from subsoil than it is pulled into biological cycle on the land at the same

time: cadmium – more than 160 times, stibium – 150 times, hydrargyrum – 110 times, lead – 35 times, arsenic, fluorine – 15 times, Uranus – more than 6 times, stannum – 5 times, copper – 4 times, molybdenum – 3 times, silver, chrome, zinc, nickel are approximately obtained as much as it is consumed by the vegetations.

Strong anthropogenic geochemical process means – burning of inflammable fossils. Only by coal burning more is released annually than it is taken out from stream flows: vanadium – 400 times, molybdenum – 35 times, titanium – 30 times, lite chrome – 20 times, lead – 15 times, uranium – 6 times, cobalt – 5 times, gland, nickel , phosphorus, arsenic – 2 times, copper , barium – 1.5 times. While burning, manganese, zinc, strontium, nitrogen, silicon, iodine silver is released as much as they are taken out by the rivers.

Commercially more elements are spread in environment while coal firing than they are taking part in biological cycle on the land: hydrargyrum – 8700 times, arsenic – 125 times, uranium – 60 times, cadmium – 40 times, lithium, yttrium, beryllium, zirconium – 10 times, tin, vanadium – 3-4 times, gland, aluminum, cobalt, nickel, molybdenum, titanium, strontium, silver, barium and germanium are spread in environment while coal firing as much as they are consumed by the vegetations.

While comparing two most significant anthropogenic – geochemical processes – coal burning and mining operations – turns out that, during the coal burning considerably more elements are spread in the environment than they are retrieved from subsoil: magnesium – 1,5 times, molybdenum – 3 times, arsenic – 7 times, uranium, titanium – 10 times, aluminum, iodine, cobalt – 15 times, mercury – 50 times, lithium, vanadium, strontium, beryllium, zirconium – hundred times, gallium, germanium – thousand times and a yttrium – ten thousand times! Approximately the same amount of manganese, nickel, chrome, sulphur, potassium, nitrogen, c silver, barium, tin are extracted annually and are spread in the environment by coal burning.

If we take into account, that the main mass of the chemical elements are extracted by a human on the land, we can calculate, that in a result of two most important considered anthropogenic geochemical processes , in spite of constant carrying out of elements' parts with a streamflow, the surface of the land is annually enriched with: iron – 350 million tones, aluminum – 8 million tones, phosphorus – 7.4 million tones, titanium – 5.8 million tones, copper – 5.7 million tones, manganese – 4.1 million tones, nitrogen – 4 million tones, zinc – 3.1 million tones, plumbum – 2.8 million tones, barium – 2.5 million tones, chromium – 1.5 million tones, lithium – 740 thousand tones, nickel – 620 thousand tones, Uranus – 230 thousand tones, arsenic – 190 thousand tones, cobalt – 190 thousand tones, vanadium – 170 thousand tones, molybdenum – 130 thousand tones, rubidium – 80 thousand tones, mercury – 79 thousand tones, zirconium – 20 thousand tones, silver – 1 thousand tones. Quite a number of other elements are accumulated on the surface of the land that are released after coal burning and are retrieved from the subsoil, however, it is not possible to make an appropriate calculation now, as at present we do not have any data on average content of these elements in the stream flows.

Thus, not only by cultivated, so called cultivated landscapes but in global aspects, intensity just in human geochemical activities, at present, are considerably excelled than the intensity of the main natural geochemical processes.

If taking into consideration that while calculation and comparison, not up to date materials on intensity but rehabilitated biological elements' cycle were used (no metering the abridgment of vegetations by humans 1/3 times) and that in examined vegetation and river water structure must already be the part of anthropogenic origin substance, than the role of producing in geochemical processes of biosphere are more significant. More importantly, in comparison with natural, intensity of anthropogenic geochemical processes permanently grow. Extraction of combustible fossils is being increased approximately 5% times. Recently, in connection with energy crisis, the tendency of coal usage growth, in comparison with oil, will

also promote the reinforcement of spreading chemical element in the environment. This is due to the fact that, coal ash content is considerably higher than oil ash content.

We may think that accumulation of such a chemical elements on the land as phosphorus, Azotes, carbon on the land will promote the growth of biological efficiency and accordingly the reinforcement of biological cycle of substances. However, accumulation of other (overwhelming majority) elements will cause all the reinforcing negative ecological consequences. [7].

The usage of main parts of the known coal reserves would have brought not only to the repeated increase of CO2 concentration in the atmosphere, but also the spreading of ash elements in the environment, excelling the land weight of whole contemporary earth biomass.

Exposed appropriateness should be considered in a practical activity.

Apparently, only the isolation of anthropogenic geochemical streams from the environment (locked technology) would have promoted not only the further ecological problem solving, but also the increase of many chemical elements' resources useful for humanity.

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Water management

DETERMINATION OF THE COORDINATES OF THE STABILIZED SURFACE OF THE CHANNEL FORMATION IN MOUNTAIN WATERCOURSES OF TRAPEZOIDAL CROSS SHAPE

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ABSTRACT: The existing methods for calculating the parameters of channel formation process often give results significantly different from the reality, as the mathematical models underlying on its basis not accurately describe the actual physical picture of the problem being investigated. The aim of this work is to develop analytical solutions for determining the coordinates of the bottom of the channel and its planned outlines formed during the stabilization period, the completion of the channel formation process in mountain culverts. Meantime it has been used a new universal theory developed by the authors which could be applied to the investigated process, rolling on the stage of damping.

KEYWORDS: bed formation, channel stabilization, flow, sediment movement.

Водное хозяйство

ОПРЕДЕЛЕНИЕ КООРДИНАТ СТАБИЛИЗИРОВАННОЙ ПОВЕРХНОСТИ РУСЛООБРАЗОВАНИЯ В ГОРНЫХ ВОДОСТОКАХ ТРАПЕЦЕИДАЛЬНОЙ ПОПЕРЕЧНОЙ ФОРМЫ

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ВВЕДЕНИЕ

Существующие математические модели руслообразующих процессов недостаточно точно описывают реальную физическую картину исследуемой проблемы [1, 2]. Используемые при этом некоторые зависимости часто не соответствуют характеру наносного режима данного водостока. Целью работы является разработка аналитических решений для определения координат дна русла и его планового очертания, образованных в период стабилизации, завершении руслообразующего процесса в горных водостоках трапецеидального сечения.

ОСНОВНАЯ ЧАСТЬ

В ранних работах авторов [3, 4] проанализированы действующие теоретические и эмпирические методы и программные решения по расчету и прогнозу параметров русло-стабилизирующих

процессов. Приведены те основные недостатки, которые существенно влияют на полученные результаты.

Исходя из этого была принята попытка разработать универсальную теорию для различных типов руслообразований, которые переходят к стабилизированной уравновешенной стадии [4]. При этом основные гидродинамические уравнения (уравнения движения, неразрывности потока и баланса наносов) в безразмерных параметрах после некоторых преобразований были представлены в виде:

$$\frac{d\bar{z}}{d\bar{x}}+\frac{d\bar{h}}{d\bar{x}}-\frac{Fr_0}{\beta_0\bar{A}^3}\frac{d\bar{A}}{d\bar{x}}=\frac{i_0\bar{V}^2}{\bar{C}^2\bar{R}}, \quad (1)$$

$$\bar{A}\cdot\bar{V}=1, \quad (2)$$

$$\bar{\chi}=\bar{A}^a, \quad (3)$$

где Fr_0 – число Фруда для “предельного участка” русла с уклоном i_0,

β_0 – соотношение $\frac{b_0}{h_0^{cp}}$ для этого участка,

a – показатель степени, меняющийся в диапазоне 2,7÷4,5. Каждое его значение соответствует определенной формуле по расчету расхода наносов.

Совместное решение этих уравнений дает возможность получать следующее универсальное уравнение, описывающее стабилизированную стадию всех руслообразующих процессов:

$$\frac{d\bar{z}}{d\bar{x}}+\frac{d\bar{h}}{d\bar{x}}-\frac{Fr_0}{\beta_0\bar{A}^3}\frac{d\bar{A}}{d\bar{x}}=i_0\bar{d}_{OT}^{1/3}\bar{A}^{(4a-10)/3}. \quad (4)$$

В настоящей работе с использованием уравнения (4) приводятся разработки, позволяющие для одного частного, но достаточно распространенного в природе случая определить координаты планового очертания и дна русла руслообразующего процесса, который переходит в стадию стабилизации.

Для трапецеидальной формы русла безразмерная площадь живого сечения и смоченный периметр могут быть представлены в виде:

$$\bar{A}=(\bar{b}+m\bar{h})\bar{h}\frac{\beta_0^2}{\beta_0+m}, \quad (5)$$

$$\bar{\chi}=\left(\bar{b}+2\bar{h}\sqrt{1+m^2}\right)\frac{\beta_0}{\beta_0+2\sqrt{1+m^2}} \quad (6)$$

Учитывая уравнение (3), безразмерную ширину стабилизированного русла $\bar{b}$ и глубину потока в нем $\bar{h}$ (выражения (5) и (6)) выразим через величину $\bar{A}$. Тогда:

$$\bar{b}=\frac{2\sqrt{1+m^2}+\beta_0}{\beta_0}\bar{A}^a-2\bar{h}\sqrt{1+m^2}, \quad (7)$$

$$\bar{h}=\frac{2\sqrt{1+m^2}+\beta_0}{2\sqrt{1+m^2}-m}\frac{\bar{A}^a}{2\beta_0}\pm\sqrt{\left(\frac{\bar{A}^a}{2\beta_0}\frac{2\sqrt{1+m^2}+\beta_0}{2\sqrt{1+m^2}-m}\right)^2-\frac{(\beta_0+m)\bar{A}}{\beta_0^2(2\sqrt{1+m^2}-m)}}. \quad (8)$$

Дифференцируя эти выражения, получим:

$$\frac{d\bar{b}}{d\bar{x}} = f_1(\bar{A})\frac{d\bar{A}}{d\bar{x}}, \qquad (9)$$

$$\frac{d\bar{h}}{d\bar{x}} = f_2(\bar{A})\frac{d\bar{A}}{d\bar{x}}, \qquad (10)$$

где $f_1(\bar{A})$ и $f_2(\bar{A})$ известные функции получающиеся в ходе дифференциации.

Подставляя значение $\frac{d\bar{h}}{d\bar{x}}$ из выражения (10) в уравнения (4) для рассматриваемой задачи получим уравнение описывающее процесс руслообразования переходящего в стадию стабилизации в следующем виде:

$$\frac{d\bar{z}}{d\bar{x}} + f_2(\bar{A})\frac{d\bar{A}}{d\bar{x}} - \frac{Fr_0}{\beta_0\bar{A}^3}\frac{d\bar{A}}{d\bar{x}} = i_0\bar{A}^{(4a-10)/3}\bar{d}_{OT}^{1/3} \qquad (11)$$

В отличие от системы уравнений (1), (2) и (3), где число неизвестных равен 6, в последнем уравнении имеются 2 искомые параметры: $\bar{A}$ и $\bar{Z}$. Следовательно для решения этого уравнения необходимо составить еще одну зависимость. В уравнении (11) производная $\frac{d\bar{z}}{d\bar{x}}$ представляет собой переменный уклон $I(x)$ стабилизированного русла (стабилизированной поверхности наносных отложений y-y), являющийся одновременно дном нового русла, образованного в результате руслоформирующего процесса (рис. 1). (Положительное направление координаты x принята с права на лево).

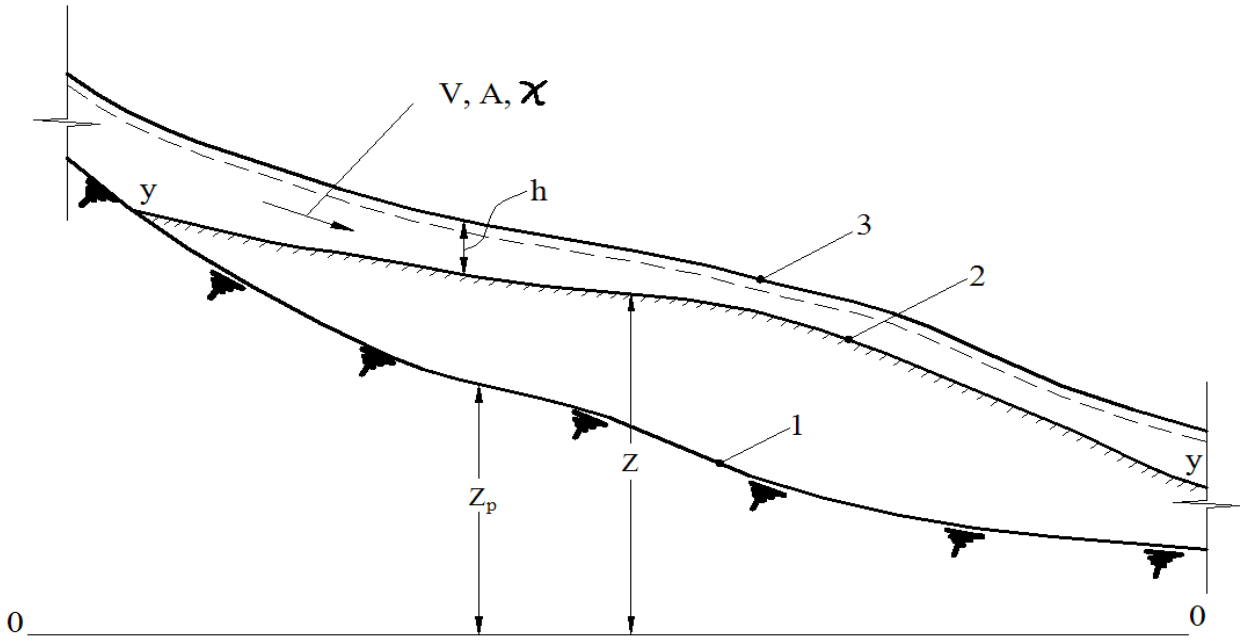

Рис. 1 Продольный профиль участка русла в стадии стабилизации руслообразующего процесса. 1 – дно естественного русла до начало руслообразующего процесса, 2 – поверхность дна русла образованной после стабилизации процесса, 3 – свободная поверхность потока движущего по новому руслу.

Дифференциальное уравнение (11) имеет бесконечное число решений. Для получения искомого решения, т.е. координат искомой стабилизированной поверхности необходимо учесть граничные условия задачи.

Естественно, что сопряжение ширины русла $\overline{b}_p$ с конечной шириной образованного непризматического нового русла B (являющийся длиной руслового заградительного сооружения по гребню) осуществляется по береговой поверхности оврага. Иначе говоря, на каждом створе реки ширина нового русла равна ширине чаши верхнего бьефа на данной высоте H (рис. 2 и 3).

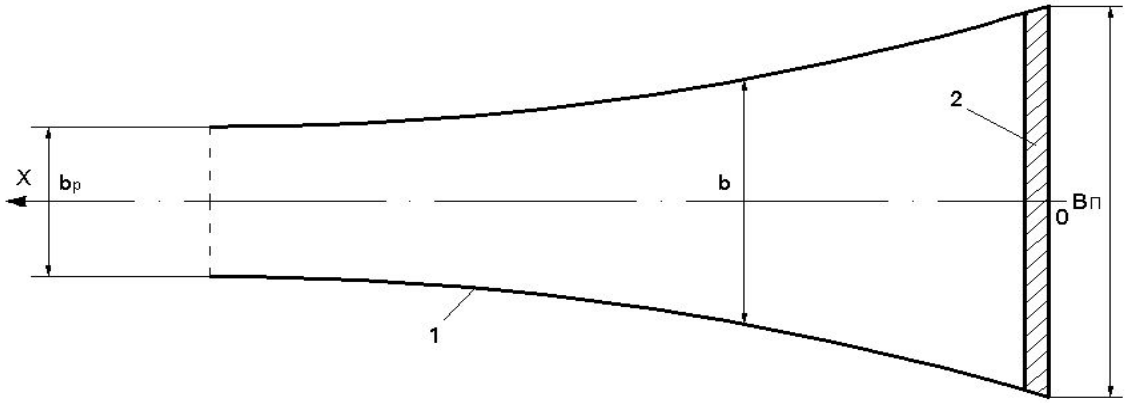

Рис. 2. План русла по поверхности отложений *y-y*:
1 – боковые стенки стабилизированного русла, 2 – заградительное сооружение.

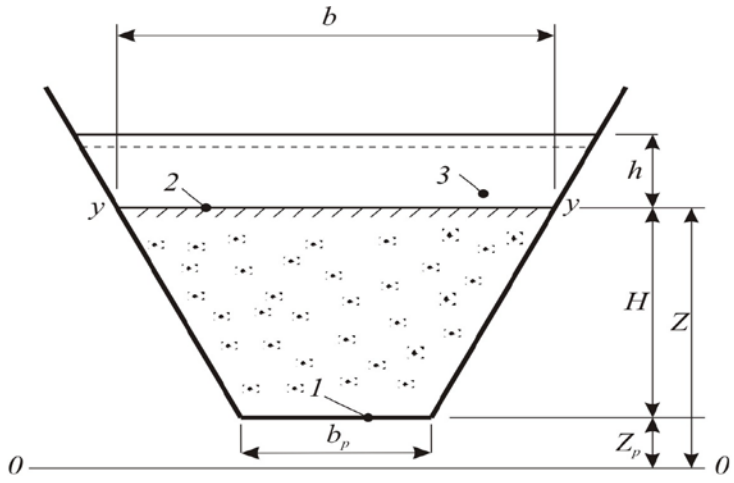

Рис. 3 Трапецеидальное поперечное сечение стабилизированного русла:
1 – дно естественного русла; 2 – поверхность дна русла образованной после стабилизации процесса;
3 – область движения потока.

В указанных условиях будем иметь:

$$Z = Z_p + H \qquad (12)$$

Учитывая, что

$$H = \frac{b - b_p}{2m}, \qquad (13)$$

получим:

$$Z = Z_p + \frac{b - b_p}{2m}. \qquad (14)$$

Все величины представив в безразмерном виде и дифференцируя полученное выражение, будем иметь:

$$\frac{d\overline{Z}}{d\overline{x}} = \frac{d\overline{Z}_p}{d\overline{x}} + \frac{1}{2m}\frac{d\overline{b}}{d\overline{x}}, \qquad (15)$$

где $\frac{d\overline{Z}_p}{d\overline{x}} = \frac{dZ_p}{dx} = i_p$ уклон дна естественного русла.

Подставляя величину $\frac{d\overline{b}}{d\overline{x}}$ из уравнения (9) в уравнение (15), получим:

$$\frac{d\overline{Z}}{d\overline{x}} = i_p + \frac{1}{2m} f(\overline{A})_1 \frac{d\overline{A}}{d\overline{x}}. \qquad (16)$$

где функция $f_1(\overline{A})$ определяется из уравнения (7).

Дифференциальным уравнением (16) создалась закономерность между искомыми параметрами $\overline{A}$ и $\overline{Z}$. Подставляя значение $\frac{d\overline{z}}{d\overline{x}}$ из уравнения (16) в уравнение (11), после некоторых преобразований окончательно получим:

$$\frac{d\overline{A}}{d\overline{x}} = i_0 \frac{\overline{A}^{(4a-10)/3}\overline{d}_{OT}^{1/3} - \frac{i_p}{i_0}}{\frac{1}{2m} f_1(\overline{A}) + f_2(\overline{A}) - \frac{Fr_0}{\beta_0 \overline{A}^3}} \qquad (17)$$

В последнем уравнении значения уклона естественного русла i_p вставляются начиная от створа заграждения против течения. Что касается величин с индексом “нуль”, а также коэффициента откоса m и диаметра отмостки $d_{от}$, то они также известные и получаются на основе изыскательных исследований или простыми расчетами.

Таким образом, результаты разработок позволили вывести достаточно надежные расчетные дифференциальные уравнения (16) и (17) для определения площади живого сечения потока движущегося по стабилизированной поверхности и координат характеризующих эту поверхность.

ВЫВОДЫ И РЕКОМЕНДАЦИИ

Опираясь на строгие законы механики жидкостей и учитывая результаты ряда существенных уточнений и обобщений, характерных естественным условиям руслообразования переходящего в стадию стабилизации, разработана методика для определения координат дна и планового очертания для русел с трапецеидальным поперечным сечением. Полученные расчетные выражения могут быть использованы для определения координат стабилизированной поверхности завершенного процесса руслообразования на верхних бьефах русловых поперечных заграждений (плотины, барражи, естественные преграды).

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Environmental protection

APPLICATION OF ALTERNATIVE TREATMENT TECHNOLOGIES FOR DOMESTIC WASTEWATER TREATMENT IN ARMENIA

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ABSTRACT: The article presents the biological lagoon system of domestic wastewater treatment in Paraqar community, which is the first biological treatment plant in Armenia. The main preconditions and results of the project; justification of using water hyacinth are presented.

KEYWORDS: domestic wastewater, wastewater treatment plant (WWTP), biological treatment, aeration, biochemical oxygen demand (BOD_5), water hyacinth.

INTRODUCTION

Contamination of surface water resources and aquatic bodies with domestic wastewater affects not only aquatic ecosystems, but also the environment and human health. In this sense the problem of rehabilitation of wastewater treatment process becomes essential for the Republic of Armenia year out (hereinafter referred to as RA).

Domestic wastewater, as well as storm water and industrial wastewater contain a variety of contaminants that are extremely hazardous to human health and the environment. Depending on the size of the impact of these pollutants on aquatic ecosystems and hydrobionts, the impact consequences are expressed in the form of direct poisoning of aquatic organisms, their physiological activity degradation, change in the properties of habitat. Therefore, industrial and domestic wastewater treatment is one of the primary tasks of environmental protection.

BASIC PART

Today, the current hard ecological situation in the regions of the RA requires implementation of radical and large-scale measures aimed at habitat protection against massive anthropogenic activities. One of the main components of the problem is pollution of the environment with untreated wastewater, and in many cases also the lack of sewerage system in settlements, which directly leads to the deterioration of habitat quality. During the Soviet times 20 municipal wastewater treatment plants were operating in the Republic, which implemented full mechanical and biological treatment of wastewater and some of them also sludge treatment.

However, not all settlements were provided with sewerage system and, therefore, with wastewater treatment plants. Wastewater from these areas was directly discharged into the surface water bodies or terrestrial areas without treatment.

After the collapse of the Soviet regime, the proper operation of all the wastewater treatment plants

(WWTP) was disrupted, the technological process of their operation was interrupted, and as a result of improper operation and maintenance of these plants, they stopped their operation at all and appeared in physically and morally worn out condition.

In recent years, in parallel to gradual solution of residential water supply problems, the government started paying serious attention to the problems of wastewater disposal and subsequent treatment. Aimed at rehabilitation of municipal wastewater removal and treatment process studies of the former WWTPs in a large number of settlements have been carried out and justified proposals for construction of new WWTPs have been developed. A sanitation strategy document is being developed for the settlements of the RA. Besides, the new wastewater treatment plant construction process has become a reality. It is true that so far this process is limited only to the mechanical treatment stage, but we believe that this is the first necessary and important step in the rehabilitation and further development of the sector. At present there are already 3 WWTPs for mechanical treatment of household wastewater built and operating in cities of Gavar, Martuni and Vardenis. Works for construction of WWTPs (also for only mechanical treatment part) for cities of Yerevan, Dilijan and Jermuk are in course of implementation. For both the WWTPs operating in the past and the ones newly built the conventional technological schemes serve a basis.

It is known that in many countries of the world, including the developed ones, alternative wastewater treatment technologies have become common. They are notable for their simplicity, low construction and operational costs and rather high treatment efficiency. This treatment technology to the extent possible simulates the wastewater treatment process in natural conditions. The selection of the technologies is made based on the local climatic conditions, the land available for construction of the plant, the system capacity, the purpose of reuse of treated wastewater, etc. [1]

With the purpose of applying such an alternative technology in Armenia, the Country Water Partnership and JINJ engineering consulting company jointly developed a pilot project for construction of lagoon type biological wastewater treatment plant in Paraqar community. The construction of the plant became possible thanks to financial support by the Global Environment Fund, DFID and the community itself.

Paraqar is one of the leading communities of the region; it has 2,500 households and developed infrastructure. Water supply is implemented by Yerevan Djur CJSC. 60% of the community is connected to sewerage network.

Before construction of the WWTPs the domestic wastewater of the community was removed through the wastewater system to the non-operating pumping station in the center of the village and afterwards discharged into the open irrigation canal passing through the village up to its south-eastern border and infiltrated into ground. For many years the irrigation canal had been almost fully filled with sediments from wastewater. The latter often flowed out the canal to adjacent areas, making foul odor and anti-sanitary condition.

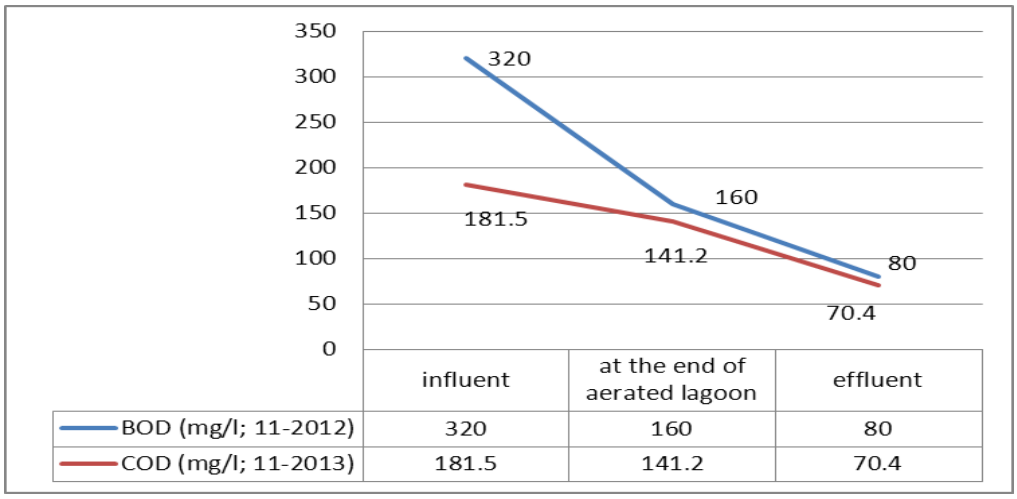
The critical situation made serious concern, since:

1) after mixing of the domestic wastewater with irrigation water, the latter was not used for irrigation purposes and about 100ha agricultural lands remained uncultivated;
2) flowing out the irrigation canal, the wastewater contaminated the cultivated lands, degraded qualitative indicators of the lands, jeopardized food safety of population;
3) wastewater posed a risk for break-out of intestinal and epidemic diseases during summer.

As a result of the first phase of the project a domestic wastewater treatment plant with aerated lagoon system was built in Paraqar community. This plant is the first and so far the only plant of biological wastewater treatment in Armenia. [2] This system consists of mechanical treatment screen, a pump station, an air blowing plant with air distribution system, a biological lagoon with artificial aeration, a settling lagoon-clarifier with natural aeration.

1.5 months after launching of the plant BOD_5 of the initial 320 mg / l of the influent was reduced to 120 mg / l in the effluent of the biological lagoon with artificial aeration and to 80mg/l in the effluent of lagoon-clarifier.

The diagram of BOD variation during the WWTP operation is provided below.



	influent	at the end of aerated lagoon	effluent
BOD (mg/l; 11-2012)	320	160	80
COD (mg/l; 11-2013)	181.5	141.2	70.4

Diagram: BOD variation by month

At present the second stage of the project is being implemented, which plans construction of the sludge bed for sludge treatment and further utilization, as well as the second biological lagoon, which in turn will allow treating the wastewater even more, reducing the BOD_5 to 30-40 mg/l and develop fishery there (the Figure 1 below demonstrates the technological model of the treatment plant).

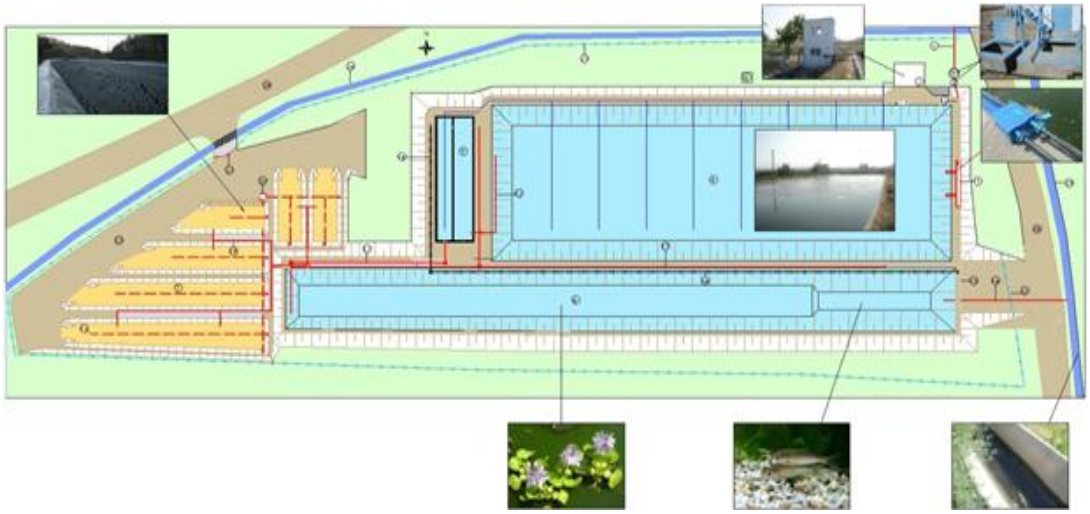


Fig. 1. Technological model of the WWTP operating in Paraqar community
1. Screen; 2. Deep-well pump; 3. Air blowing system; 4. Aerated biological lagoon; 5. Horizontal clarifier; 6. Natural biological lagoon; 7. Sludge bed; 8. Toilet facilities; 9. Sewerage collector; 10. Pressure pipe from deep-well pump station to the lagoon; 11. Wastewater distribution system; 12 to 19. Pipes providing proper operation of the system; 20. Sludge water storage chamber; 21. Metal fence; 24, 25. Upper and lower irrigation canal; 26, 27. Earth and access roads.

In the third biological lagoon secondary treatment of wastewater will be carried out by combination of sections with aquatic plants and without them.

Biological lagoons with aquatic plants occupy an intermediate place between the natural and anthropogenic facilities, therewith, in the first stage of their operation the features characteristic for anthropogenic facilities are mostly dominant, while 1-2 years after their operation, the features characteristic for natural facilities become dominant. The aquatic plants used in the treatment process are applied in the natural biochemical cycle, which makes it possible to significantly improve the ecosystem condition in the area [3, 4].

Water hyacinth systems are most common. They were used both in experimental and natural conditions for treatment of wastewater of various qualities.

The third biological lagoon for domestic wastewater treatment in Paraqar community will be divided into 8 sections, with hyacinth and non-hyacinth sections following each other. This aims to provide proper wastewater aeration, since in hyacinth systems the carpet generated by the plants on the water surface hinders the aeration process.

The advantage of the system lies in the fact that as a result of the treatment not only BOD_5 of the wastewater is reduced, but also wastewater disinfection takes place at the expense of bacterial processes taking place in hyacinth systems, reducing as a result the coliform index almost 4 times (see the Table 1 below) [3].

Table 1

Some data obtained as a result of wastewater treatment in water hyacinth systems

Monitored indicator	Before treatment in hyacinth system	After treatment in hyacinth system
COD, mgO_2/l	50.3	10.0
BOD, mgO_2/É	13.7	6.4
Hardness, mg-eq/l	1.6	1.0
Sulfates, mg/l	98.0	42.1
Phosphates, mg/l	1.4	0.3
Nitrates, mg/l	6.2	0.25
Ammonium nitrogen, mg/l	6.9	0.94
Suspended solids, mg/l	280.0	42.0
Dry residue, mg/l	430.5	10.4
Total bacterial count	2.3^{10}	0.4^{10}
Coli - index	1563	420

Application of aquatic plant systems will allow further treating of the primarily treated wastewater and using it for fishery and irrigation purposes.

Anticipated outcomes: The planned completion date of the project is October 2014. The following outcomes are anticipated from the project implementation:

- reduce the degradation of agricultural land;
- prevent penetration of about 12 tons of nitrogen and 6 tons of phosphorus into underground water;
- expand arable land at the expense of treated wastewater.
- provide additional income for the residents.
- ensure the food security of the population and a favorable environment.

Create business development opportunities as a result of the proper operation of the treatment plant.

- realization of up to 1000 m^3/day irrigation water;
- realization of high-quality organic fertilizer obtained as a result of sludge treatment;
- development of fisheries.

This pilot project aims to demonstrate the attainability and effectiveness of alternative technologies for domestic wastewater treatment in small and medium-sized settlements in our country as well as in the region.

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Environmental protection

ANTI-EROSION NON-TRADITIONAL ARRANGEMENTS AND THEIR UTILIZATION TECHNOLOGY

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ABSTRACT: With the purpose of the effective regulation of the erosion processes at the mountain slopes at the Water Management institute the resource-saving non-traditional constructions are developed, the priorities of the scientific novelty of which are confirmed with the patent certificates of Georgia. For drafting of the anti-erosion constructions, the constructions utilization technology is proposed as well as its installing scheme.

KEYWORDS: erosion, mount slopes, anti-erosion construction.

UNESCO International Program ("IDNDR", 1991-2000) and the international strategy for decreasing of disaster (ISDR) 2005-2015 at Hiogo (Japan) framework agreement considered disasters regulation with the various types of constructions, which still are acting, and for construction of which construction materials of various types are applied for, requiring elaboration on and improvement of the relevant technologies.

At the Water Management institute of the Technical University of Georgia the scientists in 1929-2014 have developed the entire variety of the new constructions against natural calamities, the scientific-technical priorities of which are protected by more than 200 foreign and over 30 Georgian patent certificates [1].

The soil erosion is one of the most dangerous happenings among the natural disasters. It causes interruption of the stability of the natural conditions, but the most important is the fact that erosion is the precondition for development of torrents [2].

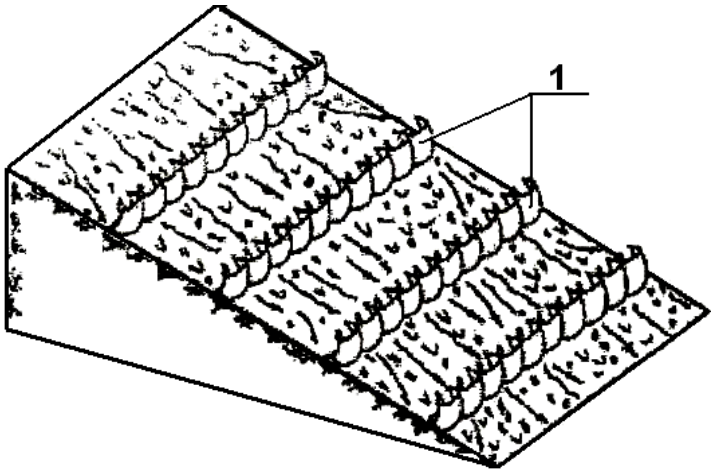

Fig. 1. Anti erosion construction

The mountain scope anti-erosion construction [3] consists of the motor vehicle amortized, cut on diameter tyres, which with one end are tightly fastened into the ground, and the other end above the soil is destined against the superficial flows incurred as the result of the intense rain at the mountain slope. The overall view of the constructions is presented at the first draft.

The distance between the tyres rows for the effective work of the mountain slope anti-erosion construction shall be selected in the way that the water flow energy on the mountain slope surface would not incur the

cracks and the water flow could not cause the slope erosion.

For reliable work of the anti-erosion constructions it is required that the tyre cut on diameter, with one end shall be fastened tightly in the ground at the depth, that it does not fall out from the ground while maximal loading of the water flow at the operational end of the tyre, which approximately equals to ¼ of the tyre round length. The mountain scope anti-erosion construction shall be always installed perpendicularly to the water flow at the entire width of the slope, in order to avoid flow of water retained at the upper part of the constructions along it, which might cause cracking of the retaining ground and violation of the construction stability.

The scheme of allocation of the mountain slope anti-erosion construction will be selected taking into account the intensity of raining at the territory, the ground geological peculiarities, the allowed washing speeds, the natural conditions and the other general hydrological and hydraulic characteristics.

The mountain slope anti-erosion new equipment [4], which is shown at the second drawing, consists of the sections consisting of motor vehicle amortized tyres. Non-used tyres are allocation with the side surfaces merging to one another, put into the ground stitch and tightly connected to each other with the metal ropes, which are arranged in preliminarily made holes of the tyres, wrapped on one end of the section to the attached metal ПП element, and the ends are fastened tightly to П element with the bolts and screw-nuts installed at the other end, at the same time, with the purpose to drive the water flow from the equipment, in the upper part of the construction the draining channels are foreseen.

For effective work of the mountain slope anti-erosion facilities the distance between the tyres rows for the effective work of the mountain slope anti-erosion construction shall be selected in the way that the water flow energy on the mountain slope surface would not incur the cracks and the water flow could not cause the slope erosion. Besides, in the upper part of the rows of tyres the arranged drainage channels shall secure the water flow in the way not to cause the water overflow on the tires.

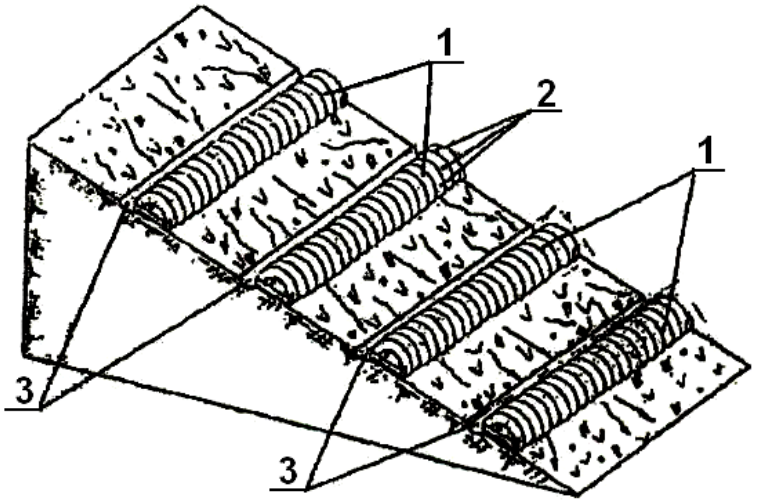

Fig. 2. Erosion control construction

The mountain slope anti-erosion equipment technical and economic characteristics are high compared to the existing constructions, as the construction is arranged with the secondary materials.

In the article the environment protective building new constructions technical and economical characteristics are given as well as the rules of their utilization.

Before installing of the mountain slope anti-erosion buildings it is required to study the sector to be protected, for which it is necessary to verify and to review implementation of the erosion processes at the indicated sector. While research of the erosion sector its physical and geographic allocation shall be taken into account, as well as the geological constitution, the soil types and the allocation, the slope, the plants density and allocation on it, the anthropogenic loads are to be underlined for the indicated sector, and which is the most important – the climate conditions.

Before starting construction, taking into account the indicated conditions hereby the distance between the tyres rows and the allocation scheme shall be verified (fig. 3).

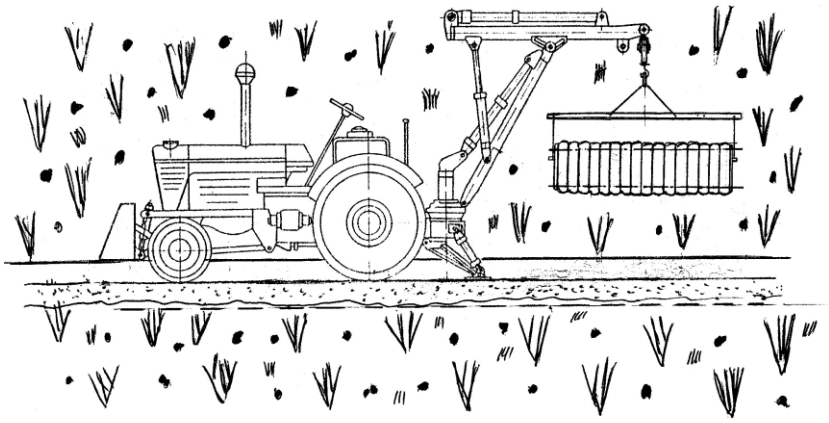

Fig. 3. The allocation scheme shall be verified

Before cutting of the tyres fastening ditch it is necessary to even and level the mountain slope relief, for which the small or the average capacity bulldozer is applied for. With that bulldozer the soil surface is prepared and leveled at the works implementation sector, and also, the cracks emerged as the result of the water erosion will be filled and leveled. Implementation of the work for the bulldozer is possible for the slope of inclination up to 15^0.

In order to cut the ditch for fastening of the tyres the light excavator is applied for. Excavation of the ditches and installing of the tyres is carried out from the upper part of the slope to the lower one. The excavated sols temporarily (before putting of the tyres) shall be allocated in the lower part at the edge of the ditch, along it to the entire length of the ditch. At the sectors of the mountain slope, at which it is impossible to apply for mechanization, the works shall be carried out manually.

Installing of the sections into the ditch is carried out from the end of the ditch to its beginning, in order the already installed sections not to interfere with the movement of the excavator along the ditch. Installing of the tyres sections schematically is expressed on the drawing 4.

According to the mountain slope, the soil type and the precipitations amount we opt for the number of the tyres rows and the distance among them. Taking into account the indicated conditions as well as the local relief, if it is possible to arrange for the excess leaking water removal from the protected sector, the draining channels are arranged for in the upper part of the tyres rows. In such event the tyres rows are inclined from the slope perpendicular direction $2\text{-}4^0$ to the water collection channel, and that enables us while intense precipitations to protect the sector from the excess leaking water, which in case of flowing over the tyres will cause the soil erosion at the particular sectors[5].

Upon arranging of the tyres sections into the ditch, the soil will be cut with the bulldozer from the ditch to the tyres sections, by means of which additionally the sections stability will be applied for. With those works the construction one row shall be installed, upon which we start to install the following row, which is completed with the above indicated sequence.

The economic indicators of producing of the mountain slope anti-erosion construction, its transportation and installing on site are calculated, for which the prices of the first quarter of 2014 of the construction resources are applied for.

As the result of the carried out mathematical calculations the value of 10 m length anti-erosion construction was verified, in case of implementation of the works manually and if mechanization is applied for. The obtained results show that applying for mechanization makes the construction installing twice cheaper.

CONCLUSION

Taking into account the mountain slopes topographic, geological, hydrological and meteorological-climatic factors anti-erosion new buildings are developed as well as the technological schemes are provided for their drafting. With the purpose to implement in practice the anti-erosion constructions, the scheme for installing of the tyres sections and its technical and economical characteristics are proposed.

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Construction

APPLICATION OF IMMERSION METHOD TO CALCULATION OF LINEARLY DEFORMED PLATES WITH STIFFNESS RIBS

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ABSTRACT: Let's consider the method of calculation of linearly deformed plates with stiffness ribs. Are derived the general conditions of adequacy of plates with shifted median surfaces of variable stiffness thin rib. From this conditions, in particular, are concluded the condition of joint deforming of plates with small depth extrudes, plates with variable cross-section ribs are applied at solution number of analysis tasks in rational design of thin-walled structures.

KEYWORDS: linearly deformed plates, deformation, thin-walled structures.

1. INTRODUCTION

At research of methods of development of calculation of ribbed plates until latest times the majority of authors are restricted by consideration of constant cross-section ribs that have obvious advantages due their manufacturability in comparison with variable cross-section ribs [1, 2, 3 and 4]. However it is clear that at problem statement of optimal design of plates with ribs is necessary to increase, as it is possible, to expand the class of reinforced elements and consider the variable cross-section ribs, having additional control parameters that gives the possibility to more fully satisfy the basic requirement of low material consumption as well as requirements of design aesthetics, convenience, operability and so on.

2. BASIC PART

Let's considered constant thickness anisotropic plate [1] on continuous elastic foundation, loaded by arbitrary normal loading $q(x,y)$. The edge Γ of plate is supported and reinforced by thin isotropic variable cross-section rib. The stiffness of rib on bending and torsion let's express accordingly as

$$A(s)=\lambda A_*(s),\ \ C(s)=\lambda C_*(s)$$

where the dimensionless nonnegative parameter $\lambda = const$ was introduced for convenience. As mathematical model of task of calculation of such plate is presented the linear differential equation of bending

$$L[W_*(x,y)]=q(x,y) \qquad (1)$$

where $W_*(x,y)$ – is the desired deflection, $L[W_*(x,y)]$ – is the known differential operator with partial derivatives of forth order.

On the contour Γ would be satisfied the boundary conditions of plate junction with rib [3]

$$W_*=0,\ L_1[W_*]-\lambda L_2[W_*]=f_*(s), \qquad (2)$$

where $L_1[W_*] \equiv M_n(s)$ – is the bending moment, expressed through deflection W_*; s – is the arc on Γ; $f_*(s)$ – is the stated distribution of external bending moments on Γ

$$L_2[W_*] = \left[\frac{A_*}{\rho^2} - \frac{\partial}{\partial s}\left(C_* \frac{\partial}{\partial s}\right)\right]\left(\frac{\partial W_*}{\partial n}\right), \quad (3)$$

where n – is the normal to Γ, $\rho = \rho(s)$ – is the radius of curvature.

For the isotropic plate, in particular, on the supporting contour we will have

$$L_1[W_*] = -D\left[\Delta W_* + (1-\nu)\frac{1}{\rho}\right]\left(\frac{\partial W_*}{\partial n}\right),$$

where D – is the cylindrical stiffness of plate. The solution of task (1)-(2) let's represent as

$$W_*(x,y) = W_0(x,y) + W_1(x,y), \quad (4)$$

where W_0 – is the known partial solution of equation (1) that satisfies to supporting condition, i.e. $W_0 = 0$ on Γ, and function $W_1(x,y) \equiv W_1(x,y,\lambda)$ is the solution of boundary value problem

$$W_1 = 0, \quad L_1[W_1] - \lambda L_2[W_1] = f_*(s) \text{ on } \Gamma. \quad (6)$$

Here

$$f(s) = f_*(s) - \{L_1[W_1] - \lambda L_2[W_1]\}_\Gamma. \quad (7)$$

For solution of task (5)-(6) let's apply the non-classic procedure of immersion [5] and assume $\lambda \geq 0$ as parameter of immersion.

For this let's consider the auxiliary boundary value problem for new non-known function $W(x,y,\lambda,s_0)$:

$$L(W) = 0, \quad (8)$$

$$W_0 = 0, \; L_1[W] - \lambda L_2[W] = \delta(s_0 - s) \text{ on } \Gamma, \quad (9)$$

where as δ is designated the symbolic Dirac delta-function. Is assumed that function $W(x,y,\lambda,s_0)$ that represents the tasks (8)-(9) for most simple case $\lambda = 0$, i.e. for non-reinforced by rib hinged supported plate either is stated, or is known as algorithm of their calculation. Due comparison of linear tasks (8)-(9) with (5)-(6), we mention that

$$W_1(x,y,\lambda) = \int_\Gamma W(x,y,\lambda,s_0) f(s_0) ds_0. \quad (10)$$

For determining the dependency of function W from parameter of immersion, let's differentiate (8)-(9) on λ and designate $\frac{\partial W}{\partial \lambda} = W_x$:

$$L(W_\lambda) = 0, \quad (11)$$

$$W_\lambda = 0, \; L_1(W_\lambda) - \lambda L_2(W_\lambda) = L_2(W) = M(\xi, s_0, \lambda) \text{ on } \Gamma. \quad (12)$$

Due the comparing of boundary value problems (11)-(12) and (8)-(9), we found

$$W_\lambda(x,y,\lambda) = \int_\Gamma M(\xi, s_0, \lambda) W(x,y,\lambda,s_0) d\xi, \; \lambda > 0. \quad (13)$$

In the equation (13) coordinates (x,y) represents the fixed parameters.

As known initial value of function W is presented

$$W(x,y,\lambda,s_0)/\lambda = 0 = W(x,y,\lambda,s_0). \quad (14)$$

The Cauchy problems (13)-(14) is solved by known numerical methods by integration in direction of increasing of parameter λ from zero up to given value. Due known of function $W(x, y, \lambda, s_0)$ let's determine the desired deflection of reinforced by variable stiffness plate in one or several points with coordinates (x, y) accordingly of formulae (4), (10). Similarly will be solved this task at more complicated boundary conditions.

3. CONCLUSION

Are derived the general conditions of plates with displaced median surfaces of thin variable stiffness rib.

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Construction

NON-LINEAR BOUNDARY VALUE PROBLEM MODELING ELASTIC EQUILIBRUM OF SHELLS

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ABSTRACT: Let's consider the non-linear boundary value problem modeling, in particular, the elastic equilibriums of thin shells. The thin shells are modeling by two point building ordinary value problems for ordinary simultaneous second order differential equations. The reduction of these tasks to Cauchy problem makes some advantages in comparison with terms of computations. In the work such reduction is stated grounded on immersion.

KEYWORDS: modeling, elastic equilibriums, thin shells, Cauchy problem.

1. INTRODUCTION

One of the main factors of technical progress represents by development of principally new types of devices, machines, structures, having the improved reliability and relative low material consumption. Shells and plates are presented as critical elements of most of engineering structures. For meeting of essential functional requirements the designers often are weakening them by various shape cuts [1]. On the other hand, for reduction of arising at this stresses concentration , for improvement of thin-wall structures stiffness often are applied plate of shell elements with displaced median surfaces that are mating with thin variable cross-section ribs or by variable depth extrusions. Such compound shells are widely applied in construction, machine building, aircrafts and other fields of engineering.

As it is known [2, 3], the various variants of refined non-linear theory of thin shells with taking into account the shear (at axis-symmetric deformation) are modeling with two-point boundary value problems for routine simultaneous second order differential equations. The reduction of such tasks for Cauchy problem makes some advantages in terms of computational machinery.

2. BASIC PART

Let's considered non-linear boundary value problem, modeling, in particular, the elastic equilibrium of mentioned shells:

$$\ddot{u}(t,a,T) = h\left(u,\dot{u},t\right),\ \ o \le t \le T\,, \tag{1}$$

$$F\left(u\left(o,a,T\right),\dot{u}\left(o,a,T\right)\right) = 0\,, \tag{2}$$

$$A_1(T)u(T,a,T) + A_2(T)\dot{u}(T,a,T) = a\,. \tag{3}$$

Here $u(t,a,T) = \{u_j(t,a,T)\}$ – is the desired n-dimensional vector function; h and F – are the given n-dimensional vector functions of their arguments; $a \equiv \{a_k\}$ – is the known n-dimensional vector; A_1 and

A_2 – are the given square ($n\times n$) matrixes; a_k and T – are the immersion parameters. The dot above the vector designates its derivative on t.

Due the immersion method let's differentiate the dependencies (1)-(3) on a_k and T. We obtain (n+1) two point linear boundary value problem regarding of vectors

$$\frac{\partial u}{\partial a_k} \text{ and } \frac{\partial u}{\partial T} \quad \left(k=\overline{1,n}\right).$$

Due the comparison of these two problems in proposing of existing and uniqueness of their solutions, we will obtain

$$\frac{\partial}{\partial T}u(t,a,T)=\sum_{k=1}^{n}B_k\frac{\partial}{\partial a_k}u(t,a,T),\ \ T>t\,. \tag{4}$$

There are designated

$$\begin{aligned} &B\equiv\{B_k\}=-\left[\left(A_1+A_2'\right)r+A_1\rho+A_2h(\rho,r,T)\right],\\ &\rho\equiv\rho(a,T)=u(T,a,T),\quad r\equiv r(a,T)=\dot{u}(T,a,T). \end{aligned} \tag{5}$$

Accordingly of (5) as initial condition for quasi linear differential equation (4) at $T=t$ is the following condition

$$u(t,a,t)=\rho(a,t). \tag{6}$$

The auxiliary vector $\rho(a,t)$ is yet unknown. For its determination due differentiating of vector r on T and taking into account (1) and (4), we will found

$$\frac{\partial}{\partial T}r(a,T)=h(\rho,r,T)=\sum_{k=1}^{n}B_k\frac{\partial}{\partial a_k}r(a,T),\ T>0\,. \tag{7}$$

From the (3) and (5) follows that

$$\rho\equiv\rho(a,T)=A_1^{-1}(T)\left[a-A_2(T)r(a,T)\right]. \tag{8}$$

Is supposed the existence of inverse matrix $A_1^{-1}(T)$.

The quasi linear equation (7) is necessary for definition of vector function $r(a,T)$, the initial value of that is

$$r(a,T)/T=0=r(a,o) \tag{9}$$

is defining at $T=0$ from condition (2), i.e. by solution of non-linear equation

$$F(\rho(a,o),r(a,o))=0\,. \tag{10}$$

The existing at this vector $\rho(a,o)$ is expressed through $r(a,o)$ accordingly of formula (8) at $T=0$.

Thus, the two point boundary value problem (1)-(3) is reduced to two Cauchy problems (4), (6) and (7), (9) that are integrated in parallel by one-step method in direction of increasing only one of immersion parameter T.

Let's assume that the Cauchy problems (4), (6) and (7), (9) have the uniqueness solutions. Let's prove their equivalence to initial non-linear two point problem (1)-(3). For this let's differentiate (4) on t

$$\frac{\partial}{\partial T}\dot{u}(t,a,T)=\sum_{k=1}^{n}B_k\frac{\partial}{\partial a_k}\dot{u}(t,a,T), \tag{11}$$

$$\frac{\partial}{\partial T}\ddot{u}(t,a,T)=\sum_{k=1}^{n}B_k\frac{\partial}{\partial a_k}\ddot{u}(t,a,T),\quad T>t\,. \tag{12}$$

Due taking into account the (11) and (5), we calculate

$$\frac{\partial}{\partial T}r(a,t)=\ddot{u}(t,a,t)+\sum_{k=1}^{n}B_k\frac{\partial}{\partial a_k}r(a,t). \tag{13}$$

Due the comparison of equations (13) and (7) at $T = t$, we found

$$\ddot{u}(t,a,\ddot{t}) = h(\rho(a,o), r(a,o), t). \tag{14}$$

Due the differentiation of function $h(u,\dot{u},t)$ on T and a_k with taking into account (4) let's compiled the equation

$$\frac{\partial h}{\partial T} - \sum_{k=1}^{n} B_k \frac{\partial h}{\partial a_k} = 0, \quad T > t. \tag{15}$$

It is obvious that at $T = t$ we have

$$h(u,\dot{u},t)/T = t = h(\rho(a,t), r(a,t), t). \tag{16}$$

The vector functions $h(u,\dot{u},t)$ and $\ddot{u}(t,a,T)$ satisfies the same equations (15) and (12) and same initial conditions (16) and (14).

By assuming the uniqueness of such Cauchy problems solutions, let's conclude that

$$\ddot{u}(t,a,T) = h(u(t,a,T), \dot{u}(t,a,T), t). \tag{17}$$

Hence the initial differential equation (1) is performed. Will be derived only accordingly boundary value problems (2), (3). For this let's mention that vector function $u(t,a,T)$ will be constructed in such manner that will be performed the initial condition (6), where the right part is defined by expression (8), but it is equal to satisfaction of boundary conditions (3). For deriving of condition (2) let's differentiate both parts of equation (4) on t

$$\frac{\partial}{\partial T}\dot{u}(t,a,T) = \sum_{k=1}^{n} B_k \frac{\partial}{\partial a_k}\dot{u}(t,a,T), \quad T > t. \tag{18}$$

Let's mention that vectors $u(o,a,T)$, $\dot{u}(o,a,T)$ are the solutions of equations (4), (18) accordingly at $t = 0$ with initial conditions (accordingly of (6), (5), (9))

$$u(o,a,o) = \rho(a,o), \ \dot{u}(o,a,o) = r(a,o). \tag{19}$$

As the mentioned equation (at $t = 0$) is satisfied for arbitrary T, it is obvious that by solution of accordingly Cauchy problems under their uniqueness will be

$$\begin{aligned} u(o,a,T) &\equiv u(o,a,o) = \rho(a,o), \\ \dot{u}(o,a,T) &\equiv \dot{u}(o,a,o) = r(a,o). \end{aligned} \tag{20}$$

The right parts of equalities (20) are satisfied the equation (10) therefore the left parts also will satisfy the condition (2) that will be necessary to be proved.

3. CONCLUSION

Due the method of invariant immersion the two point boundary value problems for ordinary simultaneous differential equations modeling the axis-symmetric bending of elastic inclined shells with stiffness ribs, are reduced to Cauchy problems. The equivalency of according problems is proved.

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Hydraulic Structures

HYDRAULIC CALCULATION METHOD FOR SEA BOTTOM SPILLWAY SEWERS

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ABSTRACT: Within the scope of the present article the problem of interaction of sea and waste water at inflow reaches is considered and formulae to calculate the maximum dimensions of salinity wedge intrusion into bottom spillways are established. These formulae foresee end slopes of spillway bottoms which must be necessarily considered in hydraulic engineering construction, especially in the Black Sea regions of Georgia.

KEYWORDS: spillway, collector, halosol, waste water, adjacent conditions.

INTRODUCTION

The problem of interaction of sea and waste water at inflow reaches, bottom spillway structures or sea sewage collectors is one of the problems associated with the hydrodynamics of coastal regions. On the one hand, the salinity wedge (halosol) intrudes into the river inflows, non-pressure or pressure discharge structures at long range, impedes with the exploitation of water-supply and sewerage systems of coastal settlements, stimulates load sedimentation and holm formation in stream canals, reduces the discharge capacity of collectors, creates threats of flooding coastal territories, causes marine pollution (which is especially dangerous for the Black Sea recreation zones of Georgia), etc.

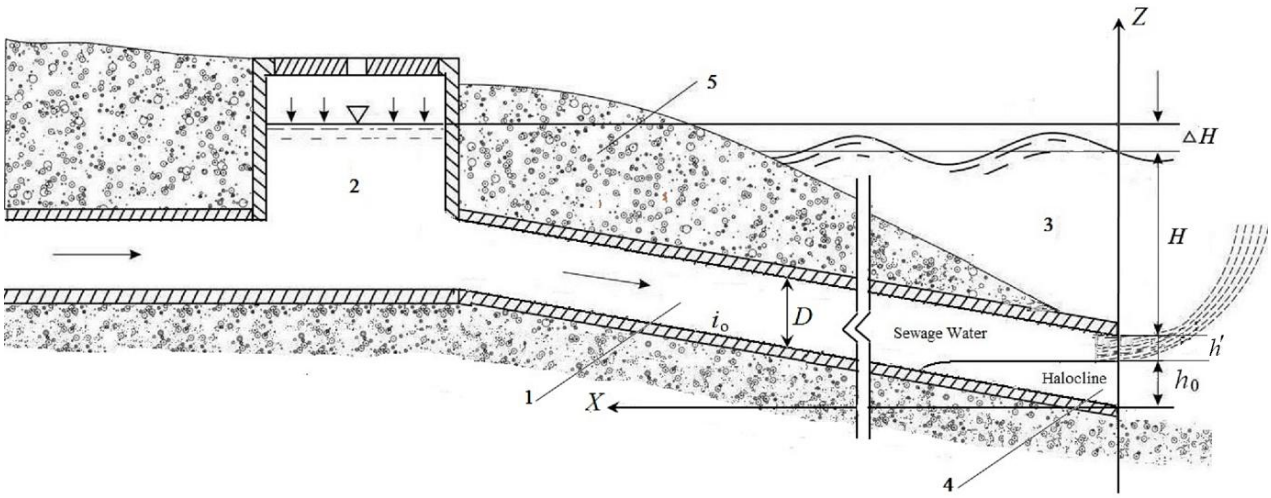
Accordingly, the practical importance of specifying the dimensions of salinity intrusions in inflow reaches and sewage collectors and studying the diffusion and range zone of impure water streams, which intrude into the sea from storm sewers and sewage collectors, is obvious.

At present, these issues have been more or less precisely studied for cases where the sea bottom has a gentle slope. As for the Black Sea regions of Georgia, the slopes of inflow reaches and the ones of the sea bottom are so steep that it's inadmissible to disregard them. The steep slopes of the sea bottom also determine the location and dimensions of a waste water flow section opening into the sea. It's practically impossible to place an ending section of a spillway on the sea bottom, 13 km away from the shore, which is required by normative documents, because of deep lead sea (200-500 mm) in the Black Sea regions of Georgia. If a spillway is arranged at a shorter distance, it's necessary to substantiate environmental safety, which directly depends on the study of expansion of impure waters by wave and convection flows directed at the shore, etc. However, in the present article we confine ourselves to just specifying the dimensions of the salinity wedge intrusion into bottom spillway structures, on which the capacity of whole spillways depends immediately.

CALCULATION METHOD FOR SALINITY WEDGE INTRUDED INTO BOTTOM SPILLWAY STRUCTURES

In a water pipeline fresh and salt waters are divided by a horizontal surface which simultaneously with the displacement of salt water by fresh one from a pipeline gradually comes down to the ending

section without deformation [12]. As soon as it reaches the ending section, the fresh water flows out into the space occupied by salt water and the dividing surface loses its initial horizontality and warps. Besides, depending on the size across of the spillway pipeline and pipeline decline, in a certain range of fresh water flow the fresh water still remains on the bottom of the pipeline, the depth and length of which are easily determined on the basis of the calculation pattern given on the picture 1.



Pic. 1. Halosol Intrusion calculation Pattern for Sea Bottom Spillway
1 – spillway collector; 2 – storm-water – observation well; 3 – the sea; 4 – halosol; 5 – shore.

Let's first assume that a spillway has a prismatic section, or discuss a plane problem. A halosol in a sea bottom spillway may be considered as a long internal wave prevented by a fresh water flow, above which the fresh water velocity reaches the critical value calculated according to the following relation [1, 2]:

$$V_{critical}^2 = g\frac{\rho-\rho'}{\rho'}h', \qquad (1)$$

where ρ and ρ' are sea and fresh water densities; h' is the depth of the fresh water in the ending section above the halosol.

If we represent the fresh water velocity by means of the reduced discharge at the ending section of the bottom spillway and the height (depth) of the waste water height, on the basis of the (1) equality, we may write

$$\frac{q^2}{(D-h_0)^2} = g\frac{\rho-\rho'}{\rho'}(D-h_0)\ , \qquad (2)$$

where $q = Q/B$ is the reduced discharge of the waste water at the ending section; Q – total design flood; B – spillway width; h' – fresh water depth at the ending section, $h' = D - h_0$; D – spillway height; h_0 – the sought-for depth of the salt water.

According to the relation (2), the depth of the sea salt water at the ending section is

$$h_0 = D - \left(\frac{q^2(1-\sigma)}{g\sigma}\right)^{1/3}\ , \qquad (3)$$

where the following notation is introduced $\sigma = 1-\gamma'/\gamma$. γ' and γ are specific weights of waste and sea waters, ($\gamma' < \gamma$). According to the relation (3), the sea water statically occupies the whole ending section of the bottom pipeline, when the river water flow equals zero, i.e., $h_0 = D$ when $q = 0$. On the other hand, the

sea water will be completely displaced from the pipeline when the reduced fresh water flow exceeds the critical value

$$q_{critical} = \left(\frac{\sigma}{1-\sigma} gD^3 \right)^{1/2} \quad (4)$$

i.e., when $q > q_{critical}$ the depth of salt water at the ending section of the $h_0 = 0$.

Assume that the river water flow which enters the bottom spillway is less than the critical value. Let's determine the length of the salinity wedge intruded in the spillway for this case. For this purpose we may use Euler equation and according to the calculation pattern admit that the coordinate of the surface dividing the salt and fresh waters in the pipeline is

$$z = z''. \quad (5)$$

Then the water flow pressure on the yet unknown dividing surface will be represented as a sum of hydrostatic pressure and pressure caused by water velocity

$$p' = \gamma'(H + \nabla - z'') + \gamma' \frac{q^2}{2g(z_0' - z'')^2}, \quad (6)$$

where H is the depth of the sea above the ending section of the pipeline; ∇ – level of river water in the observation; z'_0 – coordinate of the spillway ceiling edge.

In consideration of the representations (5) and (6), Euler equation for statistic balance of salinity wedge in the pipeline becomes the following:

$$\left(1 - \frac{\gamma'}{\gamma}\right)\frac{dz''}{dx} + \frac{\gamma'}{\gamma}\frac{q^2}{2g}\frac{d}{dx}\frac{1}{(z'_0 - z'')^2} = 0. \quad (7)$$

Let's change in the equation (7) the coordinate of the surface dividing the salt and fresh waters z'' by the sum

$$z'' = z_0 + h, \quad (8)$$

where z_0 is the coordinate of the spillway bottom and h is the halosol depth in any section. Then, if we also take into consideration that

$$\frac{dz_0}{dx} = i_0 \text{ and } z'_0 - z_0 = D \quad (9)$$

where i_0 is the slope of the spillway bottom, the equation (7) will become the following

$$\sigma\frac{dh}{dx} + \sigma i_0 + (1-\sigma)\frac{(q')^2}{2g}\frac{d}{dx}\frac{1}{(D-h)^2} = 0. \quad (10)$$

Integration of the equation (10) results is

$$\sigma h + (1-\sigma)\frac{(q')^2}{2g}\frac{1}{(D-h)^2} = -\sigma i_0 x + C. \quad (11)$$

To exclude C (constant of integration), we may use an adjacent condition $h = h_0$, when $x = 0$, where h_0 is the initial depth of the halosol of the ending section of the spillway. Then in result of a simple transformation the equation (11) will turn into

$$(h_0 - h) + \frac{1-\sigma}{\sigma}\frac{q^2}{g}\left[\frac{1}{(D-h_0)^2} - \frac{1}{(D-h)^2}\right] = i_0 x. \quad (12)$$

It is obvious that in the spillway, where the depth of the salt water $h = 0$ linear coordinate x

represents the maximum intrusion of the halosol or the length of the halosol, which, according to on the basis of the representation (12) is calculated by means of the formula

$$L = \frac{1}{i_0}\left\{h_0 + \frac{1-\sigma}{\sigma}\frac{q^2}{2g}\left[\frac{1}{(D-h_0)^2} - \frac{1}{D^2}\right]\right\}. \qquad (13)$$

In (13) h_0 must be preliminarily determined by means of the relation (3).

In case of bottom spillways with circular sections, the calculation patterns are relatively complicated and lead to insignificantly different results as compared with the results of the relations (3) and (13), if we consider D to be the pipeline diameter and calculate the reduced water flow by means of the formula

$$q = \frac{Q}{\omega^{1/2}} = \frac{2Q}{D\pi^{1/2}} = \frac{1.13Q}{D}. \qquad (14)$$

Thus, in consideration of this assumption, we may also use the formulae (3) and (13) to calculate the salinity wedge in bottom spillways with circular sections.

NUMERICAL EXAMPLE OF CALCULATION

Let's assume that we need to define the possibility of wedge intrusion into a sewage collector with a circular section and its dimensions on the basis of the following data:

$D = 0.63$ m; ρ'=1 t/m^3; $\rho = 1.008$ t/m^3; $i_0 = 0.0125$; $Q = 0.006$ m^3/sec;

We preliminarily calculate the values

$$\sigma = \frac{\rho - \rho'}{\rho} = 1 - \frac{\gamma'}{\gamma} = 1 - \frac{1}{1.008} = 0.008.$$

From the formula (4) we'll obtain $q_{critical} = (9.8 \times 0.008 \times (0.63)^3)^{1/2} = 0.14$ m^2/sec; and from the formula (14) – $q = 1.13\dfrac{0.006}{0.63} = 0.0108$ m^2/sec.

As far as $q < q_{critical}$, salt water will intrude into the sewer pipeline from the sea. According to the formula (3), the depth of the sea water equals

$$h_0 = 0.63 - \left(\frac{0.0108^2 \times 0.9921}{9.8 \times 0.0079}\right)^{1/3} = 0.63 - 0.114 = 0.52 \text{ m},$$

and according to the formula (13), the length of the sea water intrusion into the sewer pipeline is

$$L = \frac{1}{0.0125}\left\{0.52 + \frac{1}{0.008}\cdot\frac{0.010^2}{2\cdot 9.8}\left[\frac{1}{(0.63-0.52)^2} - \frac{1}{0.63^2}\right]\right\} = 46 \text{ m/s}.$$

This distance must be measured from the ending section of the pipeline up the stream.

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Hydrology and meteorology

RECOMENDATIONS ON CALCULATION OF BEDLOAD TRANSPORT IN MOUNTAIN-PIEDMONT RIVERS

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ABSTRACT: Based on the special experimental and theoretical studies made by the authors of the present paper, using as well findings of Russian and foreign investigators recommendations are established on calculation of bed material incipient motion and bedload discharge in mountain-piedmont rivers in case of structural (dune) and nonstructural forms of bedload transport.

Relationships $V_0'' = 1{,}26\sqrt{gd}\left(\frac{H}{d}\right)^{0{,}30}$ and $\overline{V}_0 = 1{,}02\sqrt{gd}\left(\frac{H}{d}\right)^{0{,}30}$ are recommended to calculate critical velocities for bedload material incipient motion.

In case of bedload structural (dune) motion equation $\frac{q_t}{q} = \left(0.0008\frac{V}{V_0} + 0.0002\right)Fr^3$ is established to calculate bedload discharge whilst the formulae of Gvelesiani (1946), Levi (1957) and Shamov (1952) movement are recommended to calculate bedload discharge in case of bed material nonstructural.

KEYWORDS: mountain-piedmont rivers, incipient motion, laboratory and field studies, dunes, bedload discharge.

Гидрология и метеорология

РЕКОМЕНДАЦИИ ПО РАСЧЕТУ ХАРАКТЕРИСТИК ТРАНСПОРТА ДОННЫХ НАНОСОВ В ГОРНО-ПРЕДГОРНЫХ РЕКАХ

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ВВЕДЕНИЕ

Для рационального использования горно-предгорных рек в практических целях: оценки заносимости горных водохранилищ, устойчивости русел, эффективной борьбы с паводками, оценки пропускной способности русел, их мониторинга, охраны и восстановления, – необходимы прежде всего расчеты таких характеристик транспорта донных наносов как предельные условия сдвига донных отложений и расход донных наносов.

Существующие методы расчета этих характеристик несовершенны и требуют дальнейшего развития.

Транспорт донных наносов в реках горно-предгорной зоны может происходить как в бесструктурной форме, без образования донных грядовых образований, так и в структурной форме. Грядовое движение на этих реках имеет место при высоких уровнях воды во время чрезвычайных и катастрофических паводков.

Специальными лабораторными исследованиями ГГИ установлено, что при полной подвижности донных отложений границей отсутствия или существования грядовых форм транспорта наносов в руслах, сложенных из крупных наносов, является условие $\frac{H}{d_{90}} \geq 15$, или $\frac{H}{d} \geq 30$, если принять, что $d_{90} = 2d$. При относительной гладкости потока (шероховатости русла) $\frac{H}{d_{90}} < 15$ гряды на дне водных потоков не образуются. При $\frac{H}{d_{90}} \geq 15$ в руслах горно-предгорной зоны могут образоваться гряды, типа дюн с длиной $l_{г} = (3{,}0 - 8{,}0)H$ и высотой $h_{г} = (0{,}1 - 0{,}3)H$ [1].

Организация и выполнение прямых измерений характеристик транспорта донных наносов на реках горно-предгорной зоны сопряжены с рядом трудно преодолимых проблем. Скорости потока во время паводков, когда происходит интенсивное движение донных наносов на этих реках, составляют 4,0÷8,0 м/с. Высокие паводки отличаются чрезвычайной быстротечностью и могут длиться всего несколько часов. Часто это происходит в ночное время.

Вместе с тем процесс транспорта донных наносов на реках отмеченной категории достаточно строго воспроизводится в лабораторных условиях: в гидравлических лотках и на пространственных деформируемых геометрически неискаженных гидравлических моделях.

Ниже приводятся результаты исследований, выполненных в ГГИ для расчета предельных условий сдвига донных частиц и расхода донных наносов при структурной (грядовой) и бесструктурной формах перемещения донных наносов в горно-предгорных реках.

ОСНОВНАЯ ЧАСТЬ

1.1. НЕРАЗМЫВАЮЩАЯ СКОРОСТЬ

В предшествующих методических подходах для определения критических условий начала движения крупных наносов неразмывающая скорость определялась качественно на основе визуальной фиксации момента начала движения донных частиц.

В настоящем исследовании в качестве критерия интенсивности транспорта донных наносов было принято отношение доли частиц, пересекающих единицу ширины потока (1 м) в единицу времени, к доле частиц, лежащих на площади размером $1 \times V_{ч} \delta t$, где δt – единица времени, а $V_{ч} = 0{,}4V$. Этот критерий может быть выражен в следующем виде:

$$P_1 = \frac{q_T \rho_S}{d l_{(1\,м)} 0{,}4 V \rho_0}, \qquad (1)$$

где $q_{Т}$ – расход донных наносов в объемном выражении, а ρ_{S} и ρ_0 соответственно объемный вес донных отложений в твердом теле (без пор) и в рыхлом теле, V – средняя скорость потока, d – средний диаметр донных отложений.

Из большого количества экспериментальных данных (лабораторных) зарубежных и отечественных исследователей, выполненных с крупными наносами (более 1 мм), а также измерений в натуре на реках с крупностью частиц более 14 мм были выбраны данные, удовлетворяющие следующим требованиям:

- отношение ширины потока к глубине больше восьми $\left(\frac{B}{H} > 8\right)$;
- состав грунта близок к однородному;
- критерий P_1 меньше или равен 0,05.

Эти данные были представлены в координатах $\frac{V_0}{\sqrt{gd}}, \frac{H}{d}$ (V_0 – неразмывающая скорость, $g = 9{,}81$ м/с^2), используемых чаще всего исследователями при поиске подобных связей. Нижняя огибающая на графике соответствует предельному состоянию потока, при котором наблюдается граничная нулевая интенсивность транспорта донных частиц. Аналитически эта огибающая выражается в виде:

$$V_0' = 0{,}79\sqrt{gd}\left(\frac{H}{d}\right)^{0{,}30}. \qquad (2)$$

Средняя линия на графике соответствует интенсивности транспорта наносов $P_1 = 0{,}025$ и выражается в виде (формула ГГИ-2):

$$V_0'' = 1{,}26\sqrt{gd}\left(\frac{H}{d}\right)^{0{,}30}. \qquad (3)$$

Область между нижней и средней кривыми отражает условия слабого транспорта донных наносов на дне водных потоков, когда, в соответствии с критерием P_1, движением в единицу времени (1 сек.) охвачено менее 2,5% площади поверхности дна потока шириной 1 м и длиной $0{,}4V\delta t$.

Осредненная кривая для этой области $\frac{V_0' + V_0''}{2}$ будет иметь вид:

$$\overline{V_0} = 1{,}02\sqrt{gd}\left(\frac{H}{d}\right)^{0{,}30}. \qquad (4)$$

Эта формула (ГГИ-1) соответствует минимально улавливаемой измерениями интенсивности движения донных частиц на дне, когда в состоянии движения в единицу времени (1 сек.) на площади поверхности дна шириной 1 м и длиной $0{,}4V\delta t$ находятся частицы, занимающие 1,2% этой площади. Таким образом, зависимость (4) для начальных критических скоростей донных наносов, в отличие от всех других зависимостей такого рода имеет количественное выражение.

Из сравнения формул для крупных наносов с эталонными кривыми ГГИ следует, что при глубине потока $H = 1$ м и $H = 3$ м, в область значений неразмывающих скоростей потока, очерченной формулами ГГИ-1 и ГГИ-2, попадают результаты расчетов по формулам Шильдса, Гончарова (1962 г.), Талмазы, Дебольского, Шамова, Мосткова, Гришанина, Леви, Латышенкова, Кнороза и Романовского. При неоднородном составе донных отложений целесообразно вводить корректив в соответствии с [2].

Эти формулы с большей уверенностью, чем это делалось до сих пор, могут быть рекомендованы для практического использования в инженерной практике.

1.2. РАСХОД НАНОСОВ НА ГОРНЫХ РЕКАХ В ГРЯДОВОЙ ФОРМЕ

Для установления расчетной зависимости геометрических и динамических характеристик транспорта донных наносов при их структурном движении на реках, сложенных из крупного аллювия, были использованы данные экспериментальных исследований грядового движением донных наносов различных авторов, выполненных в гидравлических лотках и на деформируемых гидравлических моделях с крупностью донных наносов > 1,0 мм. Были использованы данные экспериментов В.Н. Гончарова, В.Ф. Пушкарева, З.Д. Копалиани, Г. Уильямса, О. Саймонса и Е. Ричардсона.

Гидравлические условия выполнения опытов в исследованиях различных авторов и диапазон изменения гидравлических характеристик для всех экспериментов представлены в [1].

Для расчета скорости движения гряд в лабораторных условиях по данным перечисленных выше исследователей была получена зависимость:

$$C_{\text{г}} = 0{,}019VFr^3. \qquad (5)$$

Для расчета расхода донных наносов при грядовой форме перемещения донных наносов обычно используется зависимость:

$$q_{\text{Т}} = kh_{\text{г}}C_{\text{г}}, \qquad (6)$$

где k – коэффициент формы гряд $(k = 0{,}6)$, а $h_{\text{г}}$ – высота гряд.

Ранее в ГГИ, для расчета высоты гряд на реках горно-предгорной зоны при значениях относительной гладкости потока $30 < \frac{H}{d} \le 150$ была получена формула:

$$h_{\text{г}} = \left(0{,}07\frac{V}{V_0} + 0{,}02\right)H, \qquad (7)$$

где V_0 – неразмывающая скорость потока по формуле В.Ф. Талмазы.

Подставляя (5) и (7) в (6), имеем:

$$\frac{q}{q_T} = \left(0{,}0008\frac{V}{V_0} + 0{,}0002\right)Fr^3. \qquad (8)$$

Здесь $\frac{q}{q_T}$ – объемная концентрация донных (влекомых) наносов в рыхлом теле в руслах горно-предгорных рек при их структурном движении в виде микроформ – гряд длиной $l_{\text{г}} = (2{,}0 - 9{,}0)H$ и высотой $h_{\text{г}} = (0{,}1 - 0{,}3)H$.

Зависимость (8) может использоваться для расчета расхода и стока донных наносов в горно-предгорных реках для фаз и периодов водного режима, когда движение наносов осуществляется в форме гряд в диапазоне изменения гидравлических характеристик потока: $I = 0{,}001 - 0{,}024$, $\frac{H}{d} = 13{,}0 - 457{,}0$, $Fr = \frac{V}{\sqrt{gH}} = 0{,}34 - 1{,}33$, $\frac{V_*}{w} = 0{,}16 - 1{,}0$ (V_* – динамическая скорость, w – гидравлическая крупность).

Отмеченное имеет место при полной подвижности всех фракций донных отложений во время высоких паводков на реках горно-предгорной зоны.

1.3. РАСХОД ДОННЫХ НАНОСОВ НА ГОРНЫХ РЕКАХ ПРИ БЕССТРУКТУРНОЙ ФОРМЕ ИХ ТРАНСПОРТА

Был выполнен анализ и взаимное сравнение 84 формул расхода донных наносов, не учитывающих возможной структурности их транспорта. В качестве исходных данных были взяты результаты трех экспериментов, проведенных в Русловой лаборатории ГГИ специально с целью сравнения формул. Первые два эксперимента выполнены в 8-метровом гидравлическом лотке, третий – в 100-метровом. Расчеты по первым двум экспериментам велись в пересчете на натурные условия, по третьему – в единицах лотка.

Прототипами первого и второго экспериментов послужили два участка р. Мзымты, третьего – р. Туапсе. Для этих участков были воспроизведены условия паводков, во время которых транспорт наносов осуществлялся в бесструктурной форме ($\frac{H}{d_{90}} \le 15$ или $\frac{H}{d} \le 30$). В первом и во втором экспериментах гидравлические характеристики потока, расход и гранулометрический состав донных наносов определялись на каждой стадии паводка. В третьем эксперименте измерения грансостава на каждой стадии паводка не проводились, поэтому имеются данные только по исходному грунту (донным отложениям).

В первом и третьем экспериментах гранулометрический состав донных отложений был неоднородным, во втором однородным.

Диапазон гидравлических характеристик и основные параметры гранулометрических составов донных отложений по всем экспериментам представлены в табл. 1 и 2.

Таблица 1

Диапазон изменения основных гидравлических характеристик экспериментов

Характеристика	Диапазон изменения					
	Первый эксперимент (7 стадий паводка), единицы натуры		Второй эксперимент (6 стадий паводка), единицы натуры		Третий эксперимент (11 стадий паводка), единицы лотка	
	I стадия	VII стадия	I стадия	VI стадия	I стадия	XI стадия
Глубина *H*, м	0,66	2,64	0,83	2,48	0,01	0,06
Скорость течения *V*, м/с	1,49	5,20	2,38	5,55	0,17	0,57
Число Фруда *Fr*	0,58	1,02	0,84	1,13	0,46	0,87
Расход воды на единицу ширины русла *q*, м^3/с/м	0,97	13,60	1,94	13,60	0,0024	0,0344
Объемный расход донных наносов на единицу ширины русла q_T, м^3/с/м	0,000012	0,036176	0,000180	0,034153	0,0000002	0,0000260
Массовый расход донных наносов на единицу ширины русла q_T, кг/с/v	0,03	95,87	0,22	52,25	0,0004	0,0690
Плотность наносов в рыхлом теле ρ_s, кг/м^3	1438	1700	1250	1530	1611	1728

Таблица 2

Основные параметры гранулометрических составов донных отложений, использованных в экспериментах.

Характеристика	Эксперимент		
	Первый	Второй	Третий
d , м	0,11	0,14	0,0014
d_{50} , м	0,061	0,132	0,00076
$\frac{d}{d_{50}}$	1,8	1,1	1,9
d_{10} , м	0,007	0,088	0,00017
d_{90} , м	0,206	0,151	0,002
$\frac{d_{90}}{d_{50}}$	29,4	1,7	11,8

Проанализированные формулы по структуре можно разбить на несколько групп:

1. Формулы, содержащие критерий начала движения, в качестве которого используются: критическая скорость потока (18 формул), критический расход воды (7 формул), критическое безразмерное касательное напряжение на дне потока (34 формулы), критический энергетический уклон (1 формула).
2. Вероятностный подход (4 формулы).
3. Подход равной подвижности (формула).
4. Регрессионные зависимости (19 формул).

Подход к анализу формул, принятый в настоящей работе, по сравнению с предыдущими работами характеризуется следующими особенностями:

- Сопоставлялись не осредненные значения ошибок расчета, а их конкретные значения отдельно для каждой стадии паводка, характеризуемой своей степенью вовлеченности в движение донных отложений.
- Для первых двух экспериментов сравнивались формулы для двух смесей: по данным гранулометрического состава наносов на каждой стадии паводка и по данным исходного грунта донных отложений.
- Отдельное внимание в данной работе обращено на способы учета гранулометрического состава, используемые разными авторами, и на критические величины безразмерного касательного напряжения θ_0. Все формулы, использующие безразмерный критерий Шильдса и безразмерную функцию Эйнштейна, проверялись в нескольких вариантах. В качестве характеристики гранулометрического состава брались средневзвешенный диаметр d и медианное его значение по интегральной гранулометрической кривой d_{50}, а также иное значение, если таковое предлагалось автором (например, d_{35} у Эйнштейна). Расчеты показали, что в случае неоднородного грунта разница между θ, рассчитанным по d и d_{50}, может составить 2 раза и более, следовательно, оно занижается или завышается в 2 раза. Если авторы предлагали выполнять расчеты пофракционно, то мы следовали

их рекомендациям. Значения критического безразмерного касательного напряжения использовались следующие: θ_0 – по автору (если он предлагал собственное), 0,06 – по Шильдсу и 0,03 – по Копалиани [3].

На основе полученных экспериментальных данных, следуя описанному методу, производились расчеты по 84 формулам (228 расчетным зависимостям). Всего было произведено более 9000 расчетов расхода донных наносов. Оценка формул производилась с помощью критерия $\Delta = \frac{q_{T_{рвсч.}}}{q_{T_{изм.}}}$. Интервалом допустимой точности было выбрано занижение или завышение результата менее чем в два раза, т.е. $0{,}5 \le \Delta \le 2$.

Результаты выполненных расчетов показали, что ни одна из формул не дала названный результат ($0{,}5 \le \Delta \le 2$) на всех стадиях паводков во всех трех экспериментах. Формула признавалась удовлетворительной, если давала результат в пределах выбранной точности на 5 из 7 стадий первого эксперимента, 4 из 6 стадий второго эксперимента или 7 из 11 стадий третьего эксперимента (и более). Такой подход к отбору формул представляется обоснованным из-за малых абсолютных значений расхода донных наносов на первых начальных сталиях паводков. В результате расчетов были получены следующие результаты:

- 41 формула из всех не дала удовлетворительного результата ни в одном из экспериментов;
- 4 формулы дали удовлетворительный результат только для условий первого эксперимента;
- 4 формулы – только для условий второго эксперимента;
- 9 формул удовлетворили только третьему эксперименту;

Формулы, удовлетворившение всем трем экспериментам представлены в табл. 3.

Формулы А.Д. Абрахамса и П. Гао (2006) [7], Дж. Фредзо и Р. Дейгаарда (1992) [8], Я.С. Рибберинка (1998) [9], К.Б. Брауна (1950) [10] и Г. Паркера (1979) [8] также дали положительные результаты, но с различными оговорками. Это либо изменение характеристики гранулометрического состава с d на d_{50} или наоборот, либо удовлетворительный результат в каком-то эксперименте получен только для гранулометрического наносов, который, как правило, неизвестен.

Таблица 3

Формулы, давшие наилучшие результаты

Автор и формула	Примечание
Л.Г. Гвелесиани (1946) [4] $q_T = 12{,}95 \frac{dV_0}{\left(\lg \frac{12d_{\max}+d}{d}\right)^2}\left(\frac{V^3}{V_0^3}-1\right)\left(\frac{V}{V_0}-1\right)$ кг/с/м $V_0 = 3{,}4 \frac{\lg\left(\frac{8{,}8H}{d}\right)}{\left(\lg \frac{12d_{\max}+d}{d}\right)}\sqrt{d}$ м/с	Формула дает хорошие результаты на 5 из 7 стадий первого эксперимента и 4 из 6 стадий второго эксперимента при обоих видах грансостава, в третьем эксперименте на 7 из 11 стадий, поэтому мы можем рекомендовать вести расчеты по ней, используя во всех случаях грансостав донных отложений.

И.И. Леви (1957) [5] $q_T = 0{,}00076\left(\frac{V}{\sqrt{gd_{50}}}\right)^3 (V - V_0)\left(\frac{d_{90}}{H}\right)^{0,25}$ м^3/с/м для квадратичной области ($\mathrm{Re}_d > 25$, $d_{50} > 1...1{,}5$ мм): $V_0 = \left(\frac{d_{50}}{d_{90}}\right)^{0,1} \frac{C}{\sqrt{g}} V_{*0}$ м/с $V_{*0} = 0{,}16\sqrt{\left(\frac{\rho_T}{\rho} - 1\right) g d_{50}}$ м/с	Формула дает хорошие результаты 5 из 7 стадий первого эксперимента и 5 из 6 стадий второго эксперимента для обоих видов грансостава, в третьем эксперименте на 10 из 11 стадий. Это позволяет рекомендовать расчеты по ней с гранулометрией донных отложений. Поправочный коэффициент при неразмывающей скорости на неоднородность гранулометрического состава $V_0 = \left(\frac{d_{50}}{d_{90}}\right)^{0,1}$ не дает существенного улучшения результата, поэтому можно его не вводить.
Г.И. Шамов (1952) [4] – с поправкой при неразмывающей скорости на неоднородность грунта Лазарева и Чернышова [6]: $q_T = a\sqrt[3]{\bar{d}^2_{\max}}\left(\frac{V}{V_0}\right)^3 (V - V_0)\left(\frac{d}{H}\right)^{0,25}$ кг/с/м $V_0 = 3{,}83\left(\frac{d_{50}}{d_{90}}\right)^{0,2} d^{\frac{1}{3}} H^{\frac{1}{6}}$ м/с	Формула дала хорошие результаты на 5 из 7 стадий первого эксперимента с поправочным коэффициентом и 5 из 6 стадий второго эксперимента с поправкой и без поправки, в третьем эксперименте – на 7 из 11 стадий только без поправки.

Таким образом, из выполненного выше анализа следует, что в расчетах расхода донных наносов на горно-предгорных реках при бесструктурной форме транспорта наносов можно рекомендовать использовать формулы: Л.Г. Гвелесиани (1946), И.И. Леви (1957) и Г.И. Шамова (1952).

ВЫВОДЫ И РЕКОМЕНДАЦИИ

В результате выполненных исследований можно сформулировать следующие рекомендации.

Для расчета начальных условий сдвига донных частиц (неразмывающей скорости) целесообразно использовать зависимости (3) и (4).

Расход донных наносов при структурной (грядовой) форме перемещения частиц можно рекомендовать рассчитывать по формуле (8).

При безгрядовой форме перемещения донных наносов в горно-предгорных реках расход донных наносов рекомендуется считать по формулам Гвелесиани (1946), Леви (1957) и Шамова (1952).

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THE INFLUENCE OF BED CROSS SECTION ON THE HIDRAULIC ELEMENTS OF FLOW

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ABSTRACT: The privisions allow to determine discharge and average speed in bed for Newton and non-Newton fluids, in the difference cross section prismatic bedsin condition of equal and non-equal motion.

KEYWORDS: Newton and non Newton fluids, speed of flow, equal and unequal motion.

INTRODUCTION

With interaction of flow and bed establish some connection between its hidrulic and geometric charachteristic, which given rise to scientist-researchers works.

In process of evaluting of stable forms of water bed many scientists base of criterial equations recieved on the base of stability theory. It is clearly in process of evaluting of stable forms of water bed is necassary to be protected limit eqilibrium condition, as in its cross section, as on the transit sections completely.

With analysis of depiction of the study is established, that main criteria of bed form stability represented with so called form parameter and expresses mutual correlation of flow width and depth. Due to difficulty of the proces to evaluation of the stable form of the water flow bed could not with laws of mechanic and requies to conduct experiment and field research.

MAIN PART

For any form cross section bed may use by methodic, in this works [1,2,3], where charachteristic of the cross section is replaced with image.

$$\frac{H^3 B}{3} = I_{\text{gr.}}, \qquad (1)$$

where: $I_{\text{gr.}}$ is rolling moment of inertia of rectangular cross section (in the given case for prismatic channel having rectangular cross section), when $B/H \to \infty$, dischharge of Newton fluid flow determines with dependent:

$$Q = \frac{gH^3 iB}{3\nu}, \qquad (2)$$

where $\nu = \frac{\mu}{\rho}$ – is kinematic coefficient of viscosity; μ - dynamic coefficient of viscosity; γ – fluid volume weigtht ; $\rho = \frac{\gamma}{g}$ – density of homogenous fluid; g – acceleration of gravity.

Because we consider noted model is advisable integrate to make in gradient lay space and not on whole depth of flow, because speed in the flow inner border is constant, so we will have:

$$Q = \frac{BH^2}{\tau_{\text{bot..}}^2} \int_{\tau_{\text{bot..}}}^{\tau_0} \frac{\tau(\tau_0 - \tau)}{\mu} d\tau .$$

So $\tau_c = \gamma Hi$ and $\tau_0 = \gamma hi$ taking into account these dependeces after integrate we will have:

$$Q = \frac{BgiH^3}{\nu} f(\beta), \tag{3}$$

where $f(\beta) = \frac{\beta}{2}(\beta^2 - 1) + \frac{1}{3}(1 - \beta^3)$; $\beta = \frac{h}{H}$ – relative depth.

In this case, instead of (2) and (3), we will have:

$$Q = \frac{giI_{\text{gr.}}}{\nu}, \tag{4}$$

$$Q = \frac{giI_{\text{gr.}}}{\nu} f(\beta). \tag{5}$$

Justice of these replacments for Newton fluids, which noted second flows, is argumented in the publications [2, 4]. Same raplacement more justice is for non Newton fluids, where in conditions of high meaning of viscosity and on time of movement flow existing initial impedance arise died (so called stable) zones in corners existing between bed butom and walls. In both cases, this phenomena in the live cross caused, sharp distribution as normal, also tanget voltage.

In condition of consider of one-dimensional phenomen(hidraulic) is necessary operation in the cross section border. Also with average charachteristic of tangent voltage, such as it is accepted in hidraulic (discharge, average speed in cross and so on).

In such condition average speed for Newton and Non-newton fluid suitable will be :

$$V_0^{\text{n.}} = \frac{Q_{\text{n.}}}{\omega} = \frac{giI_{\text{n.}}}{\nu\omega}, \tag{6}$$

$$V^{\text{n.n.}}{}_0 = \frac{Q_{\text{n.n.}}}{\omega} = \frac{giI_{\text{gr.}}}{\nu\omega} f(\beta), \tag{7}$$

where: ω – Live cross-sectional area of the flow.

Note the rolling radius of the inertia in the image:

$$i_{\text{gr.}} = \sqrt{\frac{I_{\text{gr}}}{\omega}}. \tag{8}$$

Instead of (6) and (7) will be:

$$V_0^{\text{n.}} = \frac{gii_{\text{gr.}}^2}{\nu}, \tag{9}$$

$$V_0^{\text{n.n.}} = \frac{gii_{\text{gr.}}^2}{\nu} f(\beta). \tag{10}$$

$I_{\text{gr.}}$ – numerical valeu for various form cross section spools is given in the directory of resistance of materials. For example, for rectangular form cross section canal may use with ratio [5].

$$I_{\text{gr.}} = k_1 \cdot B \cdot H^3, \tag{11}$$

where k_1 – is proportionality coefficient.

The numerical value of this coefficient see in the table.

Table

k_1 The numerical value of coefficient B/H regarding to ratio

B/H	1.0	2.0	3.0	4.0	10.0	∞
k_1	0.141	0.229	0.263	0.281	0.312	0.333

Determination of proportionality coefficient may also with follow approximate dependence:

$$k_1 \approx \frac{1}{3+2(H/B+H^2/B^2)}. \qquad (12)$$

For wide rectangular form bed – $k_1 = \frac{1}{3} \approx 0.333$.

From $Q = B\frac{H^2}{\tau_{\text{bot.}}}\int_{\tau_{\text{bot.}}}^{o} \tau f(\tau)d\tau$ taking into account ($I_{\text{gr.}} = k_1 \cdot B \cdot H^3$) and $\omega = BH$ we get:

$$i_{\text{gr..}}^2 = k_1 H^2 \qquad (13)$$

or

$$H = \frac{i_{\text{gr.}}}{\sqrt{k_1}}. \qquad (14)$$

CONCLUSION

The provisions give us possibility, to determanedischarge and avarege speed of flow in cross for Newton and Non Newton fluids, in different cross section form prismatic bed, in condition of equal and non equal motion in case of apropriate regime.

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GLOBAL CLIMATE CHANGES AND SOME ANOMALOUS HYDROMETEOROLOGICAL EVENTS IN AZERBAIJAN

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ABSTRACT: In the article there have been discussed global climate changes and natural hazards for their influence. Also there have been analyzed some anomalous hydrometeorological processes occurred in Azerbaijan over last years.

KEYWORDS: climate changes, storms, hydrometeorological events, extreme temperatures, natural hazards.

Natural hazards are severe and extreme weather and climate events that occur naturally in all parts of the world. Natural hazards become natural disasters when people's lives and livelihoods are destroyed. Human and material losses caused by natural disasters are a major obstacle to sustainable development. Over the last century global climate changes and its regional manifestations continue threat to sustainable development. Extreme hydrometeorological processes, occurring as a result of the global climatic changes resulted in severe hazards and disasters, including floods, mudflows, deserts, typhoons, squalls, intensive rainfalls, forest fires, sea level risings.

Recently, the whole world economy has considerably been damaged by the climate change influence. Over the last decade frequency of hazards and their impacts on economies is getting increased continuously. a number of hazards for hydrometeorological processes on different zones of Earth, a quantity of their damages in several governments' economy increase continuously. According to official sources, in 1960ths, total economic losses from disasters was only 3-4 billion of USA dollars, while recently this number consists of 600-700 billion USA dollars.

According to World Meteorological Organizations, 80-85% of hazards have hydrometeorological origins, and in 1991 – 2000 y.y. a total number of hydrometeorogical and geophysical hazards over the world has been 2567 p., a number of people, died from hazards, has been 665598 p., 2107401 people have been damaged for hazards, a quantity of damages has been consisted of approximately 786.8 billion USA dollars. A number of floods has been 888, a quantity of the damages has been consisted of 272.8 billion, a number of droughts – 223; a quantity of the damages – 30.5 billion; a number of extreme temperatures – 112; a quantity of the damages – 16.7 billion USA dollar; a number of forest fires – 123; a quantity of the damages – 26.3 billion USA dollars, a number of squalls – 748; a quantity of the damages – 198.2 billion USA dollars, a number of Earth earthquakes – 221; a quantity of the damages – 239.8 billion USA dollars and.

It is important to note that 2010 has been warmest year for the last century over the world and the 2000-2010 have been noted as a warmest decade. During 2000-2010 an average annual temperature in comparison with the period of 1961- 990 has been increased by 0.5°C.

In 2004 squalls, occurring in Atlantic Ocean, have been considered as harmful squalls of the history

for their continuance, power and frequency. The damage for such squalls over one year has been consisted of 45 billion USA dollars for USA government. On the whole, squalls of 2004 y. have ended 3100 human life.

In 2005 y. over the last 10 years there have been observed unprecedented droughts in Europe, Asia, Australia, Brazil, at same time squalls on the Central American shore of Atlantic ocean, also other hazards in different regions and all of them has been resulted in social – economical destruction and human death. Only over 2005 y. the world economy has been damaged for these hazards on 200 billion USA dollars.

The increasing of extreme temperatures, global warming, droughts result in the formation of dry meteorological conditions and negatively influence to the agriculture; the cattle –breeding farming and the medicine fields, stop the sustainable development, yet contribute to the formation and the distribution of morbidities. All of these problems increase the human demand to the nourishment products and accordingly, the world deficit danger. For WMO experts, in generally, a number of people died for the food deficit over the world consists of 5.8 million per year. At the same time extreme temperatures, seasonal temperature changes, warm waves, solar impacts contribute to the great number of human death on different regions of the world. For example, 1998 y. is considered as one of warmest years and in this year only in Shanghai city a number of people, died for the solar impact, has been increased on 300%. Over the last period same number continuously increases in Central and Eastern Europe countries. Only in Europe over the 2003 y. summer the warm waves has ended the life of 35000 people. At the same time investigations show that over 1997-2000 y.y in winter months a number of died people has been consisted of 165000 p., this number has been more than that in summer of same period. Naturally, such warm stresses more expose it in big cities.

The dependence of different infrastructural fields of the economy the agriculture from hydrometeorological condition increases day by day. The result of numerical investigations shows that in result of uncomfortable weather condition the 65% of damages is in the agriculture of the world economy.

All of these problems give evidence that the climate change is a real danger for the humanity and it enforces the world community scientists and politicians to take a great attention to these problems. It is not occasional, that today there is not any high level governmental counsel, where problems, regarding on climate changes and their hazards, have not been included to agenda.

The abovementioned brief analysis of researches on global and regional climate changes problems once more shows this problem is difficulty, multi- side and not found its resolution.

The contemporary scientific-technical progress, the human factors aren't able to prevent hazards and their consequences over Earth, but they can correctly forecast them by the study their forming reasons. It enables to minimize the damage in both world economy and different regions economy, yet to prevent numerical human death.

Here only over 2010 in this point of view the increasing of the dynamics of different types of hazards, connecting with hydrometeorogical processes, is observing also in the territory of our republic, which has regional physic-geographical, climate condition.

It will be enough to indicate mudflow hazards in the Kura-Araz basin and their damages in the country economy. The climate of Azerbaijan's territory is the part of the global climate system and in this system all of processes influences to the climate condition of the country by different intensity and different time period. So, the research of climate changes, the studying its influence to different fields of the economy and the definition of adaptation possibilities in economical system have became one of important problems also for Azerbaijan's territory and its economy.

In Azerbaijan Republic, the following hazards types are being observed more frequently: mudflows, floods; strong breezes, squalls, hail cloudburst, desertification, forest fires, soil erosion etc.

The following are some anomaly hydrometeorological events, which are observing in Azerbaijan over last years:

- The December of 2002 was observed as the coldest month for the last 100 years. So, the minimal temperatures both at night and in the afternoon for Nakhichivan were – 30°C.
- In 2003 in March 5 and 6 there has been observed rare natural events. In Dashkesen the strong warm wind and storm have formed hazards: there happened forest fires and one village has been burned.
- In 2004 the strongest hail process in the territory of the republic on 21 June has been observed. The maximum size of the hails as the ice parts reached to 10 cm in Lahich of Icmayilli region.
- For 2005 year in the third date of month in Belokani happened abnormal hailstone that were not observed in a history of this edge, large pieces of ice dropped out. In 2005 with sharp rise of a water level on water basins of republic the position has come nearer to a critical limit. So, on Mingechaur water basin the maximum level has reached 82.53 m, which all on 43 sm of below maximal design level. And on Araz water basin, 18-th the level has reached May 777.85 m which, even is higher than a normal design level.
- In 2007 year the average annual temperature of air was 0.6-0.7°C below the norm. In that case mean monthly temperatures in July, November and December were below the norm temperature, in the other months above that one.
- In 2008 year in January the average annual temperature were the lower the norm on 8-9°C, but in February on 3-4.5°C. On 8 January there was fixed the least temperature -8.7°C for the last 100 years in Baku. The minimal temperature fixed in 1935 was 8.1°C; but on contrary the average temperatures for March and April, were higher than normal annual norm, on 8-11 and 5-7°C. The maximal temperature for March for the last 100 years (30.8°C) was observed on 31 March of 1952.

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Hydrology and meteorology

CALCULATION METHODS FOR PEAK FLOOD DISCHARGE OF RIVERS IN WESTERN GEORGIA WITH IMPORTANT GENERATION CAPACITY

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Georgia is considered one of the richest regions with regard to water power resources not only among the former Soviet countries but also among many countries throughout the world.

According to the specific weight of the hydropower potential, Georgia is assessed at 195 milliard kilowatt-hours; however local hydroelectric power plants produce only 10-12% of this potential today. Specific water content per 1 km^2 in Georgia equals 24.4 *l* per second, which leaves behind the former Soviet countries as well as France (19.7) Brazil (11.9), Canada (24) and Czech Republic (7.0).

In many economically developed countries water resources are almost completely developed, e.g., USA – 47%, France – 90%, Japan – 85%, Switzerland – 82,5%, Italy – 70% and former USSR – only 18%.

There is a good basis for the development of large and small-scale power generation in Georgia, because the country is rich in water resources – there are about 26 000 rivers with the total length of 59.8 thousand km in Georgia. The total volume of their streamflow is ≈ 65 km^3.

Today, it is necessary to discuss the issues associated with the protection and efficient use of water resources to optimally control the resources of storage reservoirs and rivers, protect the environment from the catastrophes caused by floods. The present study serves this purpose.

To ensure calculation of peak flood discharges and forecasting, calculating relations have been specified by means of determining the correlation between the principal factors causing it. These calculating relations make possible to assess the combination of local acting factors in whole, partially assess each acting factor, choose the sought quantity (peak discharge) as a function of all factors, and choose the most efficient one.

The complex orographical features of West Georgia, the frequent and abundant atmospheric precipitations often cause several floods on rivers each year and formation of flowages.

In the period of flowages and floods, which often have the character of natural calamities, the majority of rivers floods the adjoining territories, causes material damage to economic and production facilities and sometimes exposes a corresponding region to a serious ecological hazard [1].

To solve this important problem, many water management calculations have been made, which enable us to make the peak discharge calculation, based on strict statistical analysis of the initial observation materials and the factors which influence the peak water discharge, more precise and predictable.

It should be noted that that the numerous existing methods for the calculation of peak water discharge are of regional character [2,5,7] and/or it's too difficult to calculate the characteristics foreseen in these methods [3,6], which need to be developed, especially with regard to mountain rivers.

To achieve the specified object, a method of multiple correlations [4] has been used, which makes it possible to assess the factors in whole or each one separately. Besides, this method enables us to consider the sought quantity (peak discharge) as a function of all factors and choose the most efficient one.

The principal determining factors of this phenomenon have been chosen, where the functional relation is:

$$M_i = \mathrm{f}(F, Q, A, L, I_{avg.}, H_{avg.}, i, X), \quad (1)$$

where: M_i is the maximum modification of streamflow (l/sec km^2); F – area of a catchment basin (km^2); Q – peak water discharge (m^3/sec); A – forest areas of a catchment basin (%); L – river length (km); $I_{avg.}$ – average river fall; $H_{avg.}$ – average altitude of catchment basin (m); X – precipitation in flood periods (mm).

The objective method of multiple correlation and normalization makes possible to exclude the factors from the equation of regression curve, the portion of which does not exceed the relation of the total coefficient of correlation to the duplicate value of average square inaccuracy ($2R^2/R_0^2$), because they are considered to be inefficient.

To form the sought regressing equation (1) the following factors were chosen from the fundamental quantities within the function and the relation became:

$$M_i = \mathrm{f}(x, H_{avg.}, L). \quad (2)$$

In consideration of everything mentioned above, the equation of regression curve will be:

$$\tilde{U}_0(M_i) = \mathrm{a}_{01}\tilde{U}_1(x) + \mathrm{a}_{02}\tilde{U}_2(H_{avg.}) + \mathrm{a}_{03}\tilde{U}_3(L), \quad (3)$$

where $\tilde{U}_0(M_i)$, $\tilde{U}_1(x)$, $\tilde{U}_2(H_{avg.})$, $\tilde{U}_3(L)$ are normalized variables and a_{01}, a_{02}, a_{03} are regression equation coefficients.

To determine the streamflow peak discharge (Mmax) the diagrams of initial data $\tilde{U}(M)$, $\tilde{U}_1(x)$, $\tilde{U}_2(H_{avg.})$ and normalized variables $\tilde{U}_i$ (fig. 1), where drawn up. The regression equation based on processing these data and variables looks like:

$$\tilde{U}_0(M) = 0.568\tilde{U}_1(x) - 0.338\tilde{U}_2(H_{avg.}) - 0.203\tilde{U}_3(L). \quad (4)$$

The analysis of the obtained results demonstrates that the role of atmospheric precipitation in the formation of peak water discharge is 58%, river length – 28% and the average altitude of a catchment basin – 14%. The following correlations were attained on the basis of the graphical relations drawn up:

$$\tilde{U}_0(M_i) = 2.65\lg M - 7.36, \quad (5)$$

$$\tilde{U}_1(x) = 5.66\lg x - 10.9, \quad (6)$$

$$\tilde{U}_2(H_{avg.}) = 5.95\lg H_{avg.} - 4.46, \quad (7)$$

$$\tilde{U}_3(L) = 2.66\lg L - 18.9. \quad (8)$$

In consideration of the attained (5), (6), (7) and (8) correlations the equation will be:

$$M_{\max} = 2240K \ (l/\mathrm{sec\ km}^2), \quad (9)$$

where $K = 10^{1.211gx} - 0.76\lg H_{avg.} - 0.28\lg L$, and the correlation depicted as peak discharges will be

$$Q_{\max} = 2.45KF \ (\mathrm{m}^3/\mathrm{sec}), \quad (10)$$

where F – is the area of a catchment basin (km^2). With regard to the practical use of the empiric relation (9) the calculated values were compared with the actual data. The analysis of the comparison is given in Tab.1.

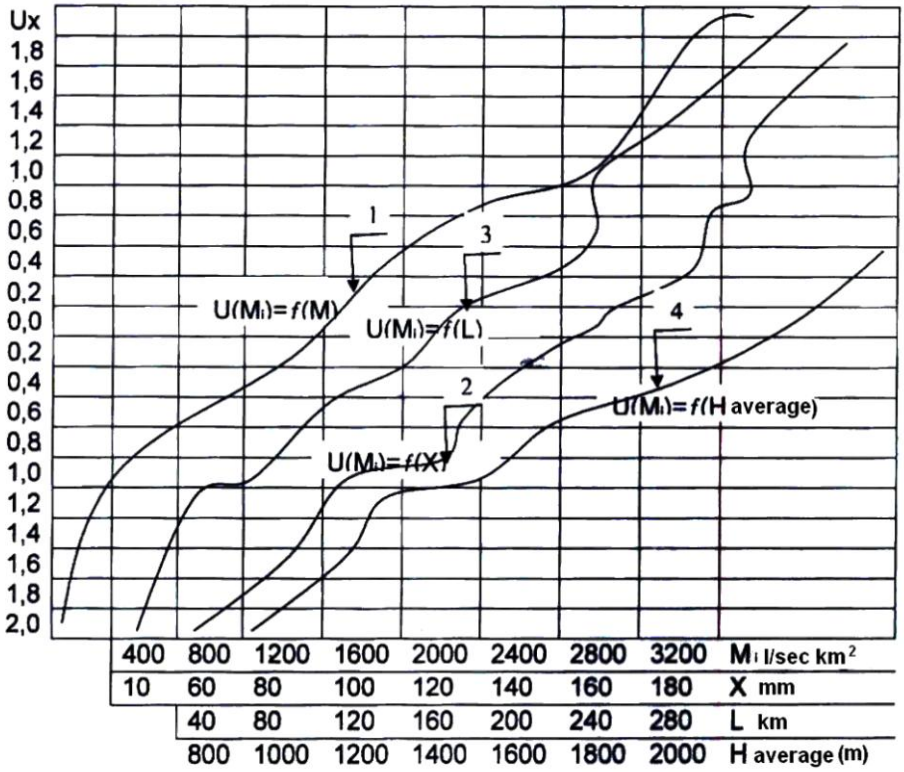

Fig. 1. $\tilde{U}_x = f(M, L, x, H)$ **Relation Diagram**

Table 1

N	River, section	Actual M, *l*/sec km^2	(9) Relation based M, *l*/sec km^2	River fall %
1	Bzipi /Jirkhva Village/	740	540	27.0
2	Kodoti /Lata Village/	869	619	28.7
3	Enguri /Khaishi Village/	410	399	2.8
4	Enguri /Darcheli Village/	420	360	14.3
5	Enguri /Jvari Village /	280	238	15.0
6	Rioni /Utsera Village/	20	217	1.5
7	Rioni /Alpana Village/	320	307	5.3
8	Rioni/Sakochakidze Village/	350	286	18.2
9	Lajanuri /Orbeli Village/	380	378	0.5
10	Kvirila /Zestaponi/	500	655	23.
11	Dzirula/Tseva Village/	500	787	36.4
12	Sulori /Salkhino Village/	990	810	18.2
13	Tskhenistskhali/Nagomari Village/	470	488	3.7
14	Tskhenistskhali/Khidi Village/	370	318	14.0
15	Tekhura/Nakalakevi Village/	940	664	29.4
16	Supsa/Chokhatauri Village/	920	657	28.6
17	Natanebi/Natanebi Village/	1510	1958	22.1
18	Kintrishi/Kokhi Village/	1720	1850	7.0
19	Acharistkhali/Khulo Village/	490	461	5.9
20	Machaxela/Sindieti Village/	1190	1279	7.0

The river fall doesn't exceed 21%, the correlation coefficient equals 0.90; and the regression coefficient is 0.93.

Thus, the peak water discharge calculation formulae obtained by us, which enable us to easily and rapidly calculate the volume of peak water discharge of centennial periodicity for the region to be studied as well as for the rivers of regions with similar physical and geographic conditions. Consequently, these formulae make easier to design water facilities and hydraulic structures of multipurpose water bodies and preparing their project feasibility studies.

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Hydraulic engineering and irrigation

COMBINED WATER INTAKE-PURIFICATION FACILITIES FOR MOUNTAIN RIVERS

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ABSTRACT: The article provides comprehensive description of new design solutions for combined water intake-purification facilities aimed at collecting and using highly turbid river from Mountain Rivers for water supply. The intake facility proposed in this article allows water collection from riverbed thereby ensuring its filtration and sedimentation process. The article also contains a layout of the extended purification plant with new design accompanied with appropriate hydraulic calculations.

KEYWORDS: water intake-purification facilities, filtration, sedimentation, hydraulic calculations.

Гидротехника и Мелиорация

ВОДОЗАБОРНО-ОЧИСТНЫЕ СООРУЖЕНИЯ ДЛЯ ГОРНЫХ РЕК

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Для целей водоснабжения используют поверхностные воды рек, озер, каналов водохранилищ и прудов. Однако в преобладающем большинстве водоотбор осуществляется из рек, и поэтому чаще всего приходится решать задачи устройства и эксплуатации водозаборов на реках. Учитывая высокое качество воды горных рек, в последнее время для водоснабжения предгорных населенных пунктов строятся горные водозаборные сооружения, что в силу особых природных условий довольно сложно.

Решение общих водохозяйственных задач водозаборных узлов и конструкций сооружений для горных рек имеет специфический характер. Большое количество донных и взвешенных наносов, а также плавника, которые несут с собой горные реки, требует специальных устройств для защиты от них водоприемника.

При повышенных требованиях к качеству воды необходимо осаждение, в первую очередь, крупных взвешенных наносов. Для этого устраиваются отстойники значительных размеров, удорожающие строительство и эксплуатацию водозаборного сооружения. Борьба с донными наносами ведется в русле реки с использованием внутренней структуры речного потока и конструктивных особенностей водозаборного сооружения. Забор воды из рек после заиления верхнего бьефа гидроузла сопровождается интенсивным поступлением в систему взвешенных и донных наносов. Поэтому для забора воды иногда применяются фильтрующие элементы [1].

Фильтрующие водоприемники с песчано-гравийной и другой зернистой загрузкой хорошо очищают забираемую воду, но обладают такими недостатками, как быстрая кольматация загрузки и

трудная ее промывка. В связи с этим и по результатам исследований эксплуатационных режимов действующих водозаборных сооружений на горных реках Азербайджана авторами разработана новая конструкция водозаборного сооружения [2, 3]. Предлагаемая конструкция по существу является водозабором, отстойником и фильтром, которые совмещены в одном сооружении. Она предназначена для одновременного забора воды из рек в целях водоснабжения и орошения, а также предварительной очистки потока для технических нужд непосредственно в русле реки. При этом забор воды осуществляется из поверхностного слоя речного потока и обеспечиваете; надежная рыбозащита сооружения. На рисунке 1 приведены план и разрез разработанной конструкции.

Сооружение представляет собой водоприемно-отстойную камеру с боксовыми заборами воды. Боковые водоприемные окна оборудованы каркасами из металлических стержней, которые заполняются крупными гранулами вспененного полистирола или шунгизита. Следовательно, в данной конструкции одновременно с отстаиванием происходит фильтрование забираемой воды.

Водозаборно-очистное сооружение состоит из следующих конструктивных элементов: водосбросная плотина 7, промывной шлюз 2, криволинейный порог 3, щитовая плотина 4, водозахватная галерея 5, полые удлиненные быки 6, разделительная стенка 7, фильтрующая плавающая загрузка 8, крышка для управления промывкой 9, щиты для промывки отложений 10, затвор для регулирования фильтрационного режима 11, отводящий канал 12.

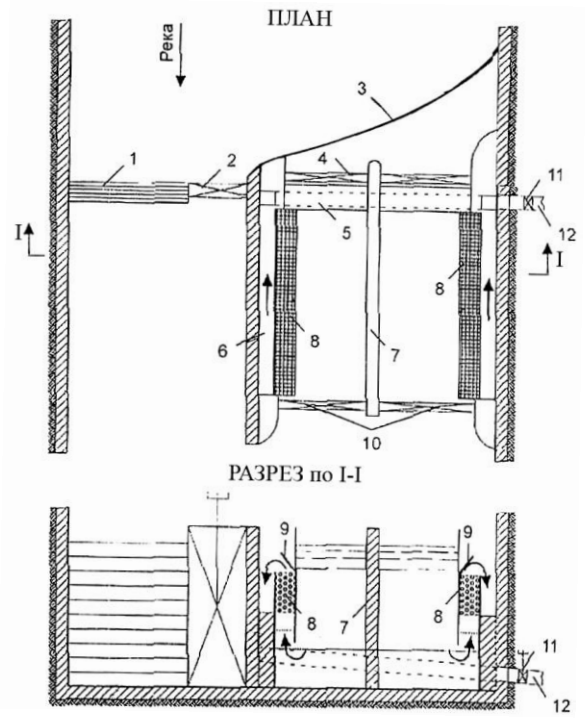

Рис. 1. Новая конструкция предлагаемого фильтрующего горного водозаборного сооружения

Водосбросная часть сооружения позволяет осуществить сброс паводкового потока и тем самым создать требуемый уровень воды в камерах между полыми быками для забора воды. Криволинейный порог обеспечивает направление донных наносов к промывному шлюзу, уменьшая поступление их в щитовую плотину [4]. Фильтрующие секции сверху снабжены специальными крышками, которые при работе фильтров полностью открываются, а при промывке фильтрующих элементов закрываются и открываются поочередно.

Сооружение работает следующим образом. Речная вода поступает через щитовую плотину 4 в отстойные камеры и далее, проходя фильтрующую загрузку 8, переливается в лоток 6 внутри полых быков и направляется в отводящий канал 12. При этом речная вода на первой стадии отстаивается в камерах сооружения и фильтруется через фильтрующую плавающую загрузку.

При забивании фильтрующей плавающей загрузки останавливается работа одной из камер для промывки и действует другая. Для промывки камеры от отложений открываются промывной щит 10 и щитовая плотина 4. При таком режиме речная вода, выходя из-под щитовой плотины 4, с большими скоростями промывает отложения в камере и транспортируется в нижний бьеф водозабора. Фильтрующие загрузки промываются за счет чистой воды, забираемой из соседних работающих камер.

С этой целью затвор 11 закрывается, и осветленный поток из водозахватной галереи 5 поступает в промываемый лоток 6 и далее, переливаясь на плавающие загрузки 8, промывает его.

Для ускорения промывки закрываются крышки 9 всех фильтрующих загрузок, и только одна секция оставляется открытой. Это позволяет направить весь промывной поток в одну секцию и добиться большой интенсивности промывки. Скорость фильтрования предлагаемого сооружения можно регулировать с помощью задвижек 11.

Внедрение предложенных конструкций водозаборно-очистных сооружений с плавающей фильтрующей загрузкой для водоснабжения и различных типов орошения позволяет существенно снизить капитальные и эксплуатационные затраты. Эта конструкция проста, не энергоемка и не требует специальных устройств для регенерации фильтрующих загрузок. Водозаборно-очистное сооружение можно построить на старых, реконструируемых водозаборах донно-решетчатого типа, так как их нижний бьеф в первое время подвергается интенсивному размыву, а также имеется место для размещения камеры отстаивания.

В настоящее время для осветления высокомутных поверхностных вод широко применяются традиционные радиальные и горизонтальные отстойники.

В зависимости от требуемой степени осветления воды, размеры известных конструкций отстойников иногда получаются большими и при этом условия смыва наносных отложений сильно ухудшаются. Большие размеры (длина и ширина) отстойников делают затруднительным удаление отложений гидравлическим способом, уменьшается уклон дна и увеличивается требуемый расход воды на промывку [5, 6, 7].

Для осветления высокомутных поверхностных вод можно применить конструкции линейно расширяющихся многокамерных отстойников в веерообразном виде [8].

Преимущество веерообразного отстойника выражается в уменьшении размеров входных устройств, в развитии длинны отводного водослива и в более равномерном распределении наносов по длине камер и улучшения условий его работы. Для интенсивной промывки расширяющихся отстойников их разделительные средние стенки оборудуются промывными каналами (рис.1). Промывные каналы располагаются по обеим сторонам средней стенки. По длине промывного канала установлены плоские затворы, а боковая стена со стороны камер выполнена в виде ступеней, высота которой уменьшается по течению потока. Такая конфигурация промывного канала позволяет промывать камеры по частям.

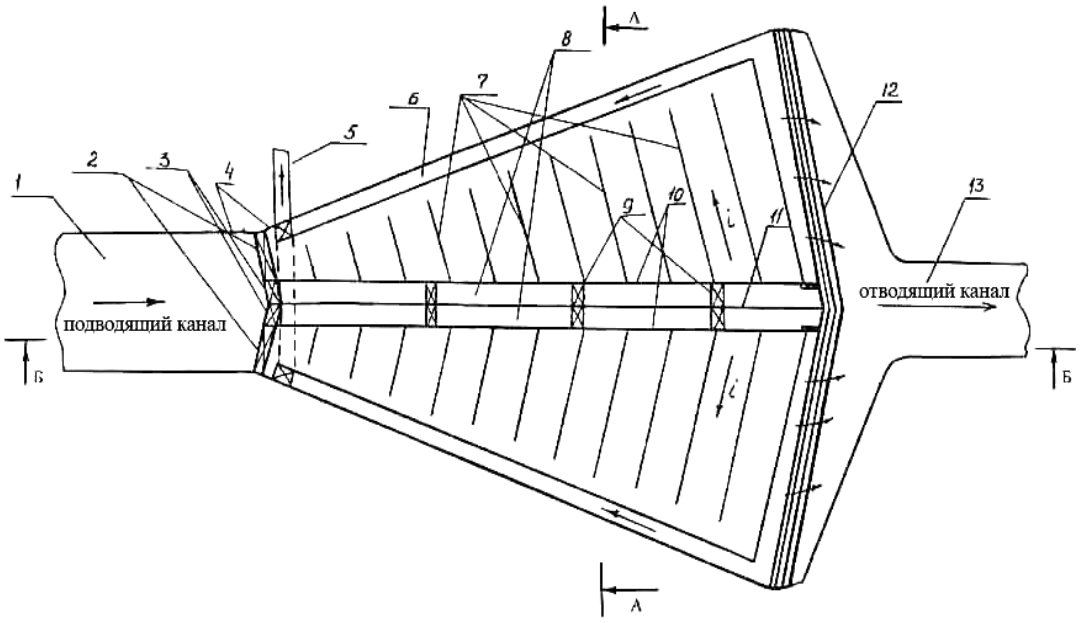

Рис. 2. Расширяющийся отстойник

В канале уменьшается высота борта; дно камеры выполняется с поперечным уклоном в сторону боковых пульпозахватывающих коллекторов; поперечный уклон дна камеры уменьшается по течению воды в камере; дно камеры обеспечено донными струенаправляющими стенками; дно камеры и боковая стенка канала стыкуются по криволинейной форме и это делается с целью полного использования энергии ниспадающего потока [9].

В составе сооружений отстойника имеются: подводящий канал 1; входной затвор 2; входной затвор промывного канала 3; промывной канал 4; пульповод 5;пульпозахватывающий коллектор 6; донные струенаправляющие стенки 7; промывной канал 8; промывные щиты 9; боковой ступенчатый водослив 10; средняя стенка 11; выходной водослив 12; отводящий канал 13. При очистке от наносов, отложившихся в камере отстойника, промывка начинается пуском воды через промывной канал в предварительно опорожненную камеру. В этом случае промывной расход подается в промывной канал 8 с помощью входного затвора 3. Перед промывом полностью опускается входной затвор 2 промываемой камеры и открывается затвор промывника 5. После опорожнения камеры открывается входной затвор 3 промывного канала и промывной расход подается в канал 8. Последовательно закрывая и открывая затворы 9, расположенные по длине канала 8 создаются условия перелива промывного расхода через ступенчатые боковые стенки в промываемые части камеры отстойника. Открытие впереди расположенного и закрытие последующего за ним затворов 9 позволяют сосредоточить сливающийся поток в промываемой части камеры и создают условия интенсивного размыва отложений на этом участке.

С целью распространения промывного сливающего потока в промываемой части камеры, дно ее обеспечено донными поперечными направляющими 7, через которые пульпа поступает в пульпонаправляющий коллектор 6. Далее при открытых щитах 4 пульпа поступает в пульповод 5.

Нами получено выражение изменения мутности вдоль расширяющегося по длине отстойника:

$$\rho_x = \frac{\frac{360^0 Q_0}{\pi\alpha W_0}\rho_0}{\left(x^2 - r_0^2 + \frac{360^0 Q_0}{\pi\alpha W_0}\right)},$$

При начальной ширине отстойника b_0 для значения r_0 можно получить:

$$r_0 = \frac{180^0 b_0}{\alpha\pi}$$

Для определения длины камеры отстойника получено зависимость в виде:

$$L = \sqrt{\frac{360^0 Q_0}{\pi\alpha W_0} \cdot \frac{\rho_0 - \rho_{вых}}{\rho_{вых}} + \left(\frac{180^0 b_0}{\pi\alpha}\right)^2}.$$

Ширина камеры в его конце определяется по формуле

$$b_k = \frac{\alpha\pi}{180}(L + r_0)$$

Необходимо отметить, что в отличии от существующего способа гидравлической промывки, в предлагаемом промывном устройстве, смыв наносов со дна отстойника происходит в двух направлениях. При этом движение промывного потока в пределах камеры происходит в двух направлениях. Первое направление – боковое по ширине камеры, от промывного лотка к пульпонаправляющему тракту, и в этом случае происходит смыв наносных отложений с

поверхности берегового откоса и дна камеры. Второе направление движения промывного потока по длине отстойника – вдоль пульпонаправляющему тракта. Здесь происходит смыв наносных отложений со дна пульпонаправляющего тракта, сбор и транспортировка пульпы бокового притока.

Расход воды в основном направлении формируется при непрерывном присоединение вдоль движения потока расхода бокового притока. Кроме того для процесса промывки и обеспечения транспортирующей способности промывного потока в основном направлении необходим начальный расход определенной величины. Для этого из верхнего бьефа из-под щита в промывной тракт пропускается дополнительный промывной расход воды.

Для мутностью промывного потока получено выражение.

$$\rho_x = \frac{A}{B} - \frac{A - B\rho_0}{Be^{\frac{Bx}{Q_0}}}.$$

где $$A = q\rho_б + \rho_{тр}U_{вз}b - \rho_{тр}nWb\,,$$

$$B = U_{вз}b - nWb + q$$

Для изучения гидравлического режима работы предлагаемого промывного устройства в лабораторных условиях были проведены модельные исследования. В экспериментальном павильоне НИИ Аз"ВОДГЕО" была построена модель фрагмента камеры отстойника с предлагаемым промывным устройством.

Результаты экспериментальных исследований показали, что при наличии предлагаемого промывного устройства обеспечивается распространение промывной воды по всей площади чаши камеры, в результате чего происходит интенсивное разрушение структуры наносных отложений и взмучивание их промывным потоком.

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Environmental protection

"GLYPHOS.ARM" WSP – NEW ECOLOGICALLY SAFE HERBICIDAL COMPOSITION FOR PROTECTION OF ARCHITECTURAL BUILDINGS

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ABSTRACT: On the base of glyphosate large usage as the system type herbicide and with the composition of ionic and none-ionic surfactants and stabilizers it was elaborated a new herbicidal preparative form "GLIFOS.ARM" 77% WSP and there were epitomized some experiments on vineyards and fruit orchards. In this paper it will be discussed the possibility of application of this new compositional preparative form for protection of architectural buildings and memorials from unregulated growth of weeds with the maximal ecological safeness.

KEYWORDS: glyphosate, herbicide, ecological protection, architectural buildings, weed control.

INTRODUCTION

A dense covering of vegetation, usually herbs, ivy and sometimes trees is a common feature on many ruined, historic monuments. Established vegetation can cause irreparable damage to historic monuments, including root damage, displacement of wall fabric and abrasion against monuments due to wind action. In some cases, the extent of the damage caused by unchecked growth can eventually present safety problems for visitors. And this situation is being well demonstrated in cities with high humidity [1].

Only approved herbicides (pesticides used to control unwanted plants) may be sold or used. Approved pesticides are given either a MAFF number (up to 09999) or a MAPP number (10000 and over). Herbicides are approved for specific fields of use, and should not be used outside the locations for which they are specifically developed. Products suitable for vegetation removal on and around masonry monuments will contain the active ingredients either Glyphosate (N- (phosphonomethyl) glycine) or Triclopyr (3,5,6-Trichloro-2-pyridinyloxyacetic acid). Glyphosate is non-selective; therefore it will target all vegetation with which it is in contact. Triclopyr controls woody and broad leafed species (such as ivy) but will have minimal effect on surrounding grass, for example. Mentioned herbicides can be used in conjunction with an approved adjuvant, which reduces surface tension and assists in the absorption of the herbicide into the plant organism, increasing the effectiveness of herbicide activity.

According to this situation in agrochemical practice there is a very actual problem of creation and application of a new economically and toxicologically effective and a comparably safe pesticides, with low volumes of consumption in correspondence to the strong influence on not targeting organisms and other environmental objects. Based on this all, the central attention is being paid permanently to elaboration of system herbicides of a total effect, especially with chemical base of organochlorine compounds [2].Based

on an ecological rationality and efficiency, an interest of plant protection specialists to this class of herbicides is not being decreased within the period of last years.

The activity of many types of preparative forms like this not so rare is being combined with low level of penetration possibility inside of plaint organism and with low level of water resistance in general. All of listed negative effects can lead to decrease of herbicide final effect. Moreover, the irritative influence on human eyes and skin and the toxicity can become a cause of some serious problems while the usage of current preparative form of herbicide.

As it was shown during the research in our laboratory, all mentioned above effect are predominantly determined by SAS (Surface Active Substances) and not by the main effective component of herbicide. So, MON 1808 (the composition of water solutions of etoxylated fate amines and etylenglycole) has LC_{50} for water animals -6,5mg\kg, which is the limit concentration for the SAS toxicity. Etylenglycole is toxic, and it can lead it to an appearance of renal pathologies of animals, while the inbreathing of this substance and while the per oral contact with compound. This substance is genotoxic too. Etoxylated fate amines have iritative influence of eyes and skin. Besides, sometimes SAS can be antagonists for active component [3].

Usage of household SAS can as well as possible give a solution of this problem. So, in Yerevan Science-Production Organization "Agroscience", in collaboration with SEUA (State Engineering University of Armenia) there where investigated, elaborated and certificated a new herbicidal composition "GLYPHOS.ARM" WSP in form of 77,7% Na-salt of Glyphosate, in correspondents to 360g\l of Glyphosate [4] and in collaboration with Yerevan State Medical University there were epitomized experiments and measurements of ecological, toxicological and hygienic parameters of "GLYPHOS.ARM" WSP preparative form [5].

EXPERIMENTAL PART

"GLYPHOS.ARM" WSP, which was elaborated in our laboratory, consist of: (mass/%) Na - salt of Glyphosate – 77.7; Non ionogenic SAS (Ethoxylated alcohols) – 1…2; Ionogenic SAS (salts of alkyl sulfonic acids) – 2…3; Polyethylene glycol – 2…2.5; Film-forming additives and thickeners – 1…1.5; Excipients – under 100%.

"GLYPHOS.ARM" WSP is based on a compound from the class of organophosphorus compounds, which are being broadly used by agroindustry as the herbicides, insecticides, nematocides and defoliants. According to the results of tests for identification of current herbicidal composition residual concentrations and the products of degradation of "GLYPHOS.ARM" after the sowing it was not discovered any infringements of standards of Republic of Armenia. This herbicidal composition is a comparably unstable xenobiotic, because of what the rout system of plant can be saved for next year and gives a new generation. After the implement of this preparative form of herbicide there were epitomized numerous measurements of residual quantities of it in water, alfalfa hay and spring barley grains.A different concentrations of "GLYPHOS.ARM" WSP were tested in Qanaqeravan fruit orchards within the period 2011-2012, during the weeds growth phase, when the length of weed did not exceed 30cm. All experiments and calculations were epitomized in correspondence to standards with fourfold repetition for every 100 m^2 on most common weeds of this territory: *Cynodondactylon,* from monocots and Chenopodiaceae, *Amaranthus*, *Adonis, Seneciorhombifolius, Portulaca grandiflora* from dicots. The average results after 3 sprays are being presented in Table 1.

In aspect of the ecological safety positions the fact of absence of herbicide in all types of listed probes is very important. This preparative form is being totally inactivated during 16 days in the soil after the spraying of plants by it. That is why this compound could be evaluated as the xenobiotic with non significant effect on an environment and ecosystems. Probably, weeds cannot gain resistance against it.

In a Yerevan State Medical University's Laboratory of Environment Hygiene and Toxicology there were given some characteristics of this herbicide as the eco-toxicologically important substance. The evaluation of economical efficiency of "GLYPHOS.ARM" WSP which is based on a Glyphosate was given too. It was shown that this herbicide is low toxic substance (3 class of danger according to the hygienic classification of toxic compounds by World Health Organization).

Table 1

"GLYPHOS.ARM" WSP usage results in fruit orchards in 2011 – 2012

Variant		Quantity of Weed's Units per 1m^2 and The Decrease of It				Number of Weed's Lesions per 100 m^2
		Annual and Biannual Plants		Perennial Plants		
Control		*Monocots*	*Dicots*	*Monocots*	*Dicots*	
		Fruit Orchards				
		31	44	4	6	11
"GLYPHOS.ARM" WSP	1.5kg/ha	10(68)	15(66)	4(0)	3(50)	4
	2.0 kg/ha	5(84)	7(84)	2(50)	2(67)	1
	2,5 kg/ha	0(100)	2(95)	0(100)	0(100)	0
	3,0 kg/ha	0(100)	1(98)	0(100)	0(100)	0

It was discovered that there is no any activity of this preparations the local irritant and skin-resorbtive agent. It is clogs irritant of conjunctiva native state. The imitative properties of work concentration of this preparative form (1%) are not so significant and demonstrative. And based on it, this preparation is evaluated as the 4 class danger compound. Cumulative properties of this type of pesticide are expressed not so significant. K_{cum}>5; trees hold dose for chronic experiment is – 3,6mg/ml.

During the research there were not discovered any teratogenic effects, embryotoxicity, and gonadotoxic effects on organism of animals while the different ways of income of this preparative form into the organism."GLYPHOS.ARM" WSP is not low toxic for bees and fishes. Daily dose is – 0,1mg/kg for human. It normalized on water (0,02 mg/*l*), air of work zone (1,0 mg/m^3), in food products (0,1… 3 mg/kg).

CONCLUSION

During all experiments, it was discovered that eco-toxicological danger of preparative forms which are based on a glyphosate is predominantly determined by the type of SAS and stabilizers is being used in current composition and not by the active component. And usage of household SAS could give a resolve the main part of ecological problems, while usage of herbicide.

Powder form of "GLYPHOS.ARM" permits to decrease the consumption of it, because of the enhanced activity of general component, which is being determined by the increase of active component concentration in the same volume of preparative form, simultaneously with the decrease of possible ecological harmfulness after the use of this herbicide.

WSP form of "GLYPHOS.ARM" preparation is decreasing the praises of it and insuring more easy transport of herbicide to the place of use. And it is not only positive for the increase of economic efficiency

but although ensures the use of minimally toxic, bio-degradative auxiliary components (SAS and stabilizers) in preparative mixes.

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Environmental engineering and landscape management

THE IMPACT OF METEOROLOGICAL CONDITIONS ON DRAINAGE RUNOFF IN DIFFERENT SEASONS

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ABSTRACT: The activity of drainage during various seasons and the impact of meteorological conditions on drainage runoff in different seasons (winter, spring, summer and autumn) during the period of 1970-2009 are reviewed. Particularly important indicator of drainage activity – dynamics of water runoff. The present article analyzes the change of climatic conditions in the object, Central Lithuania, following the data of Kaunas Meteorological Station; and it is determined that during the period of 1970-2009 the lowest quantity of precipitation is during spring and winter, and the highest – during summer and autumn in the territory under research. While analyzing the temperature in decades, it is found that it has been constantly increasing during spring, and in the past decade (2000-2009) was 1.13°C higher, compared to the average temperature of 1970-2009. Following the data of four decades, drainage runoff is the highest in spring and the lowest – in summer. While examining the impact of meteorological conditions on dynamics of drainage runoff in the presence of changing climatic conditions, it is determined that the relationship between drainage runoff and precipitation during different seasons was weak (spring and summer) and the average one during winter and autumn. The analysis of relation between drainage runoff and average air temperature during different seasons revealed the average relation during winter and very weak relation during other seasons.

KEYWORDS: drainage, drainage runoff, air temperature, precipitation, water runoff.

INTRODUCTION

Over the past century the average annual air temperature increased by 0.6°C (Root et al., 2003). A. Bukantis et al. (2009a) examined the distribution of precipitation and the changes of air temperature (2009) in Lithuania, in the background of changing climate more broadly. Precipitation distribution in a territory and their change within a year has a great impact on hydrological phenomena, soil formation and plant-growing seasons (Bukantis, 1994). Climate change impact on flora is receiving increasing attention around the world (Fuhrer, 2003). Air temperature and moisture content generally determines the duration of plants vegetation and development, size of yield. The influence of meteorological conditions occurs not only directly on the yield, but also on its quality indicators (Kupčinskas et al., 2003; Šidlauskas et al., 2001). Climatic conditions and physical geographic factors determine the fact that in the territory of Lithuania there are 3.4 million hectares of too wet land or about 86 percent of total agricultural area, which may be used extensively and productively only after draining (Lukianas et al., 2009). Particularly important indicator of drainage activity – dynamics of water runoff. The efficiency of land use also depends on the speed of removal of excess water. The changes of climate (temperature increase, precipitation decrease) can be linked to the environmental pollution. At low temperatures and low moisture, the plants intake

nutrients worse, therefore, they are eluted from the soil with drainage runoff more intensively (Soussana et al., 2006). While analyzing the elution of biogenesis from soil through drainage, much research has been carried out (Šileika et al., 2003, McDowell et al., 2001). Mališauskas et al. (2008) determined that the highest trend of increase of nitrates in drainage water is in May, and the concentration of nitrates in drainage water was characterized by the lowest increase in October. Climate changes (temperature increase, precipitation decrease) may be related with the environmental pollution. The most important is the size of drainage runoff (Bučienė, 2008). The measure of reduction of drainage runoff impact on environment is a so called controlled drainage. This drainage is not continuously active, but only at certain times, i.e., it operates usually during required periods, but when the removal of water from soil is not needed, drainage runoff is intercepted (Ramoška et al., 2006). Controlled drainage is a promising mean for several reasons. Drainage damming by intercepting runoff may be considered as a measure, promoting the rational use of water resources and reduction of environmental impact (Morkūnas et al., 2001). Controlled drainage is recognized as an advanced management mode, limiting nitrogen and phosphorus elution from soil and its fall onto the pools of surface water (Evans et al., 1995). By controlling the intensity of drainage runoff a large part of runoff and dissolved chemical substances are intercepted (Wesstrom et al., 2001). Controlled drainage is important, seeking to control hydrological cycle and in order to use water resources (Zhonghua et al., 2006). In order to control runoff, it is necessary to know the periodicity of drainage activity, runoff and factors, which determine it.

OBJECT AND RESEARCH METHODS

In order to carry out the analysis of drainage runoff fluctuations and the impact of climatic factors on this process, the test object of Lithuanian Agricultural University in Kazliškės was selected. This decision is based on one of the largest data row of drainage system runoff in Lithuania. Summarize the five long-term drainage systems (No 21, area 0.44 ha, no. 22, area 0.45 ha, no. 23, area 0.44 ha, no. 24, area 0.44 ha, no. 25 area of 0.45 ha) of drainage studies, which began in 1967 and continuing up to now, the data. Research object is located in the southern part of Kaunas district, in the territory of training farm of Lithuanian Agricultural University (Fig. 1). Drain depth of 0.8, 1.10, 1.40 m, the drainage distance – 12, 18 m. Average test object surface slope – 0.008. The test site soil sod podzolic (the experimental according to FAO: calcar – Hypogleyic Luvisol), texture – light loam, dripping down on medium loam. Topsoil layer thickness is 0.2 to 0.25 Arable layer of filtration rate – 1.0 to 2.0 m/day, the lower layers of soil – from 0.01 to 0.004 m/day. Drainage flow data to 1994 taken from the published edition (Lietuvos...; 1995) and subsequent years, data from the Aleksandras Stulginskis University, Department of Land Reclamation employee (B. Bendaravičius, A. Dirsė, O. Miseckaitė). The meteorological parameters (precipitation and average air temperature) of forty years (1970-2009) period were analyzed in this article meanwhile data was obtained from Kaunas Meteorological Station, which is the nearest to the analyzed object (at the distance of 0.5 km).

Homogenous series were made and tendencies of the series according to time were studied. Drainage runoff parameters trends and significant positive or negative trends (5 percent confidence level) were determined by non-parametric statistical Mann-Kendall test. The rank-based Mann-Kendall trend analysis was applied to meteorological and runoff time series to determine if there is a significant changing trend in climate variables. Mann-Kendall is a popular non-parametric trend analysis method (Yilmaz et al., 2011). Also correlative relations between precipitation and runoff and between temperature and runoff and reliability of the correlative relationships during the different seasons in the complete studied period were determined.

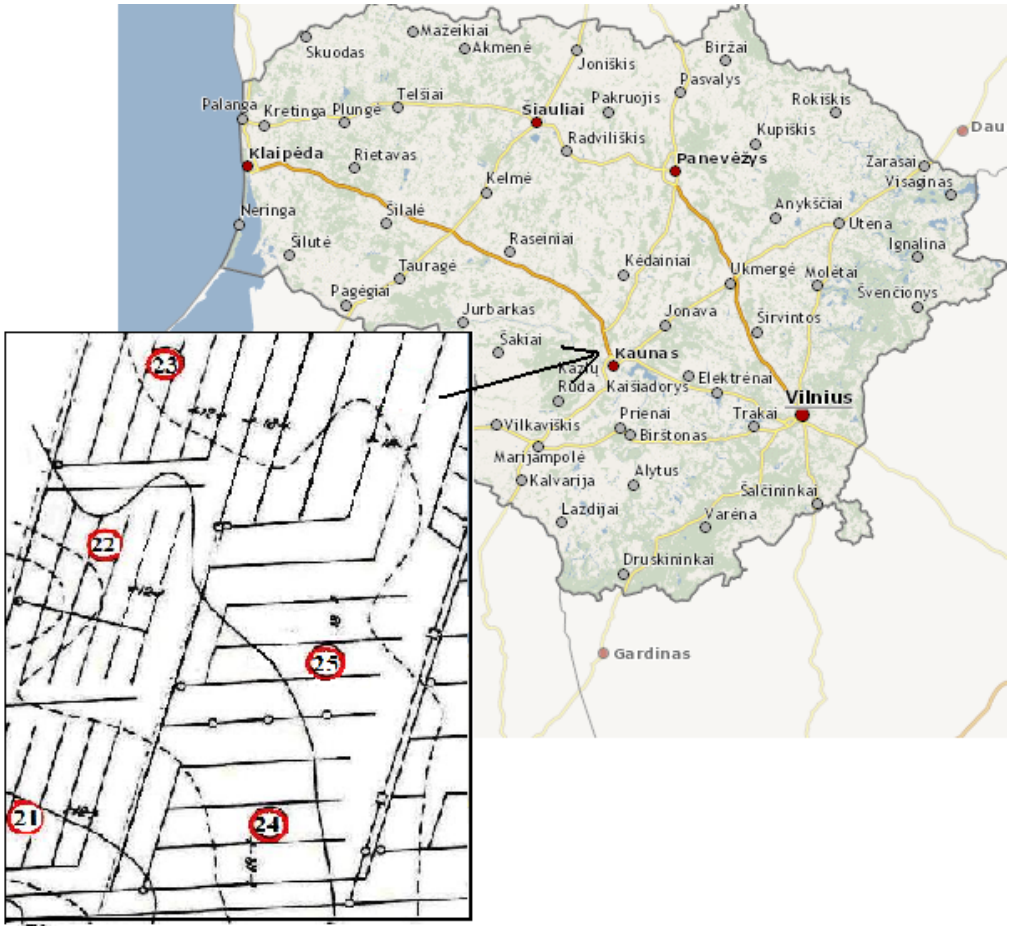


Fig. 1. Study area location

RESULTS

Meteorological conditions in 1970-2009 were studied while analyzing changes in seasonal distribution of the average air temperature and precipitation amount in Central Lithuania during the period of four decades (1970-2009), according to data of meteorology station located in the Academy, meanwhile complete studied period was divided each ten years.

In the recent decade (2000-2009) the average winder air temperature in Academy was 0.71°C warmer in compare with average temperature of the four decades (1970-2009), and amount of precipitation increased only in 0.7 mm in compare with average of 40 years period (Fig. 2).

During analysis of the temperature in decades it was revealed that in the spring it was always increasing and during the past decade (2000-2009) was 1.13°C warmer in compare with average temperature of year 1970–2009. Average sum of precipitation amount in spring (124.0 mm) and winter (125.1 mm) is very similar, and during the past decade average precipitation amount had decreased only in 1 mm in compare with the average precipitation amount of the complete period. Temperature in the summer was also increasing, and in 1970-1979 it was insignificantly (0.1°C) higher than in 1980-1989, and in the last decade (2000-2009) the summer temperature was in 0.5°C higher than the average temperature in 1970-2009 (2 illustration). The biggest amount of precipitation is in summer months. In the June-August of the last decade amount of precipitation increased in 33.3 mm in compare with the average of complete period, and when comparing with decade of 1990-1999 – amount increased even 56.6 mm. In the last decade (2000-2009) autumn in the region of Central Lithuania was warmer in 0.9°C, although during analysis of

the last four decades data in decades, decrease of average temperature was observed (in 1980-1989 and 1990-1999). Autumn season is also characterized by plenty of precipitation, although in the last two decades insignificant decrease in precipitation amount was observed (in 1990-1999 – 6.2 mm, in 2000-2009 – 0.7 mm.) in compare with average precipitation amount of the studied period.

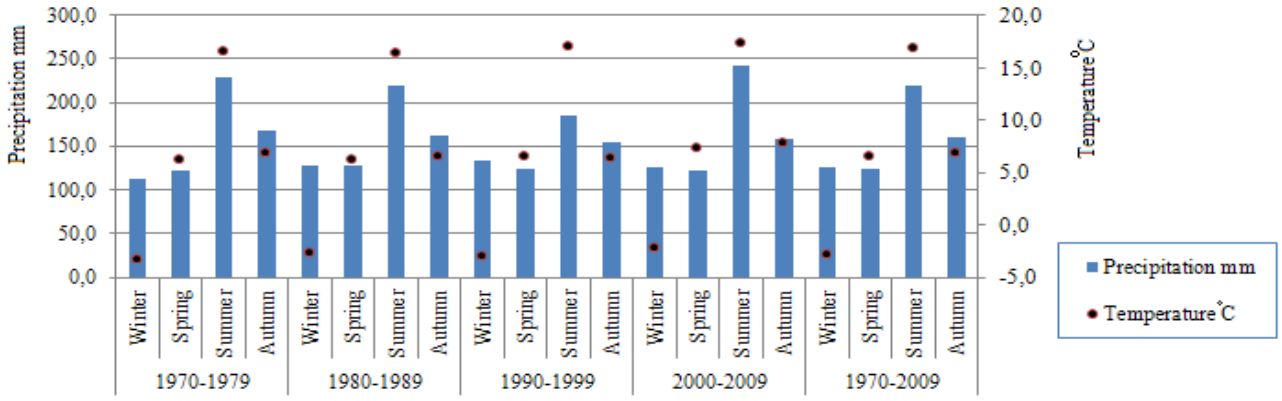


Fig. 2. Perennial (of 1970–2009 period) and four decades (in1970–1979, 1980–1989, 1990-1999 and 2000–2009) average air temperature and precipitation amount of different seasons in Central (Academy) Lithuania

Analysis of air temperature and precipitation amount change during four decades of 1969–2009 had shown that the average air temperature of 2000-2009 was the highest, and the lowest average temperature was observed in 1970-1979 m. (Fig. 3). The smallest amount of precipitation was in 1990-1999, and the largest amount – in 2000-2009, although it was only in 5.2 mm more than before three decades (in 1970-1979). During analysis of the drainage runoff dynamics it can be seen that the largest runoff was in 1980-1989, and the smallest, the same as in the case of precipitation amount – in 1990-1999.

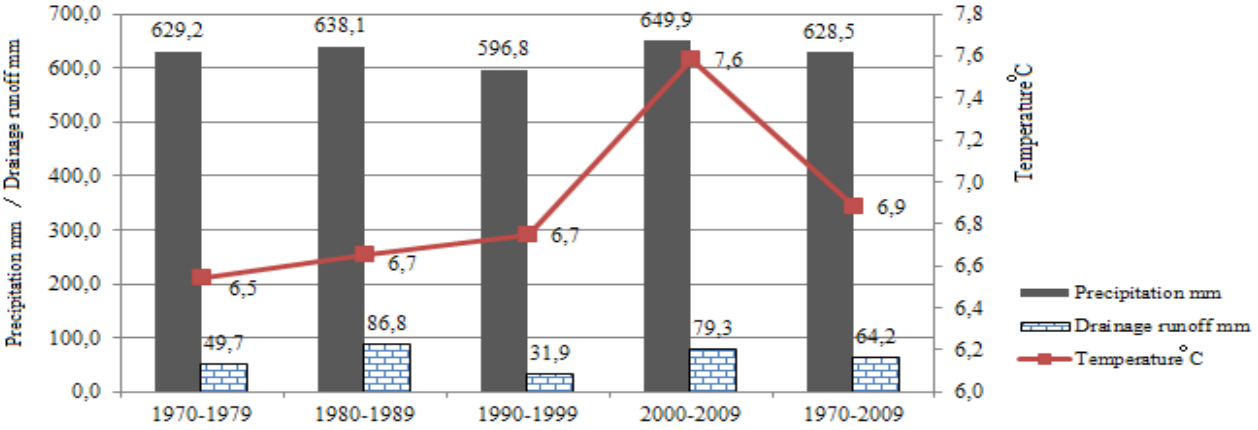


Fig. 3. Perennial (of 1970–2009 period) and four decades (in 1970–1979, 1980–1989, 1990-1999, 2000–2009) average air temperature °C, amount of precipitation mm and drainage runoff mm and precipitation amount of different seasons

When studying seasonal distribution of the drainage runoff in decades, the summer season should be distinguished as constantly decreasing, meanwhile the average drainage runoff of the other seasons during decades is fluctuating (Fig. 4). Although in the last decade the winter season had distinguished itself – the average runoff height was 32.4 mm (average of the four decades is 17.2 mm).

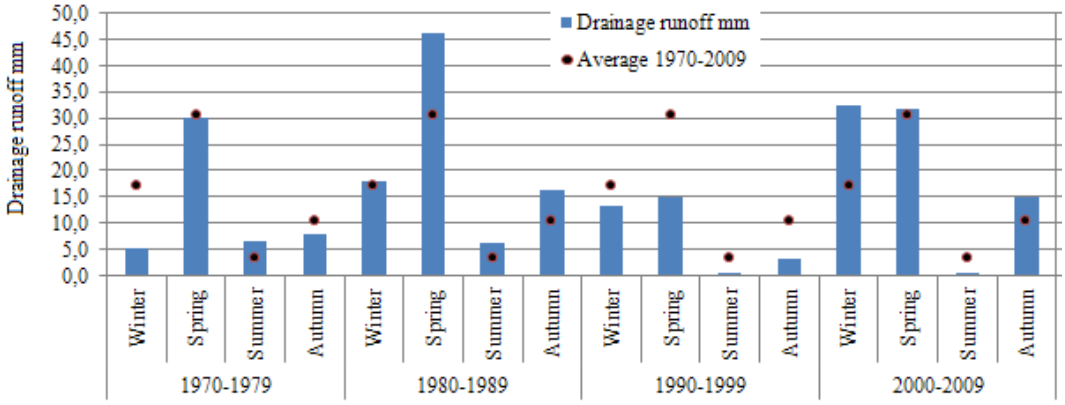


Fig. 4. Perennial (of 1970–2009 period) and four decades average drainage runoff mm and of different seasons (winter, spring, summer and autumn months)

When analyzing data of 1970-2009 in the studied territory it was determined, that the smallest precipitation amount is in spring (19.7%), in winter – very similarly (19.9%), and the largest precipitation amount is in summer (even 34.8%) and in autumn (Fig. 5). Meanwhile the highest drainage runoff is namely in spring (48.7%), and the lowest – in summer (4.9%). So regulated runoff would help the plants to source water as there is a lack of moisture for the germination of the plants. Ramoška *et al.* (2006) after performance of studies revealed that performance nature of the runoff usually hadn't critical impact on the ground water level in the gap between the drainage lines.

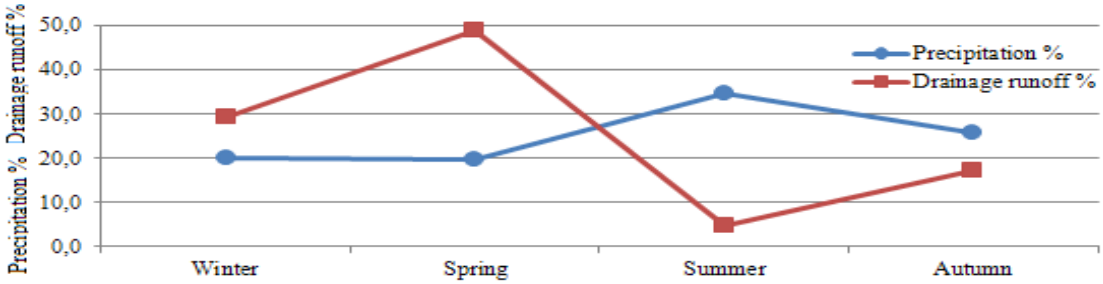
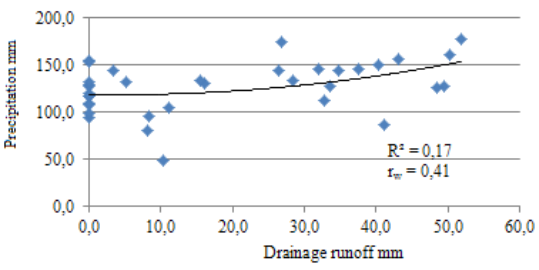
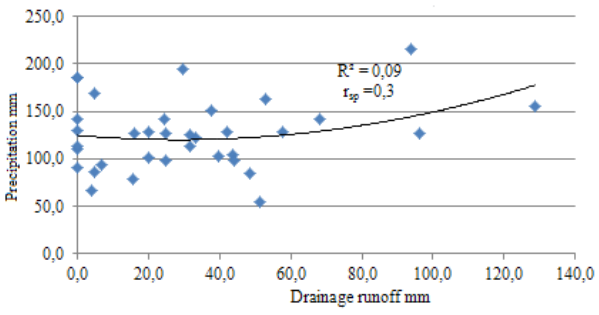


Fig. 5. Distribution of the percent amounts of the average precipitation and drainage runoff in 1970–2009 according to the seasons

After performance of correlation-regression analysis of the study data it was revealed that relation between drainage runoff and precipitation amount during different seasons was weak (in spring (r = 0.3) and in summer (r = 0.33) or average (in winter (r = 0.41) and autumn (r = 0.40), Fig. 6).





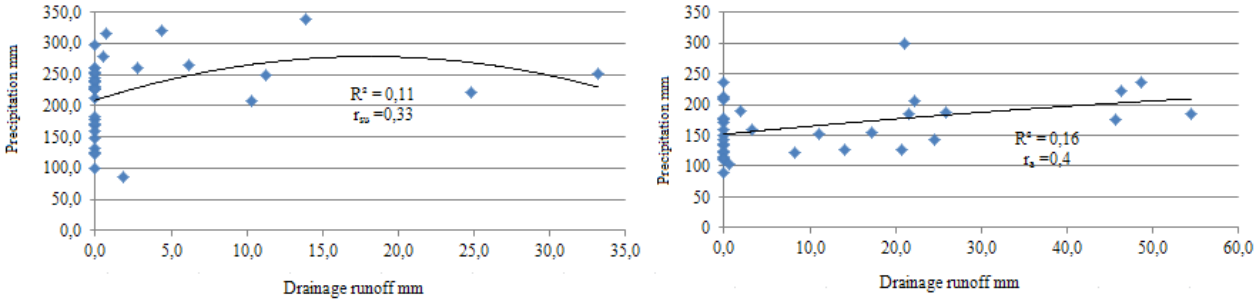


Fig.6. Dependence of the monthly drainage runoff from the average precipitation amount in different seasons of 1970–2009 period (r_w – winter, r_{sp} – spring, r_{su}- summer, r_a – autumn).

When studying relations between drainage runoff and average air temperature in different seasons it was determined that in winter there was an average link (r = 0.55), and in other seasons – the inter-relation was very weak: in spring – r = 0.17, in summer – r = 0.17 and in autumn – r = 0.14 (Fig.7).

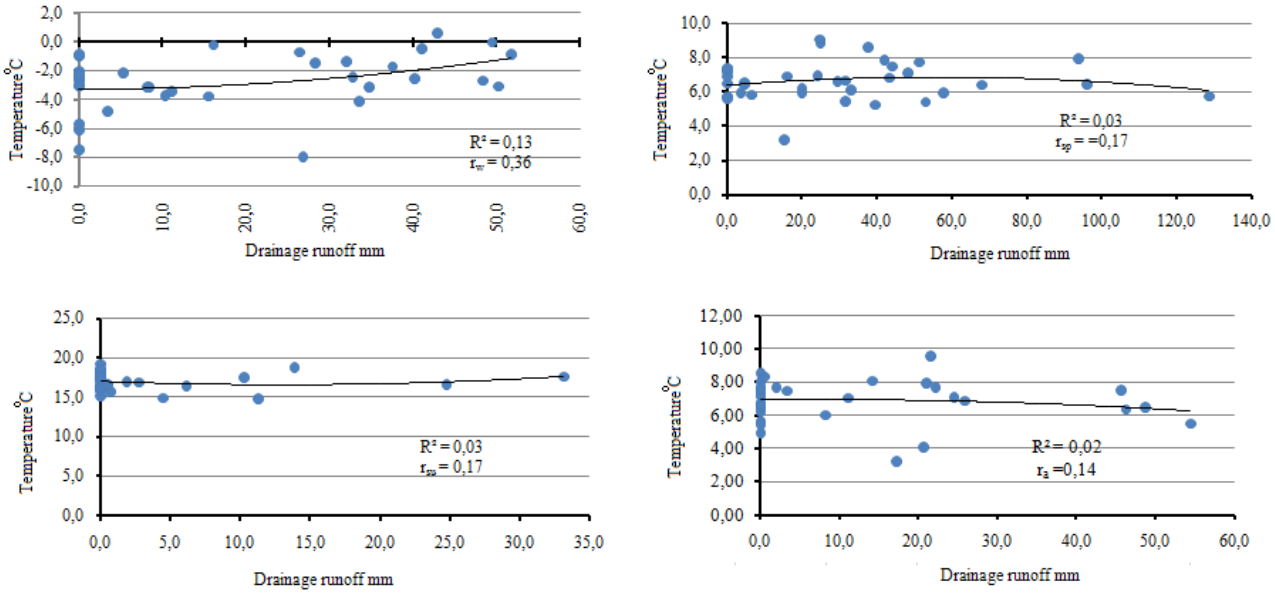


Fig.7. Dependence of the monthly drainage runoff from the average air temperature in different seasons of 1970–2009 period (r_w – winter, r_{sp} – spring, r_{su} – summer, r_a – autumn).

After performance of non-parametric statistical Mann-Kendall test of four decades, were revealed one significant negative trends and one significant positive trend. The general analysis of 1970–2009 periods is showing significant the significant positive trends in winter.

It was already earlier defined that drainage runoff of 2000-2009 period was the highest, therefore here significant positive trends can be seen, that are showing increase of the runoff.

Tendency of trends decrease can be seen in summer (table 1).

Table 1

The results of Mann–Kendall test

Decades	Seasons	Test statistic	Reliability
1970-1979	Summer	-2,00	0,05
2000-2009	Winter	2,24	0,03
1970-2009	Winter	2,92	0,01
	Spring	0,83	0,41
	Summer	-1,22	0,22
	Autumn	1,91	0,06

CONCLUSIONS

1. When analyzing data of 1970-2009 in the studied territory is was determined, that the smallest precipitance amount was in spring (19.7%) and winter (19.9%), and the biggest amount of precipitance was in summer (34.8%) and autumn (25.6%). The drainage runoff according to data of four decades reached the highest point namely in spring (48.7%), and the smallest drainage runoff is in summer (4.9%).
2. After correlation-regression analysis of the study data it was revealed that relation between drainage runoff and precipitation amount during different seasons was weak (in spring and in summer), and average in winter and autumn.
3. When studying relations between drainage runoff and average air temperature in different seasons it was determined that in winter there was an average link, and in other seasons – the inter-relation was very weak.
4. After performance of non-parametric statistical Mann-Kendall test of four decades, more significant positive trends were revealed in winter season – it shows the decrease of runoff in summer.

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Environmental protection

NUMERICAL CALCULATION OF UNEVEN TRAFFIC FLOW OF HYPER-CONCENTRATED SEDIMENT LOADED MUDFLOW WITH VARIABLE EXPENDITURES ALONG ITS TRAFFIC

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ABSTRACT: The reference image of the free surface curve for hyper concentrated debris-flow is proposed, in which, the sustainability of mudflow toward erosion hub has been taken into consideration, as well as its motion and dynamics in water plumbing.

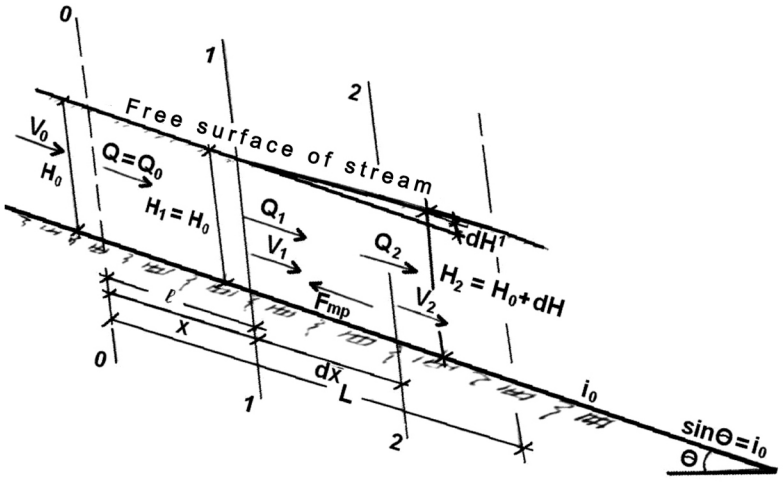
KEYWORDS: mudflow, sediment, loaded.

One of the most severe exposures of natural disaster is mudflow. This mixture moves along the stream bed in the form of hyper-concentrated coherent flow (if the amount of torrential sediments is about $10 \div 20\%$ of the whole mudflow weight) or incoherent flow (low concentrated turbulent flow) (the amount of torrential sediments $70 \div 80\%$ of the whole weight) or rainfall flood (the amount of torrential sediments 95% of the whole mixture weight) [1]. Solidity of hyper-concentrated mixture $1.8 \div 2.3$ t/m^3; moving area – plastic debris-flow aggregation.

Turbulent mudflow (low concentrated, incoherent) –is the water environment which often enriches with colloidal suspensoids, it transports rubbly masses and certain rubbles; this solidity varies from 1,1 to 1,7 t /m^3, hard spots $10 \div 70\%$ according to the mass. Flows within water or water collodion mixture [1].

When moving in the stream bed, hyper-concentrated mudflow often takes with itself sediment loaded mudflow and flow expenditure increases along its traffic.

Mudflow amount variation whilst moving between the flow area ($1 \div 1$, $2 \div 2$) equals (see picture 1), and the range of flow in the mixture ($1 \div 1$) per unit of time will be:



Pic.1. Mudflow expenditure variation graphic along its traffic

$$\frac{\gamma}{g} \cdot QV, \tag{1}$$

whereas γ is absolute weight, g – acceleration of gravity, Q – flow expenditure rate, V – medium speed rate at free flow area.

Similar to this, the range of flow in the mixture $2 \div 2$ will be:

$$\frac{\gamma}{g} \cdot (Q + dQ)(V + dV) \tag{2}$$

The alternation of the flow rate between the mixtures will be:

$$\frac{\gamma}{g} \cdot (Q + dQ)(V + dV) - \frac{\gamma}{g} \cdot QV = \frac{\gamma}{g} \cdot [QdV + (V + dV)dQ] \tag{3}$$

The whole range of mudflow G between the areas $(1 \div 1)$ and $(2 \div 2)$ taking under consideration the stream fall will be:

$$G \sin\theta = \gamma \cdot i_0 \cdot (\omega + \frac{1}{2} d\omega) \cdot dx, \tag{4}$$

whereas $i_0 = \sin\theta$ – stream fall at the examined site. The unit containing $dxd\omega$ goes down because of a little quantity when instead of it we'll have (4):

$$G \sin\theta = \gamma \cdot i_0 \cdot \omega \cdot dx, \tag{5}$$

whereas ω – free flow area

Loss of pressure at dragging between the areas will be:

$$h_{mp} = i_{mp} \mathrm{dx} \tag{6}$$

Whereas from [2]:

$$i_{mp} = \frac{Qv}{BgH^3 \cdot t(\beta)} \tag{7}$$

$$\mathrm{f}(\beta) = \frac{\beta}{2}(\beta^2 - 1) + \frac{1}{3}(1 + \beta^2) \tag{8}$$

$\beta = \frac{h_0}{H}$ – relative depth of flow; h_0 – depth of flow core; H – whole depth [3]:

$$h_0 = H\left(3\frac{V}{V_0} - 2\right) \tag{9}$$

Whereas: $V_0 = V_{\max}$ – speed of flow core with the other words –the speed at the free surface flow.

Dragging force along the traffic equals the pressure in accordance with the force which is used for overcoming the total dragging force multiplied by the average area in the free flow area:

$$F_{mp} = \gamma \cdot (\omega + \frac{1}{2}\mathrm{d}\omega) \cdot \mathrm{i}_{\mathrm{тр}} \cdot dx = \gamma \cdot \omega \cdot i_{mp} dx \tag{10}$$

In accordance (10) unit $dxd\omega$ is missing because of being little.

The pressure force in the mixture $1 \div 1$ in the direction of flow equals to the hydrostatical pressure in the midst of heavy area of free flow area ω, multiplied by the free flow area, in the other words:

$$P_1 = \gamma \cdot \overline{Z}\ \omega, \tag{11}$$

Whereas $\overline{Z}$ – the depth of loading the center of gravity of free flow area, that is calculated from the free stream surface.

Similar to the mixture $(2 \div 2)$ we get:

$$P_2 = \gamma(\overline{Z} \cdot + dH)\omega + \frac{\gamma}{2} d\omega \; dH ;$$

As $d\omega \; dH \approx 0$, we get:

$$P_2 = \gamma(\overline{Z} \cdot + dH)\omega , \qquad (12)$$

whereas: dH – the difference of depth between the mixtures $(1 \div 1)$ and $(2 \div 2)$.

Composite force of pressure between the mixtures will be:

$$P_1 - P_2 = -\gamma \cdot \omega \cdot dH \qquad (13)$$

When equaling the alternation of range amount to the area (1÷1) and (2÷2) taking under consideration (3) all external forces, that affects the volume between the $(1 \div 1)$ and $(2 \div 2)$ areas we get:

$$\frac{\gamma}{g}\left[Q \cdot dV + (V + dV)dQ\right] = P_1 - P_2 + G\sin\theta - F_{mp} \qquad (14)$$

Avoiding units $dV \; dQ$ and replacing (14) according to (5), (10) and (13), replacing differential components with finite decrement, instead of (14) we get:

$$\frac{\gamma}{g}\left[Q\Delta V + (V + \Delta V)\Delta Q\right] = -\gamma \int_0^{\Delta H} \omega dH + \gamma i_0 \int_0^{\Delta x} \omega dx - \gamma i_{\text{тр}} \int_0^{\Delta x} \omega dx = -\gamma \overline{\omega}\Delta H - \gamma i_0 \overline{\omega}\Delta x - \gamma i_{mp} \overline{\omega}\Delta x \qquad (15)$$

Whereas : $\overline{\omega}$ – average area of free flow area between the mixtures:

$$\overline{\omega} = \frac{Q_1 + Q_2}{V_1 + V_2} \qquad (16)$$

Then dependency (15) assuming that $\Delta V \Delta Q$ can be rewritten, then we get the following:

$$\frac{\gamma}{g}\left[Q\Delta V + V\Delta Q\right] = -\gamma \overline{\omega}\Delta H + \gamma i_0 \overline{\omega}\Delta x - \gamma \overline{\omega} i_{mp}\Delta x$$

Taking under consideration (16) and also that $Q = Q_1 ; V + \Delta V = V_2$ we get:

$$\Delta H = -\frac{Q_1}{g}\left(\frac{V_1 + V_2}{Q_1 + Q_2}\right)\left(\Delta V + \frac{V_2}{Q_1}\Delta Q\right) + i_0\Delta x - i_{mp}\Delta x \qquad (17)$$

The equation that we get (17) little bit differs from common equations that are used for making free surface curves with the assistance of numerical method of calculation, but the main thing in this case is defining the unit of resistance for hyper concentrated mudflow.

As the bottom slope of the traffic is positive, the evident relation should be taken under account.

$$\Delta H' = -\Delta H + i_0\Delta x \qquad (18)$$

Then the dependence (17) will be as following:

$$\Delta H' = -\frac{Q_1}{g}\frac{(V_1 + V_2)}{(Q_1 + Q_2)}\left(\Delta V + \frac{V_2}{Q_1}\Delta Q\right) + i_{mp}\Delta x \qquad (19)$$

Dependence (19) gives us opportunity to make free surface curve with hyper concentrated mudflow at the expense of taking with itself sediment loaded mudflow.

The same way we can calculate free surface curve at surface traffic with low deformation capacity when drawdown curve of the flow is seen.

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Earth sciences

THE ROLE OF GEOGRAPHICAL TERMS IN THE FORMING OF RIVER NAMES OF THE AZERBAIJAN REPUBLIC

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ABSTRACT: The majority of river names in the investigated region are Azerbaijani names. Geographical appellatives such as chay, kashka, boom, ar, daba, tap and others play an active role in the formation of river names.

Comprehensive study of river names in this region is of great importance for the development of Azerbaijan toponymy.

KEYWORDS: river, su, ar, boom, saddle, gudab.

Науки о Земле

ГЕОГРАФИЧЕСКИЕ ТЕРМИНЫ, УЧАСТВУЮЩИЕ В ОБРАЗОВАНИИ НАЗВАНИЙ РЕК АЗЕРБАЙДЖАНСКОЙ РЕСПУБЛИКИ

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ВВЕДЕНИЕ

При классификации названий рек выясняется, что основную массу названия рек исследуемого региона составляют азербайджанские. Однако встречающиеся здесь названия относятся и к другим языкам. В частности к кавказскому, ираноязычному, русскому и к еще неустановленным языковым принадлежностям.

Основная часть. В образовании названий рек активную роль играют географические апеллятивы, такие как "чай", "су", "каша", "боом", "ар", "даба", "там", "эмбер", "ятыг" и т.д.

При исследовании названий рек в зависимости от причин их возникновения установлено, что некоторые реки взяли свои названия от этнонимов, антропонимов, оронимов, фитонимов, зоонимов, ойконимов, ряда гидронимов и получили свои названия по специфическим особенностям ландшафта. Но есть и такие реки, причины названий которых до сих пор неизвестны.

В образовании названий рек часто встречается термин "чай" (река). Например, Агчай (Белая река), Аджичай (Горькая река), Гара чай (Черная река), Шор чай (Соленая река), Гуру чай (Сухая река), Гашга чай ("гашга" – лысый), сухое место, лишенное растительности. В Киргизии кашка су – "чистая прозрачная вода". Существует и этноним кашка[1].

В указанном регионе воды этой реки очень прозрачны и текут по серым и черным булыжникам, вследствие чего и использовано такое название. Значит, Гашга чай-чистый, прозрачный чай.

"Бум чайы". Слово "бум" ("боом") в азербайджанском языке не сохранилось но на тюркских языках Алтая оно обозначает "крутая", "высокая", "отвесная стена образующаяся в узком местечке речной долины", "высокий утес" и т.д.

Река получила свое название от ойконима Бума, расположенного у подножья горы Кум (в ущелье между двух гор).

"Ардаба чайы". Кроме топонимии Азербайджана, термин «ар» встречается на других территориях Союза независимых государств и даже за его пределами.

"Ар" – левый приток Быстрый Танып в Башкирии, в Венгрии "ар" – "река", "приток", на башкирском диалекте "ар" – "сухое русло реки".

Имеется и этноним "ар" (названия у удмуртов, башкир и татар) [8].

Вторая часть слова – "даба" ("дабан", "дава", "даван"): по Э. и В. Мурзаевым "высокий, трудный перевал через горы", "седловина в хребте" [9]. У калмыков термин "дабан" употребляется в смысле "холм".

Можно предположить, что река Ардаба здесь означает Горная речка. "Ар" – "река, речка", "даба" – "гора".

Гудялчай сформирован от термина "гуд", "гудаб" означает "высоту, большое". Гудялчай означает высоко текущую реку, большую реку. Дюбрарчай берет свое начало у горы Дюбрар в переводе с иранского означает "два брата".

Агкесек чайы. Аг – (букв.) белый: "кесек" – "ком земли", "глина, камень". Аггязчайы. "Гяз" – "самое пониженное место в седловине" [7]. Гейбаир чайы – "баир" – "холм, бугор", "холмистое место" [2]. Дуруджа чайы – "дурру" – (букв.) "жидкий", здесь "дурру" – означает "чистый", "прозрачный". Тап чайы – "тап" – "открытое ровное место в предгорьях". Эмберчай – "эмбер" – "выпуклый". Чайлагдере чайы: "чайлаг" – "сухое русло". Ятыгдере чайы – "ятыг" – "наклонный, вогнутый", "дере" – "ущелье". Гуругобу чайы – "гуру" – "сухой", "гобу" – "долина, балка" и т.д.

Су – "вода, река". Агсу (Белая вода), Сарысу (желтая вода), Гара су (Черная вода), Истису (Теплая вода) и др.

В ойкониме, Илису участвует термин – "су". О значении слова "Илису" существует очень много мнений. Одни авторы этот топоним объясняют как "элли су" – пятьдесят вод [1]. Разумеется, эта этимология неубедительна. Местные жители говорят, что "Илису" означает "Ийли су – пахнущая вода". По В.А. Никонову "или" является монгольским словом и употребляется в смысле "блестящий, сверкающий".

Названия рек, в составе которых имеется "или" зафиксированы также в Средней Азии.

В словаре Махмкда Кашкари отмечены названия "Или" и "Илису" в Средней Азии.

В западной группе диалектов и говоров азербайджанского языка употребляются глаголы "илынмаг" – "греться", илытмаг – "греть, нагревать" и т.д. На кумыкском языке это слово встречается в форме "Йыллы", что обозначает "теплый". Древней формой слова "или" является "Йыллы". На определенном этапе развития языка слова произносятся без интонации. Например, "йылан", "илан" – (змея), "йылдыз", "илдыз" – (звезда), "йылдырым", "илдырым" – (гром) и т.д.

Слова "или" также можно отнести к этой категории. "Илису" в смысловом значении соответствует "Илыг су – теплая вода".

В названиях рек слова "аг" и "гара" не только указывают цвет воды, но также: "аг" – чистая, питьевая вода, "гара" – некачественная вода, грунтовые воды и т.д. Этот вопрос получил свое

освещение в работах некоторых ученых.*)

Вельвелечай происходит от арабского слова и означает разрушительный, тревожный и пр. Связано с сильнейшими селями и половодьями происходящими на реках. В исторических источниках название Вельвелечай показано как «Бяльбяльчай», «Бильбильчай», «Бельбельчай».

На южном склоне Большого Кавказа ряд рек, получивших названия от близлежащих сел, относятся к этноойконимам. например, реки: Базар, Биледжик, Арган, Гуллар, Гыпчак, Джелаир, Джунут (Зунут), Кюнгют, лекит, Лагидж, Муганлы, Падар, Тангу, Тиканлы и др.

Базарчай. на Кавказе было зафиксировано 15 топонимов, в названиях, которых участвовало слово «базар». Интересно, что и среди каракалпаков имеется племя, именуемое «базар (басар)» [5]. Из вышеуказанного видно, что базар(басар), в топонимах отражается как название племени.

Арган чайы. Очень возможно, что "Арган" образовано от этнонима "аргын" ("аргун").

Гыпчаг чайы. "Гыпчаг" – одно из самых крупных тюркских племен, которые оставили след в названиях рек данной территории. Историки Азербайджана прибытие кыпчаков в Азербайджан объясняют следующим образом.

По Р.А. Гусейнову, во время нашествия на Закавказье, в том числе на Азербайджан, XI-XIII вв. тюркских племен, возглавляемых сельджуками – огузами, в их составе были и кыпчаки [10]. На основе этого факта можно утверждать, что появление кыпчаков в этом регионе приходится на это время. Но некоторые ученые считают, что кыпчаки еще в VIII в. совершали походы в Азербайджан. Отсюда ясно, что кыпчаки в Азербайджане прослеживаются в разное время. Следовательно, до их массового прихода в Азербайджане уже жили кыпчаки.

Гуллар чайы. Одним из очень интересных и порождающих споры этнонимов является река Гуллар. Бесспорно, этот топоним нельзя связывать с азербайджанксим словом "гул(раб)".

Мы стремились объяснить смысл топнима от патиронима, но ареал его распространения (в Грузии – Аккуллар, в Дагестане – Куллар и т.д.) доказывает, что это название происходит от наименования племени.

Многие источники подтверждают, что одно из кыпчакских племен называлось "кул" [4].

Кюнгют чайы. В формировании топонимии Азербайджана определенную роль сыграл приход сюда монголов в XIII в. В составе монголов были и племена тюркского происхождения. названия некоторых из этих племен отразились в топонимии Азербайджана. Действительно, монгольский историк XIII в. Рашид-ад-Дин отмечал наличие племени "кюнгют" среди монголов [3].

Тангут чайы. По своему происхождению тангут является названием тибетских племен. В XI в. они напали на провинцию уйгуров Бешбалык, захватили ее и создали там свое государство – Тангутское. В 1227 г. оно было захвачено монголами и его население в составе монголов начало продвигаться на запад [1]. Часть племени тангутов достигла вместе с монгольской армией Азербайджана и т.д.

Определенная часть гидронимов исследуемого региона выражена антропонимами. Здесь некоторые реки носили имена хозяев близко расположенных хозяйств. Например, Агаджан чайы, Бадалчай, Назар чайы и т.д.

Одна группа рек в своих названиях содержит названия животных и растений. Например, Мераллы чай-(Марал-олень), Кечили чайы (Кечи-козел), Девели чай – (Деве-верблюд), Гозлу чай

*) См. **А.Н. Кононов.** *О семантике слова кара и ак в тюркской географической терминологии*. Изв. отд. общ. наук. Ан Таджикской ССР. 1954, вып.V. стр. 83-85;
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(Гоз-орех), Чинар чайы – (Чинар-платан), Хайвалы чай-(Хайва-айва) и др.

В регионе имеется несколько гидронимов относящихся к аварскому, грузинскому, цахурскому, удинскому, персидскому и др.языкам. Так, по сообщению информаторов названия рек Гурсу ор (Гурсу-глубокий, "ор" – река, аварск.), Гугараб ор ("Гугараб" – мутная, "ор" – река аварск.), Багтала хеви ("Баг" – сад, азерб., "тала" – поляна, азерб., "хеви" – река), Джинджар чайы (Джинджар – "крапива") грузинск., удинск., Дахна чайы ("Дахна" – водоспуск), "устье канала", "дорога между двумя горами", иранск. и т.д.

Ситалчай происходит от лезгинского слова, и означает Дамджылычай. Ситалчай также именуется и агрычаем.

Южная часть Большого Кавказа Азербайджана отличается своим этническим своеобразием. здесь имеются гидрографические названия сохранившиеся на лезниском, аварском, татском, будигском, кырызском, хыналыгском языках. Например, "джуй" – "маленькая река" (иранск.), "валтс" – "чай" (лезгин.), "унга" – "чай" (хыналыгском, "кюр" – "чай" (кырыз., будуг.) и т.д.

Исследование названий рек позволило установить, что названия некоторых ныне существующих населенных пунктов перешли в пассивный топонимический фонд республики. Например, реки Вегвер, Джыных, Чигиль, Шахнабад и др. носят названия одноименных населенных пунктов.

Можно прийти к выводу, что всестороннее изучение названия рек данного региона имеет важное значение для развития азербайджанской топонимики в целом.

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Water analysis

SKALAR YOUR PARTNER IN CHEMISTRY AUTOMATION FOR WATER ANALYSIS

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ABSTRACT: The article gives an overview about modern analytical equipment for water analysis. Important role in routine analysis plays automatization. It helps to avoid operator error, get precise results, saves reagents and time.

KEYWORDS: automatization, COD, BOD, TOC, water analysis, robotics.

Skalar is a Dutch company established in the mid-sixties as an analyzer manufacturing company. Over the years we manufactured many different types of analyzers and specialized in the late seventies in the automated analysis of water, soil, plant and food samples.

In water management the Dutch have big challenges in water quality control as the country is one of the most densely populated countries in the world and has a vast agricultural industry. Water in The Netherlands is recycled and reused several times. The production of safe drinking water and unpolluted irrigation water requires these waters to be intensively analyzed for both chemical and microbiological pollutants.

Skalar has been part of this development during the last 30 years and has built up a wealth of experience in its highly sophisticated range automatic analyzers. Skalar now distributes and supports its range of water analyzers in over 70 countries worldwide. Our analyzers are manufactured according to the highest quality standards and comply with international standards such as EPA, ISO, Standard Methods, ASTM, GOST etc.

All analyzers provide laboratories:

– accurate, reproducible and precise results
– fast and high sample through-put
– saving on labour and reagents
– standardization of methods and operation conditions
– fully automatic analyzer control, calculation, calibration, quality control and data transfer

New developments in analyzer technology are continuously being introduced into our analyzers to maintain our superiority and to provide state of the art analyzers to our clients. A comprehensive course of training programs and seminars are part of our support.

SAN^{++} CONTINUOUS FLOW ANALYZER, SAN ++

This fully automatic modular analyzer offers complete automation for parameters such as NH_4, NO_3, PO_4, F, Cl, TOC, SO_4, MBAS, Phenol, Total /Free Cyanide , Total Nitrogen and Phosphate with automatic in-line sample pretreatment e.g. distillation, extraction, digestion, etc.

The analyzer can be equipped with a range of detectors such as colorimetric, ion selective, fluorimetric and Flame photometry

The analyzer is designed to analyze from one up to 12 parameters simultaneous, with multiple sample pick up if required, The multi language software package offers full automatic analyzer control, automatic calibration, data calculation and quality control.

The closed analytical system is ideal for contamination free low level analysis such as in seawater and it is the perfect analyzer for the safe handling of toxic reagents at elevated temperature.

The high flexibility in design will enable water laboratories to analyze a wide variety of samples matrices and ranges fully automatically.

Over 300 different applications are available for the San^{++} analyzer

ROBOTIC ANALYZERS

Skalar's extensive range of robotic analyzers, offers flexible and affordable automation for a large number of parameters such as Biochemical Oxygen demand (BOD), Chemical oxygen demand (COD), pH, Conductivity, Carbonate/Bicarbonate, Oxygen, Alkalinity, Titrations, ISE analysis, and Clay Fraction. Analyses are performed either sequential or simultaneous depending on application and analyzer model.

Application examples:

Biochemical Oxygen Demand

This analyzer is designed to measure Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD), saving up to 50 % operators and eliminating operator, calculation and reporting errors. Various degrees of automation are possible, with automatic capping/decapping of the bottles, automated additions and dilutions and bar code reading.

Sample trays can be added during analysis runs to handle any required sample load. The analyzers can hold all available standard BOD bottles, and a wide range of sample trays are provided to fit all available incubators.

Chemical Oxygen Demand

Skalar's robotic analyzers can be configured to automate Chemical Oxygen Demand (COD) for several standard procedures.

The standard chromate digestion under reflux by the Skalar semi automatic digester followed by automatic titration on the robotic analyzer, or the recently developed automatic analyzer for the micro shielded tube method, his method is based on the same reaction, but instead of titration, a photometric detection is used. An advantage of this COD method is the use of pre-prepared tubes, which minimize handling of toxic and hazardous reagents. The robotic analyzer automates the complete procedure from sample pipetting until COD measurement with pc for data handling and control.

The COD analyzer can also be used for BOD analysis and vice versa. If there is a requirement for other water analyses such as pH, conductivity, alkalinity and turbidity then these methods can be combined with BOD on the same analyzer.

FULLY AUTOMATIC TOTAL ORGANIC CARBON AND NITROGEN ANALYZERS

Skalar offers the flexible Formacs$^{HT\ range}$ for measuring TOC, TC, IC, NPOC and POC and TN in liquid samples.

The analyzer is of a modular concept and can be expanded with Autosampler, Nitrogen detector and Solid module for sludges and sediments

The technology of the Formacs^{HT} is based on high temperature catalytic combustion with NDIR detection method, and offers within a few minutes accurate, simultaneous results for Total Organic Carbon and Total Nitrogen.

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Environmental protection

MODULAR BUILDINGS FOR TREATMENT OF WASTE WATER: REALITY AND PERSPECTIVE

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ABSTRACT: Submitted Modular construction for treatment of waste water is a complex of cylindrical and rectangular vessels through which water flows dying series. In the process of transition through the courts dissolved substances in water face down mechanically and biologically degraded, so that the output of the construction of water has the specified parameters.

This modular structure provides the following benefits:

- Working with a constant biological filtration with a very short interval of arrest (4.7 hours)
- Do not use electricity (100% economy)
- Installation of cleaner not expensive (40-66% saving construction sites, 20-30% economy)
- During the operation does not require highly qualified staff - requires only weekly monitoring.
- Purified water can be used for watering lawns and green areas, in toilet tank, etc.
- Rainfall in these cleaners in 5-10 times less than in aerobic cleaners. Residue can be used as fertilizer
- Certain parts of the installation can be prepared off-site construction, which allows for construction and installation work for 3-5 days
- Do not threaten odor, insects and biological infections
- Construction cleaner aesthetic appearance does not violate the neighborhood - all of its principal parts are located under the ground.

KEYWORDS: waste water, mechanically and biologically degradation.

Охрана окружающей среды

МОДУЛЬНЫЕ СООРУЖЕНИЯ ДЛЯ ОЧИСТКИ ОТХОДНЫХ ВОД: РЕАЛЬНОСТЬ И ПЕРСПЕКТИВЫ

Иванка Ганчева ПОПОВА

ВВЕДЕНИЕ

Современное развитие цивилизации вызывает постоянное увеличение техногенного загрязнения окружающей среды. Одним из основных загрязнений водоемов и рек являются бытовые сточные воды. Высокое содержание органических веществ в коммунальных сточных водах ведет к увеличению в водоемах органики и вызывает "цветение воды" – развитие низших микроорганизмов, которые своим воздействием приводят к вымиранию высших водных организмов и, тем самым, уменьшают биологическое разнообразие поверхностных водных объектов.

Нарушение экобаланса уменьшает способность водохранилищ, озер и рек самоочищения, что ведет к увеличению расходов на очистку бытовых и промышленных сточных вод. По этой причине все более актуальным является очистка сточных вод в населенных пунктах, перед её сбросом в водоприемники.

Строительство очистительных сооружений для бытовых сточных вод приведет к улучшению окружающей среды, через уменьшение количества и состава техногенных загрязнений на водные объекты.

В Болгарии этот вопрос является частью государственной политики в соответствии с Европейским законодательством. Наша фирма уже десять лет работает над проблемой очистки сточных вод вместе с чешскими коллегами и коллегами биологического факультета Софийского университета. Мы организуем этот бизнес с проектированием, производством, поставкой, строительством, монтажом и эксплуатационным пуском – т.е. – полный цикл на базе фирменного патента.

Для мелких поселков, деревень, отелей, кемпингов и домов с численностью до 2 000 жителей применение модульных очистительных сооружений для очистки коммунальных отходных вод оказывается очень удобным и надежным. Если увеличится число жителей поселка, к существующему очистительному сооружению прибавляется дополнительный модуль.

НОВАЯ ГЕНЕРАЦИЯ ОЧИСТИТЕЛЕЙ СТОЧНЫХ ВОД

Данный тип анаэробных очистителей может быть поставлен в размерах, требуемых для населенного пункта или объекта с численностью от 5 – до 2 тыс. человек.

Рекомендуемые стандартные размеры на 5, 10, 20, 30, 40, 50, 75, 100, 150, 200, 300, 400, 500 человек.

Очиститель сточных вод предоставляет следующие выгоды:

- Работает с постоянной биологической фильтрацией с очень коротким интервалом задержания (4,7 ч);
- Не использует электроэнергию (100% экономия);
- Установка очистителя не дорогая (40–66% экономия строительных площадей, 20–30% экономия финансов);
- При эксплуатации не требуется высококвалифицированный обслуживающий персонал – необходим только еженедельный контроль обученным персоналом и очистка фильтра от грубых частиц;
- Очищенная вода может использоваться для поливки газонов и зеленых насаждений, в туалетных бачках и т.п.;
- Количество осадков в этих очистителях в 5–10 раз меньше, чем в аэробных очистителях. Этот осадок имеет стабильное химическое сложение и может быть использован как удобрение;
- Отдельные части установки могут быть подготовлены вне места строительства, что позволяет провести строительно-монтажные работы за 3–5 дня;
- Не угрожает появление неприятного запаха, насекомых и биологических инфекций;
- Сооружение очистителя эстетически не нарушает вид окрестности – все его главные части находятся под землей.

ПРИНЦИП ДЕЙСТВИЯ АНАЭРОБНОГО ОЧИСТИТЕЛЯ СТОЧНЫХ ВОД

Сточная вода протекает через фильтр, который задерживает грубые частицы (деревянные, пластмассовые, бумажные и т.д.) и втекает в двухкамерный осадочный бак. Здесь происходит отделение от воды плавающих частиц (жиров, белков и т.п.), а оставшиеся тяжелые частицы оседают на дно и создают осадок с 15–20 % содержанием твердых веществ. Органические вещества (жиры и белки) являются предметом гидрофилизации в верхней части бака, где происходит первичная редукция биохимических показателей. Двухкамерный осадочный бак проектирован на базе колодца Имхофа. Система Имхофа показала свои преимущества в процессе эффективного осаждения осадка и в процессе биохимической деградаций. Здесь происходит осаждение до 80% коллоидных частиц.

В результате анаэробного гниения в двухкамерном осадочном баке вновь поступающие осадки теряют около 47% органики. Хорошее представление степени деградации осадков дает предложенный Бахом “модуль минерализации”, который выражает отношение органической материи к пеплу в свежем и конечном осадке:

$$m = P / P_1$$

где – m есть модуль минерализации; P – отношение органической материи в свежем осадке к органической материи в конечном осадке; P_1 – отношение пепла в свежем осадке к пеплу в конечном осадке.

В момент технического предела деградации (при 50% деградации осадка по отношению к сухой беспепельной материи, который отвечает на 50% деградации по отношению объема) $m = 2$.

При нормальном протекании процесса в двухкамерном осадочном баке вода из второй камеры должна иметь следующие показатели:

– алкалность с 30 по 60 гекв/м^3,
– жировые кислоты с 5 по 12 гекв/м^3,
– жировая кислота до 20%.

Из двухкамерного осадочного бака вода переходит в анаэробный реактор, где идет процесс чистого биологического очищения в анаэробных условиях. Здесь совершается понижение биохимических показателей более чем на 60%.

После анаэробного реактора вода проходит в сегментах биологического фильтра, где вода очищается на 80%–90% в сравнении с водой на входе. Фильтр тоже функционирует в анаэробных условиях. Здесь задерживается небольшое количество активных осадков, которые связаны с диссимиляцией биодеградационного процесса.

Очистное сооружение функционирует в анаэробном режиме и не требует больших экономических расходов на поддержание и эксплуатацию. Редукция органики и очищение водой идет за счет генерирования осадка и отходного газа (биогаза). Получение биогаза есть неизменное явление в анаэробных процессах биодеградации органики в сточных водах. В ходе эксплуатации модульное сооружение на 500 жителей генерирует в среднем 3-4 м^3 биогаза в сутки. Для стабилизации анаэробного режима работы принимается соотношение CH_4:CO_2 как 1:1. Из за низкой концентрации метана в отходном газе, он выходит в атмосферу через газовые отводные трубы.

Основной критерий для правильного функционирования – это контроль и отстранение осадка с функциональных единиц очистительного сооружения.

Осадки, которые образуются в очистительной установке, имеют два вида:

– осадок из суспензированных частиц, с более высокой плотностью чем вода;
– осадок с биомассой микроорганизмов биодеградантов.

Осадок из микроорганизмов формируется как в двухкамерном осадочном баке, так и в анаэробном реакторе. Осадок в биофильтре не формируется, так как анаэробные микроорганизмы,

ассимилируются от живых, приклеенных к фильтрующему материалу, микроорганизмов. Количество осадков от анаэробных бактерий оказывается минимальным из за природы их метаболизма (анаэробные микроорганизмы продуцируют меньше биомассы по сравнению с аэробными). Третирование этих осадков получается через перемещение части осадков от анаэробного реактора к двухкамерному осадочному баку гидравлическим путем. В двухкамерном осадочном баке бактерии помогают инициированию биодеградационного процесса, а мертвые бактерии выпадают в осадок на дне.

Первичный осадок задерживается в двухкамерном осадочном баке, где идет процесс стабилизации от микроорганизмов. Для стабилизации осадков необходимо время приблизительно 6 месяцев при средней температуре – 20°C. Стабилизация включает уничтожение части патогенных микроорганизмов (в двухкамерный осадочный бак непрестанно поступает новое количество "неочищенной" воды, следовательно, полное уничтожение невозможно).

После 6 месяцев необходимо достать накопленный осадок и его дальнейшую судьбу можно определить в зависимости от следующих возможностей:

– транспорт осадка до сооружения для окончательной стабилизации осадка (в метанстенки в больших коммунальных очистительных станциях);

– использование в сельском хозяйстве как удобрение (после отстоя в грязеуплотнителе или приспособленном для этой цели резервуаре, предварительно дезинфицированным хлором).

На выходе очистного сооружения возможно найти бактерии, отмытые с биофильтра. Они не опасны, так как из за своей анаэробной природы они быстро умирают (кислород является токсичным для их метаболизма).

Вода с растворимыми и коллоидными веществами поступает в биофильтр. Здесь органический материал в процессе анаэробной ферментации превращается в биогаз. В конце процесса вода биологически фильтруется. Осадок из бака перемещается в грязевой резервуар один раз в 3 месяца, далее один раз за 6 месяцев вывозится для сельскохозяйственного использования. Общее время задержания – 4,7 ч.

Данные параметры определяют размеры и строительную площадку очистительной установки:

Параметры анаэробного очистителя:

- Время задержания 3,5 – 4,7 ч;
- Температура 10 – 55°C;
- Продукция биогаза 9–11 $м^3$/ день;
- Степень пурификации по отношению к химическому потреблению кислорода 82%;
- Итоговое количество биологического расхода кислорода 10–15 мг/л;
- Итоговое количество химического расхода кислорода 20–30 мг/л.

Резистентность к ингибиторам

Новый биофильтр имеет очень высокую устойчивость к следующим ингибиторам: **фенолу, формальдегиду, метанолу, тяжелым металлам** и т.п. Например, 6,4% формальдегида, прошедшего через биофильтр (мезофильные условия), преобразован в биогаз в объеме 96%. Тяжелые металлы Cr(6+) редуцированны на менее токсические формы Cr(3+). Фенол в концентрации в 1000 раз большей, чем концентрация ингибирующая аэробный процесс, не нарушает функционирование биофильтра.

Элементарная сера из разных веществ редуцируется на натуральную форму. Все процессы протекают при соответствующем потенциале внутри биофильтра.

Общий вид и устройство сооружения для анаэробного третирования сточных вод

Очистные сооружения проектируются в соответствии с запросами заказчика, условиями участка и местоположения. В общем виде сооружения приведены ниже, см. схемы 1, 2, а также фото 1-5.

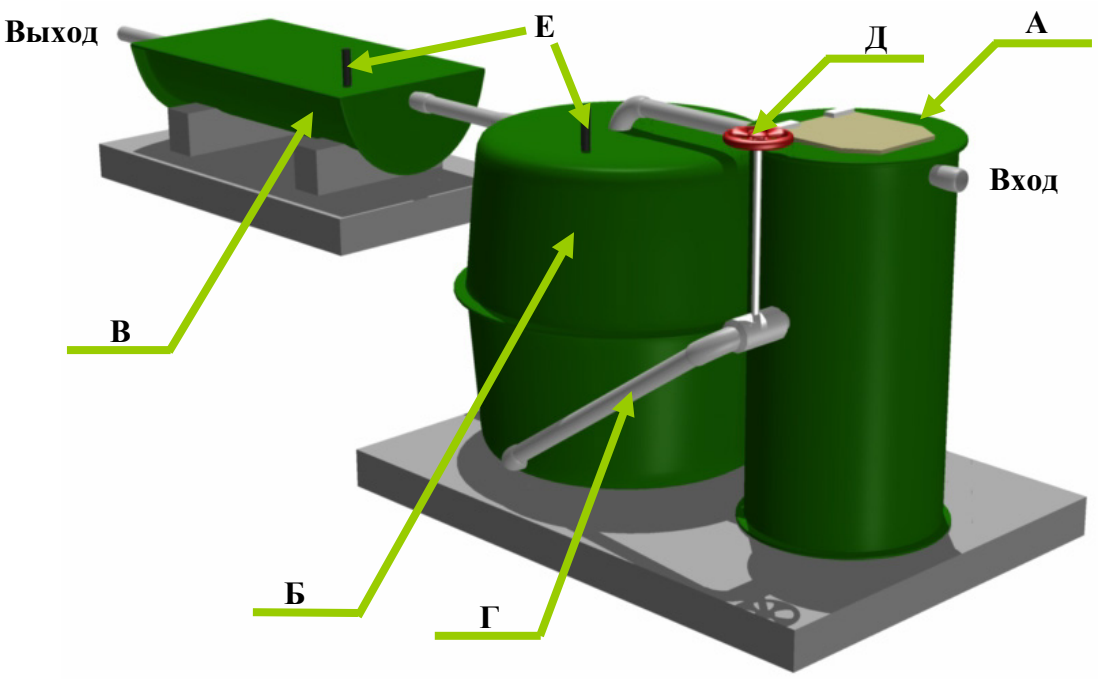

Схема 1. Малое водоочистительное сооружение (ЕЖ до 20)
А – Двухкамерная емкость; Б – Анаэробной осадочный реактор; В – Биофильтр; Г – Труба для перекачки микробиологической массы; Д – Кран для перекачки осадка из биореактора (опциональный); Е – Выходы для биогаза

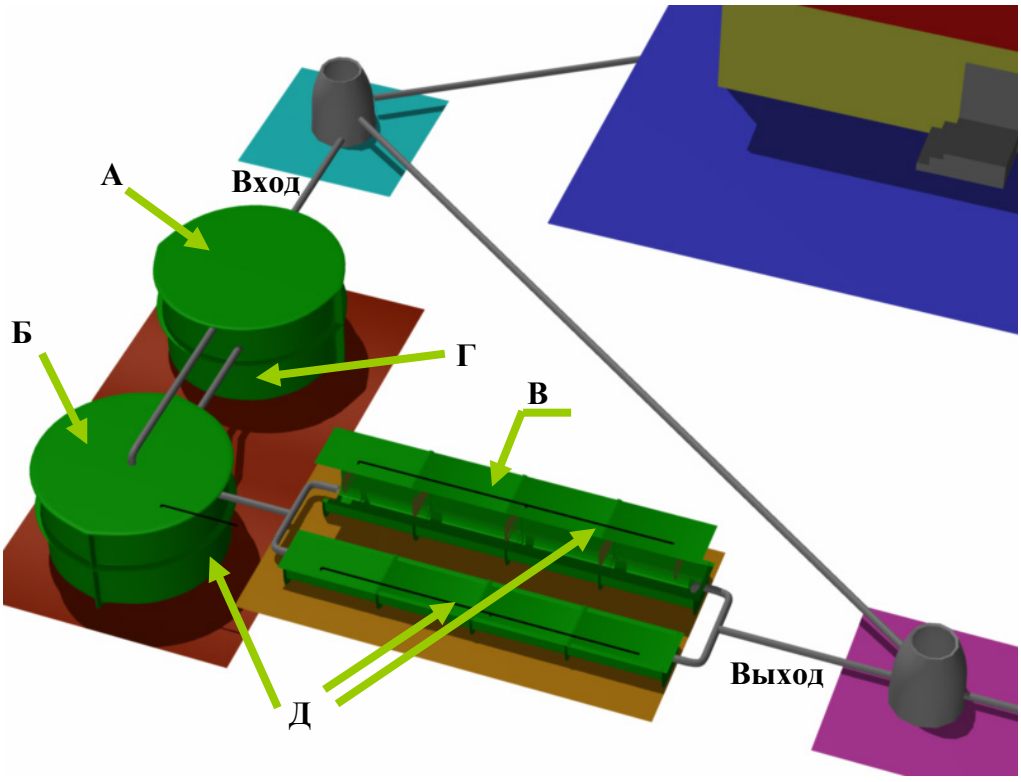

Схема 2. Крупное водоочистительное сооружение:
А – Двухкамерная емкость; Б – Анаэробный осадочный реактор; В – Биофильтр – состоит из нескольких сегментов в зависимости от нагрузки; Г – Труба с возвратным клапаном для перекачки микробиологической массы обратно в двухкамерную емкость; Д – Выходы для биогаза

За данной схемой сооружения стоит запатентованная и высокоэффективная система анаэробного третирования сточных вод с высокой органической нагрузкой. Данная система может меняться в зависимости от желания клиента, чтобы удовлетворить одно из двух или оба требования эффективности водоочистки: малая энергоемкость и высокая биологическая активность микробиального консорциума.

По данной технологии мы построили более чем 30 объектов в Болгарии, 24 – в Чехии, Узбекистане, Таджикистане, Грузии и Македонии.

Охрана природы это наша обязанность. Чистой воды на планете Земля становится все меньше и меньше, она все больше загрязняется. Мы очищаем воду от бытовых загрязнений и стараемся постоянно усовершенствовать наши установки и помогать природе в борьбе с последствиями техногенного и бытового загрязнения природных вод, способствуем наилучшему использованию одного из самых ценных природных богатств – ВОДЫ!

Подробную информацию относительно нашей фирмы можете получить, посетив сайт – ***www.prote.hit.bg***.

Фото 1. Песколовка (ОСОВ - с. Лясковец)

Фото 2. Поле для высушки осадка в процессе строительства (ОСОВ - с. Лясковец)

Фото 3. ОСОВ для Болгарской антарктической базы на о-ве Ливингстоне

Фото 4. Очистительная станция для отходных вод – мясоперерабатывающая фабрика

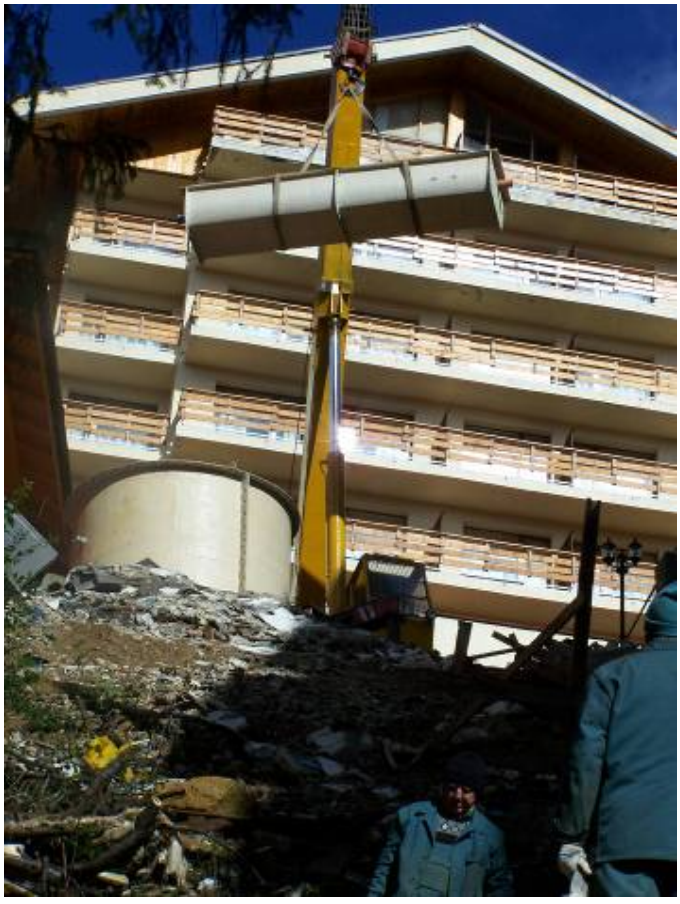

Фото 5. Разгрузка - спортивная база для отдыха, к-к Пампорово

Environmental protection

ADMISSIBLE NORMS OF EROSION AND THEIR ROLE IN PLANNING SOME EROSION-PREVENTIVE MEASURES

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ABSTRACT: The definition of the term "depth of soil" and three ways to determine the admissible norms of erosion are given in the present article which also provides a formula of admissible irrigation erosion to be used in planning some erosion-preventive measures.

KEYWORDS: erosion, soil, depth, time resource, intensity.

High-intensity erosive processes rarely occur in natural conditions. These processes are characterized by high-intensity rains, strong breezes, surface irrigation processes with high-rate discharge, etc. The losses of soil layer caused by erosion are compensated by the soil formation process which may be considered to be a continuous one.

The existence of a soil layer on slopes indicates the fact that the soil formation process has been more intensive in the natural conditions than erosion and there was some balance between these processes for a long period of time. Soil management for the purposes of farming industry, deforestation, mechanical and other impacts on the earth's surface, which have different aims, disrupted the natural balance between these processes and the imbalance resulted in intensification of erosion. In response to the development of these processes the quality of agricultural lands degraded and the danger of their turning into completely inarable ones appeared. That's why it became necessary to work out, plan and carry out measures which will reduce the intensity of erosion processes, restore balance between formation and loss of soil in the conditions of continuous farming industry [4, 5, 6, 7].

Intensity of soil formation and rapidity of this process is determined according to thickness of soil layers or depth of soil. Admissible norms of erosion are determined on the ton-per-hectare-per-year basis, which may be recounted at the average admissible soil erosion depth. If we take into consideration the fact that due to various reasons the depth of soil differs on different slopes and the intensity of erosion is different at different sections of the same slopes, then it becomes obvious that establishment of admissible norms of erosion in the form of admissible depth of erosion must have advantage. e.g., rainfall runoffs intensively wash lower parts of slopes, but exceptions may be even at lower parts of slopes with sag profiles. During irrigation processes erosion progresses in upper parts of irrigation lines and canals. In case of soil aeolation, relief, windbelts and wind directions gain importance. Thus, the risk of erosion may be evident at their different parts. That's why the admissible norms of erosion must be specified in consideration of the depth of soil within these parts of slopes. Of course, determining the admissible norms on the ton-per-hectare-per-year basis doesn't enable us to do it.

In the majority of cases determination of the admissible norms of erosion is associated with the soil-building rate. It is supposed that the thickness of eroded layer during a year must not exceed the soil-building rate at the average [1, 2].

According to the existing data, the admissible norms of erosion fluctuate from 1-15 tons per year. According to American data, in natural circumstances the soil-building rate equals 0.08 mm, which

becomes ten times as much when the soil is cultivated. These data deal with soils with minor depth, because other data evidence that for deep soils this process is significantly slowed down. This peculiarity of the process is understandable because in the first case at the lower edge of a soil layer chemical, physical, biological and mechanical processes are more intensive then in case of deep soils. If in such conditions we relate the determination of the admissible norms of erosion immediately with the soil-building rate, then well face a certain discrepancy, where soils with minor depth may have higher admissible norms of erosion than deep soils.

Let's consider a method to determine admissible norms of erosion, which is not related with the soil formation intensity. According to this method, the formula to calculate admissible norms of erosion is the following:

$$W_{SO} = \frac{\xi_1 - \xi_0}{T} \qquad (1)$$

where ξ_1 is the actual depth of soil, ξ_0 – minimum admissible depth; T – time resource. It's generally accepted that ξ_0=10-15 cm, and T, the variable of time must represent a long period of time during which we're going to use the existing layer of soil as a material resource. The formula (1) implies that if the annual loss of soil doesn't exceed W_{SO} variable, then after T period of time the depth of soil won't be minimum admissible depth ξ_0 named preliminarily.

These two methods aimed at the determination of the admissible norms of erosion may be combined if we take into consideration that during T period of time the process of soil formation will take place. Then instead of the formula (1) we'll have

$$W_{SO} = \frac{\xi_1 + \int_0^T V_p d\,t - \xi_0}{T} \qquad (2)$$

where V_p is the soil-building rate; and t – time; V_p soil-building rate depends on the depth of soil and it's rather difficult to forecast it as a function of time for a long T period. So let's replace it with a mean V_p and assume that $\int_0^T V_p d\,t = \overline{V_p} \cdot T$, then the formula (2) will turn into

$$W_{SO} = \overline{V_p} + \frac{\xi_1 - \xi_0}{T} \qquad (3)$$

to determine T time resource, we my use an assertion that a period of 1 000 years in enough for the restoration of soils of all types [3]. In this case we may equal with the time resource with a half of the restoration period T = 500 years.

We may assess all three ways to determine the admissible norms of erosion. If we equal the admissible norm of erosion with the soil-building rate, it implies that the present condition of soil is preserved even if its weak. In the third case the restriction of the admissible norms of erosion is somehow mitigated as compared to the second one, but in both cases it's implied that with the lapse of time the condition of the soil will degrade (depth reduction).

All these approaches have a passive (self-protection) character and imply preservation of the present condition or delaying the unavoidable degradation.

Considering the issue from a slightly different point of view, let's suppose that ξ is still the existing depth of soil, which increases during T_0 period of time by $V_p \cdot T_0$ – value, and will be reduced by $V_p \cdot T_0$

value because of expected erosion processes. Let's use ξ_{OL} to represent the depth of soil which will be desirable after T_0 period of time. Then we may write the following equation:

$$\xi_1 + \overline{V}_p \cdot T_0 - W_{SO} T_0 = \xi_2 \qquad (4)$$

from which

$$W_{SO} = \overline{V}_p + \frac{\xi_1 - \xi_2}{T_0} \qquad (5)$$

where T_0 is the time to restore the desirable depth of soil.

If $\xi_2 > \xi_1$, then $W_{SO} < \overline{V}_p$ $W_{SO} < V_p$ and during T_0 period of time increase of ξ_1 – depth ξ_2 – value. T_0 period of time must certainly be chosen in consideration of the mandatory requirement $W_{SO} > 0$. If $\xi_1 = \xi_2$, then $W_{SO} > \overline{V}_p$ and in this case the condition of soil will be preserved. If $\xi_1 > \xi_2$, then $W_{SO} > \overline{V}_p$ and for economic reasons we shall not carry out erosion-preventive measures and use the soil as a material resource or a certain period of time.

Thus, on the basis of the formula (5) determining the admissible norms erosion enables us to regulate the condition of soil on areas.

The necessity to carry out erosion-prevention measures must be argued by means of comparison between the W_{SO} admissible norms of erosion and prognosis of erosion processes. If we denote the latter W_P, then the in equation $W_P > W_{SO}$ conditions the necessity to carry out erosion-preventive measures. If we denote the prognosis for rainfall erosion W_1, and the prognosis for aeolation – W_2, then $W_P = W_1 + W_2$.

We are not able to regulate winds and rains and the irrigation erosion depends on the development of irrigated areas and irrigation technology. So, if slopes are characterized by rainfall erosion (aeoloation), then preventive measures must be directed against the erosion of this type. If both types of erosion exist simultaneously, then measures preventing one of them or both ones simultaneously must be planned according to their portions in the W_P prognosis. If the areas characterized by aeolations or rainfall erosions are subject to broad irrigation, then for one case of irrigation the value

$$W_{Si} = \frac{W_{SO} + W_P}{m} \qquad (6)$$

will be the admissible norm of erosion where *m* is the irrigation repetition factor.

The prognosis of the expected erosion hazard and admissible norms of erosion must be taken into consideration with regard to the part of irrigated areas. For this purpose we must know all indicating values at the heads of irrigation lines and canals, which condition the intensity of erosion. Namely, water flow, velocity, duration of irrigation, fall of slope, etc.

CONCLUSION

The existing scientific data and experience point to the fact that it's too and often impossible to prevent erosive processes and they always occur with some degree of intensity. That’s why plans for erosion-preventive measures must foresee reduction of the intensity of processes within certain boundaries. Due to this factor, it becomes necessary to determine admissible norms of erosion. These norms must be based on certain considerations conditioned by set goals. Besides, because of the variety of erosion processes it’s necessary to find out ways and means for further consideration of these norms.

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Hydrology and meteorology

THE ARPA RIVER NATURAL FLOW ASSESSMENT

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ABSTRACT: Investigation of the Arpa river factual outlet has been implemented and according to the results the natural outlet values of Jermouk and Areni water metering observatory of Arpa river have been restored taking into consideration the values of water intake from the basin in various economic purposes. Their intra-annual and seasonal distribution was implemented based on the monthly natural outlets. Here there are presented the Arpa river water flow decreasing trends within the last 50 years. The drawn trend lines equations are suggested to apply for the performing of projections of Jermouk and Areni observatory's average annual outlets over the next 15 years. The assessed natural flow results are suggested to apply in Arpa basin water demand planning and water use permissions application processes.

KEYWORDS: water regime, natural outlet, water flow intra-annual distribution, water intake, trend line, climatic change.

For the efficient use of basin water resources it is very essential to draw reasoning on the changes in the hydrological regime, which have already befallen under the influence of economic activities and on those consequences, which can lead to planned measures of the transforming conditions of water forming and water flow in river water collects.

The assessment of river regime and quantity changes is of scientific significance under economic activity influence in the purpose of measures processing of rational use, maintenance, fish farming and irrigation of water resources.

Over the last few decades, especially in the lower stream of the river the human economic activity has greater impacts on water flow intra-annual regime, which on the annual basis leads to water flow considerable redistribution.

At present there exist a few dozen water intake constructions allocated in the distance of more than 90km from Arpa river source to the Republic of Armenia state border, including the Arpa-Sevan tunnel having been put into operation since 1981, which transfer water to Lake Sevan. The Arpa water flow annual distribution has been drastically changed under the influence of approximately 50 billion m^3 water transfer from Arpa basin to Lake Sevanby the tunnel in hitherto period of time.

However the Arpa river water flow in the formation zone at the source theretofore under the human economic activity influence hasn't been nearly changed in practice and it can be considered close to natural, and its regime insignificant change is mainly connected to global climatic changes.

Figure 1 shows the annual quantity dynamics of Lake Sevan transferred water since 1968 until the Arpa-Sevan tunnel operation.

The small values of transferred water volumes from Arpa basin in the period of 1987-88 and 2011-12 presented in Figure 1 are connected to the tunnel reconstruction works.

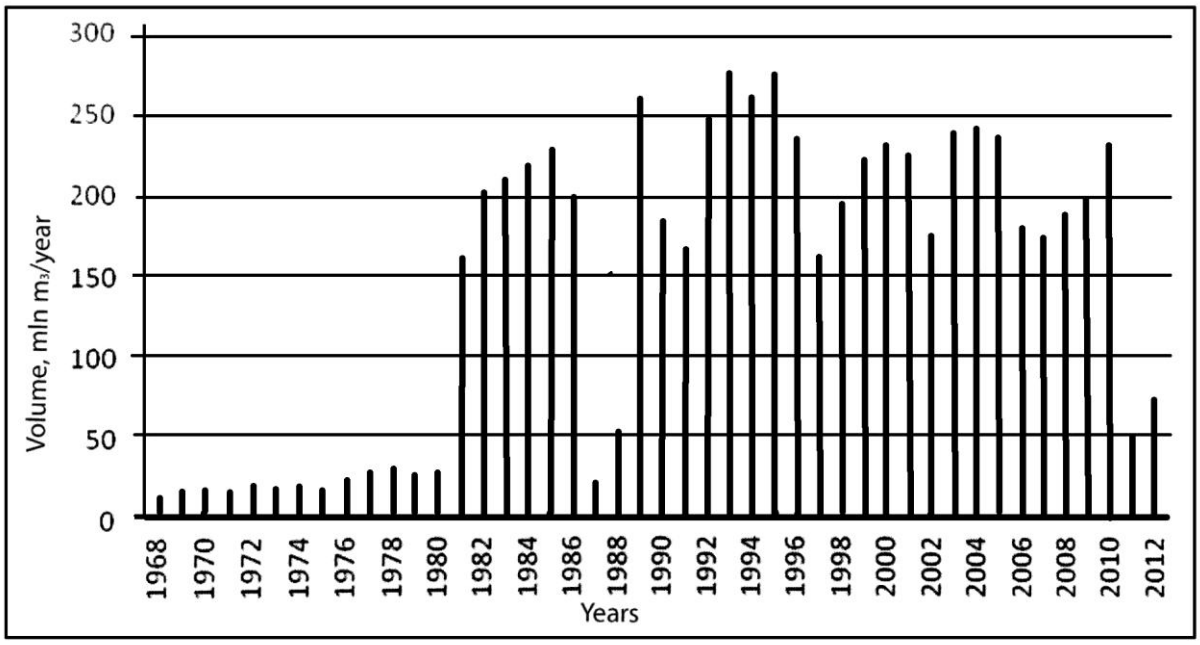

Figure 1. Lake Sevan transferred annual water volume from Arpa basin from 1968 to 2012 period

Taking into consideration, that in the last two decades the factual water intake data existed in different purposes in the result of the republic's economic crisis in the organizations under operation are not complete, hence there have taken place restoring of river outlet missing data on the basis of water intake existing data and the last years water intake values until 1995 and according to the permission by the Agency of Water Resource Management of the Ministry of Nature Protection given to the water intake to implement appropriate interpolation between these periods.

It is known, that after water intake some part of the water is returned to the river (backwaters) for different economic reasons, but a significant part of it is lost not returning especially after the irrigation.

According to the results of the surveys of the Institute of Water Problems and Hydro-Engineering on the territory of the republic the average quantity of the backwaters after the irrigation forms approximately the 20% of the used water, and after the use in water supply purpose forms approximately 80%, which are accepted as the water intake calculated value.

The water quantity taken form Arpa and Yeghegis rivers by the Arpa –Sevan tunnel and transferred to Lake Sevanbelow the Ketchut basin and for the hydrological observatory of Yeghegis river is accepted totally not returning as they are transferred out of the Arpa basin.

Above the Arpa-Jermouk observatory the water intake from Arpa basin is mainly implemented in irrigation purposes, as well as from the sources in Jermouk town water supply purpose.

Above Arpa-Areni observatory the water intake is mainly implemented by Arpa-Sevan tunnel in nature protection, irrigation and hydro-energetic purposes as well as underwater sources of Spitakjur, Mayrgortsaran, Darayurd, Ketchut, Sarnaghbyur, Madin, Vank and othersdispersed in the basin in the purpose of water supply of Jermouk, Vayk and Yeghegnadzor towns and basin communities.

For the restoration of Arpa basin natural flow there was added the flow value of the Yelpi river flowing into Arpa below the closing observatory, the water quantity transferred to Lake Sevanfrom Arpa basin by Arpa-Sevan tunnel as well as water intake values in different economic purposes taking into consideration the river returning water quantity after the usingto the Arpa-Areni factual estimated flow value of the basin closing observatory.

For the assessment of economic impact on the hydrological features, as well as for the bringing the Arpa factual flow to natural we used the below mentioned formula in the following manner

$$Q_{sA} + Q_{wu} + Q_{sE} \pm Q_t = \Delta Q, \qquad (1)$$

where Q_{sA} - is the Arpa river water outlet in the studied water-metering observatory taken into consideration the Darayurt, Zirakijur, Gravb, Her-her, Vayk, Gladzor, Yeghegis streamlet outlets flowing into Arpa, Q_{wu} - is water intake values in different economic purposes taken into consideration the returning water quantity returned to the river after the using, Q_{sE} - is the Yelpi river outlet, Q_t - is the Arpa basin (from Vorotan)or eighboring other basin transferring (from Arpa and Yeghegis by Arpa-Sevan tunnel) water quantity from neighboring basin in different (drinking-household, irrigation, industrial, hydro-energetic) economic or nature protection purposes, ΔQ - is the formula's parity fault, which includes the evaporated and filtrated waters from the river, as well as the estimated allowable errors values of the equation balance members.

To determine Q_{sA} and Q_{sE} there were applied the average annual outlets of measured water in Arpa-Jermouk, Arpa-Areni and Yelpi hydrological observatories.

Q_{wu} were determined applying the water intake data from Arpa and its streamlets, taking into consideration not returning and above mentioned percentages of water lost after the use.

To determine Q_t there were used hydrological yearbook and bulletin [1, 2] materials as well as the water use permissions given by the agency of water resource management.

By the use of the restored factual flow and water intake data, there were estimated and restored the natural average monthly outlets of Jermouk and Areni water-metering observatories of Arpa for the 1961-2012 period of time.

By the use of derived natural monthly outlet values and simultaneously by the use of the suggested flow annual distributed mode for river waters applied by Adrianov [3], which is used in hydrology, the average multiyear natural values of the above observatories were calculated for the hydrological seasons of three years. The above is presented in Table 1.

Table 1

The average multiyear seasonal values of Arpa natural flow

River - observation	Natural flow	March – June	July – November	December – February	Year
Arpa – Jermouk	mln. m^3	106.20	43.29	20.12	170.24
	%	62.38	25.80	11.82	100
Arpa – Areni	mln. m^3	417.67	154.13	71.47	643.27
	%	64.93	23.96	11.11	100

Based on the annual outlets data of Arpa there have been created the flow change graphs for 1961-2012, the value of which are presented in Figure 2.

The studies show the hydro meteorological characteristics in the river upper and lower streams in Arpa basin have been changed in different degrees.

For instance, according to Jermouk hydro meteorological station's data the snow precipitation quantity within 50 years have been increased by approximately 14%, as a result of which, according to Arpa-Jermouk hydrological station water-metering data, in that period of time the natural flow by the trend line equation (3) has been increased by 20.5% and the factual flow by 17.1% (equation 2).

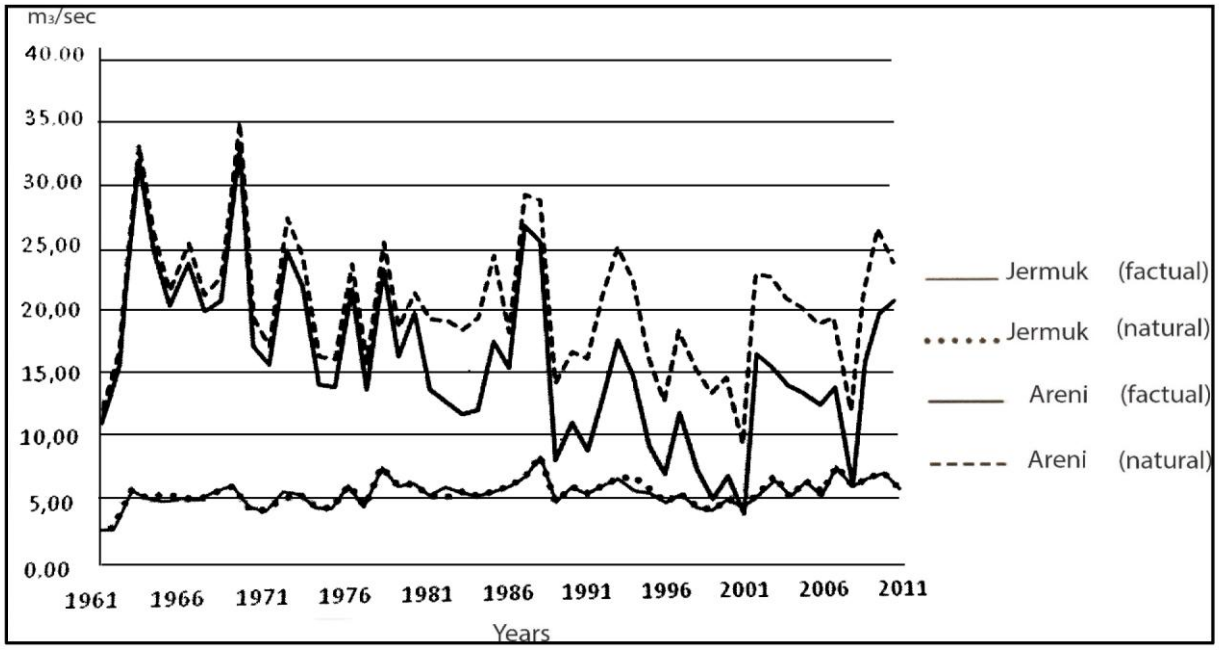

Figure2. The flow change tendency in Arpa-Jermouk and Artpa-Areni observatories from 1961 till 2012

According to Yeghegnadzor meteorological station data, the atmospheric precipitations in 1961-2012 period of time were decreased, as a result of which the natural flow in Arpa-Areni was decreased by 19.1% (equation 5) and the natural flow below Jermouk town reaching Areni residential area was decreased by 52.09% (equation 4) as a result of economic massive activity, especially after Arpa-Sevan tunnels operation.

$$y = 0.016x - 26.80, \quad (2)$$

$$y = 0.018x - 30.81, \quad (3)$$

$$y = -0.221x \div 455.32, \quad (4)$$

$$y = -0.086x \div 192.28. \quad (5)$$

The connection lines presenting the flow decrees tendencies of Arpa basin as well as their linear trend equations suggest applying in Jermouk and Areni observatories within the next 15-20 years to prevent the flow decreasing tendency.

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Environmental protection

THE EVALUATION OF EROSION PROCESSES INTENSIVELY RUNNING ON THE RESORT TSAGVERI BURNT MOUNTAIN SLOPES ON THE BASE OF DETERMINATION OF CLIMATIC, PHYSICAL-MECHANIC AND CHEMICAL CHARACTERISTIC OF SOIL-GROUND

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ABSTRACT: Have been implemented determination of climate indicators, soil physical-mechanical and chemical characteristics which caused soil erosion processes running on the burnt mountain slopes of resort Tsagveri. On the base of the research may be tell that geo-ecological investigation, implemented in 2012-2013 show us a number changes occurred on the Rusi stream section of the Tsagveri.

KEYWORDS: erosion, geologic process, humus.

The field studies were carried out in the burnt district was selected strongly eroded slope of the Rusi burnt mountain stream, which is located in the central part of the folded system in the Borjomi valley. Were separated two engineering-geological elements of the burnt area (EGE): burnt and partially burnt humus layer (EGE-1) and containing the roots of plants, inserts of crushed rock and gravels (EGE-2). Carried out the soil sampling and meteorological data mining on the burnt slope (See the photos 1 and 2).

Carried out the laboratory analyzes of samples taken from the stream of the Rusi burnt slope. Determined by soil physical properties, composition, strength characteristics and humus content of the varying degrees of damage to soils. Therefore, were taken structure of the samples violated and inviolable (Deep in the soil – 0-0,05 m, 0,05-0,1 m, 0,1-0,15 m, 0,15-0,2 m, 0,2-0,3 m, etc). Also defined physical and physical and chemical parameters.

Photo 1. The Photos of the investigated slope (IV. 2013 Year)

For assessment of slope stability and erosion processes determining is soil strength characteristics, namely the angle of internal friction and cohesion.

Determinations of strength characteristics have been implemented by standard device *BCB* – 25 under vertical loads p = 0.5-3.0 kgf/cm ^{2}, as the natural moisture conditions, also water saturated conditions.

The experiment was carried out the soil EGE - 2 (Engineering geological elements – 2) containing the roots of plants, inserts of crushed rock and gravels for in fact, the current layer samples in the natural moisture and water saturated conditions. In the second case without root samples. Same moisture, for modeling samples (see the table 1 and 2).

Table 1

Chemical analysis results of the soil on the Borjomi region Tsaghveri (Rusi stream)

№	The soil sample	Soil layer, cm	Hygro-scopic water, %	Dry residue mg/*l*, %	Humus %	pH	CO_2	Anions			Cations		
								mg/100g %	mg/*l* %	mg/*l* %	mg/*l* %	mg/*l* %	mg/*l* %
		Samples taken in January 2013											
1	Tsaghveri, Rusi stream Pit 1	0.0-0.05	2.24	554 100%	2.2	7.34	5.0	24	223.99	28.96	142.8	7.34	126.72
								4.33	40.43	5.22	25.77	1.32	22.87
2	Tsaghveri, Rusi stream Pit 2	0.0-0.07	2.25	451.4 100	2.04	7.60	5.49	37	174.21	14.48	93.84	75.88	55.97
								8.12	38.59	3.2	20.79	16.8	12.39
3	Tsaghveri, Rusi stream Pit 1	0.05-0.25	2.41	338.3 100	**0.55**	**6.77**	**5.43**	37	124.9	7.27	61.44	–	**107.73**
								10.94	36.92	2.15	18.16	–	**31.84**
		Samples taken in July 2013											
1	Tsaghveri, Rusi stream Pit 1	0.01-0.1	0.0967 9.67%	6.07	7.56	5.0	36.25	48.8	28.4	4.0	9.6	**99.85**	0.01-0.1
2	Tsaghveri, Rusi stream Pit 2	0.0-0.05	0.1094 10.94%	**8.75**	7.50	5.0	10.0	61.0	31.95	16.0	9.6	77.35	0.0-0.05

Table 2

The results of determining (φ, c, tgφ) stability characteristics of regulatory and reporting options of the Borjomi region Tsaghveri (Rusi stream) fixed area 2008-2013

The rock title and experimental conditions	X. 2008 Year						IV. 2013 Year						VIII. 2013 Year					
	With roots			Without roots			With roots			Without roots			With roots			Without roots		
	φ^n	c^n	tgφ^n	φ^n	c^n	tgφ^n	φ^n	c^n	tgφ^n	φ^n	c^n	tgφ^n	φ^n	c^n	tgφ^n	φ^n	c^n	tgφ^n
	φ^c	c^c	tgφ^c	φ^c	c^c	tgφ^c	φ^c	c^c	tgφ^c	φ^c	c^c	tgφ^c	φ^c	c^c	tgφ^c	φ^c	c^c	tgφ^c
EGE-1 Soil layer a large number of roots, strong humus layer burning of organic waste, inserts of crushed rock and gravels																		
A) Natural moisture conditions	38°22'	0.442	0.791	11°52'	0.226	0.210	31°42'	0.56	0.6167	12°	0.24	0.2116	28°56'	0.83	0.5573	11°	0.24	0.1944
	34°32'	0.294	0.688	10°22'	0.150	0.183	26°44'	0.37	0.537	10°27'	0.16	0.185	28°54'	0.558	0.481	9°39'	0.16	0.17
B) Water-saturated condition	22°	0.295	0.404	7°33'	0.184	0.1325	18°36'	0.33	0.3365	6°24'	0.18	0.1122	17°15'	0.42	0.31	7°	0.170	0.123
	18°24'	0.196	0.337	6°33'	0.122	0.115	16°14'	0.22	0.295	5°36'	0.12	0.098	15°19'	0.28	0.270	6°6'	0.113	0.1.7
EGE-2 Clayey containing the roots of plants, inserts of crushed rock and gravels																		
A) Natural moisture conditions	17°13'	0.393	0.30	16°	0.38	0.287	21°51'	0.51	0.4116	20°	0.36	0.364	23°13'	0.688	0.4312	19°36'	0.37	0.356
	15°6'	0.262	0.260	13°42'	0.253	0.249	19°51'	0.34	0.3580	16°47'	0.24	0.316	21°6'	0.458	0.375	17°12'	0.246	0.309
B) Water-saturated condition	15°42'	0.085	0.2505	7°36'	0.075	0.1334	17°48'	0.487	0.322	6°18'	0.09	0.011	9°14'	0.52	0.144	6°34'	0.09	0.121
	13°48'	0.057	0.218	6°18'	0.05	0.116	15°42'	0.324	0.28	5°26'	0.06	0.0095	7°6'	0.35	0.125	6°	0.06	0.105

Note: Numerator – φ^n, c^n, tgφ^n; Denominator – φ^c, c^c, tgφ^c.

Photo 2. The Photos of the investigated slope (VIII. 2013 Year)

Thus, the experimental data show that vegetation has positive role on the soil stability to erosion. During evaluation of vegetation necessary note, that it is fully rehabilitee during past six years.

The research results can be used to restore the unique biodiversity resort Tsagveri developed for the implementation of the complex in order to obtain preliminary data.

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Hydraulic engineering and irrigation

USE OF COMBINED DRAINAGE FOR DEHYDRATION OF EXCESSIVELY MOIST LANDS ON KOLKHETI PLAIN

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ABSTRACT: The article is about the problems of taking modern draining measures for perfecting the structure of agricultural lands on hard excessively moist soils located in the central part of Kolkheti Plain.

Until the recent years (until the 1990s), a complex technological method of arranging Kvali of cultivation of excessively moist soils and tube drainage was elaborated for subtropical perennial cultures, though it was not able to create a proper hydrological regime.

Combined (two-tier) drainage has been offered. Its technology envisages the creation of an optimal water-air regime for yearling cultures.

KEYWORDS: pipe drain, fissure drain, filter material, two-tier drainage, upper layer of ground water, excessively moist soils.

INTRODUCTION

The place and role of Kolkheti in Georgian agricultural system is defined by its unique agroclimatic resources and suitable geographical location which make a basis for formation of modern, effective agricultural production. Due to the temperature regime of the climate here it is possible to carry out continuous agriculture during the whole year. On the other hand, the existence of quite important areas of excessively moist territories is a factor decreasing the economic potential of Kolkheti. But amelioration of the lands can greatly decrease the negative impact of this factor and greatly define the level of development of economics in the Region.

MAIN PART

Each territory of Kolkheti Plain (225 thousand ha) is in unequal conditions in the viewpoint of amelioration. The most unprofitable conditions are in its central part which is distinguished with plain relief, low hypsometric location, insignificant inclinations, unprofitable soil conditions and abundant atmospheric precipitation (1,700-2,000 mm). Almost 75% (90,000 ha) of the area of this part of the plain is built with hard montmorillonite clays which have important filtration properties (K_f = 0.00 nm/day). Undesirable agrophysical properties in addition with hard clays are stipulated by great ability of swelling which, in case of soaking with moisture, minimizes active porosity, aeration and water flow in soil.

In parallel with cultivating Kolkheti Plain, the tendency of decrease in the share of ploughing areas and increase in the share of perennial plants (tea, citruses) were formed in the structure of agricultural lands; this depicted enhancing of intensification of agricultural production and development of

specialization in producing subtropical cultures of Kolkheti. The areas for subtropical cultures were drained by means of closed tube drainage. This measure based on the surface and intraground drainage principle should have facilitated an optimal water-air regime envisaged by the norm of drainage in one-meter thick layer for normal growth and development of plants. It must be noted that drainage perforated plastic pipes were laid without arranging a volumetric filter (mixture of sand and gravel). It was mostly stipulated by the fact that quarries of inert materials for drainage embankment were located in a long distance (50 km and more) from the construction site and by non-existence of mechanisms of filling drainage trenches with inert filtration materials, as well. At the same time, in European countries, during draining of soil-ground with week water penetration, a drainage volumetric filter had been used as a necessary element of drain construction for a long time. As the result of operation of tube drainage system as well as the tests carried out on the sections under study it was revealed that this amelioration measure was not able to create a relevant hydrological regime due to the composition of great amount of clay and silt fraction in the hard soil-grounds of the central part of the Plain. Mudding, depositing and clotting of pipes was developed which resulted in unsatisfactory performance of the drainage system and, accordingly, very poor harvest of tea and other cultures.

As soon as the Soviet Union was collapsed, the issue of providing the population with food products emerged. Considering the increase in the demand on crops all over the world and, accordingly, the growth of prices, it became necessary to make essential changes in the agricultural arable land system in the central part of the Plain. This requires the reconstruction of the existing draining systems which is necessary any way. Draining ways acceptable for yearling cultures shall be used envisaging the local conditions.

As it is mentioned above, the main reason of excessive moisture in the central part of the Plain is abundant long-term atmospheric precipitation in addition with hard soil-grounds. There are days when the amount of precipitation is ≥ 50.0, ≥ 75.0 and ≥ 100 mm. In this part of the Plain the number of days with ≥ 50.0 mm precipitation amounts to 6-8 and mainly in August-October. In this case the objective of hydrotechnics is to shorten the period of flooding the area in the period of falling atmospheric precipitation and decrease in soil saturation; this means that it is necessary to remove the precipitation fallen on the surface of soil and deposited in the layer for ploughing as soon as possible. The faster there are removed, the quicker the process of draining the soil will begin beneath, mainly, in the form of evaporation and transpiration. In consideration of the above said, a combined drainage has been widely spread in North European countries in the process of draining excessively moist hard soils in the zone of abundant atmospheric precipitation with saturated, mostly bound water. The said combined drainage presents a systemic network of pipe drains arranged with volumetric filter and arrangement of mole drains laid towards them in rectangular manner [1, 3]. Tube drainage plays a role of a permanent main drainage and mole drains have auxiliary functions, and they are renewed if necessary as the period of their operation does not exceed 3-5 years. That is why tube drainage is only arranged when an area is to be cultivated for yearling cultures for which it is necessary to create an optimal water-air regime in the upper 50 cm. layer according to the norm of draining. The use of this way is exceptionally rational in territories with plain relief where, in addition to removing surface water, upper layers of ground water leaked in soil shall be extracted.

On the basis of the materials of the studies carried out by the Water Management Institute it has been determined that in the swelling soils of Ktolkheti Plain the period of operation of mole drains does not exceed 1 year because of hard and often rains. Considering the said, the Institute offers **a new construction of a combined drainage** which is **distinguished** with the following: a fissure (width 0.1 m., height 0.6 m.) is filled well with water drain material during its arrangement [2]. In this case fissure drains

present a closed water reservoir, this means that a combined drainage consists of two tiers from soil surface (see the fig. 1).

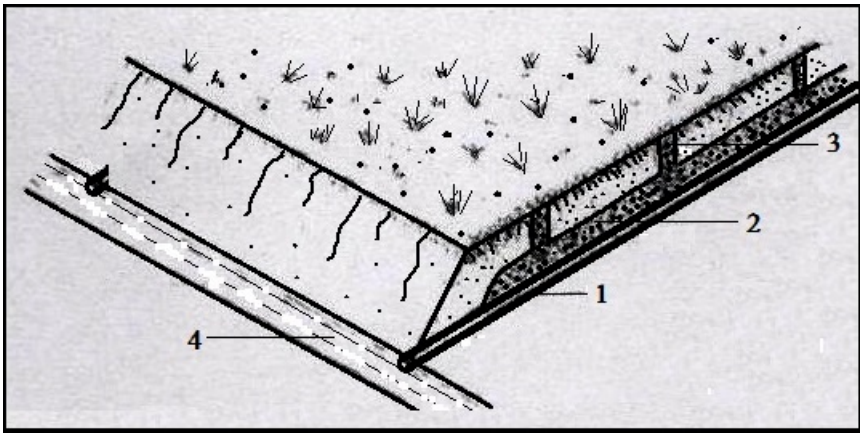

Fig. 1. Scheme of a combined drainage

1 – a pipe drain; 2 – filter material; 3 – a fissure drain; 4 – an open water reservoir.

The first tier from the surface is closed water collecting network, and the second tier – a tube drainage. The function of the first tier is to receive water and transport it the tube drainage of the second tier or it has a function of regulating the natural regime of soil moisture and upper layer of ground water. The function of the second tier is to transport water to the open water collecting network. Filtering filler provides hydraulic linking between the active layer of soil and the tube drainage which stipulates smooth receipt, transportation and accelerated draining of surface and soil-ground waters from the area to be drained [2, 4]. The proposed combined, two-tier drainage facilitates equal distribution of moisture on the area to be drained and in its soil profile; whole cultivation of the land area; mechanization of work processes are rather easy; operation of draining network becomes easier than Kvali which needs periodic restoration of an oval profile and annual cleaning of drainage ditches from deposits and plants which is related to material and labour expenses.

In Georgia, the construction of two-tier drainage was carried out on the testing territory ("Golden Fleece" farming territory in Village Torsa, Khobi Region) of the Water Management Institute, in 1989-1990. The area of this territory was 5 hectares. After cleaning the territory from trees and bushes and its leveling, tube (perforated, plastic $d = 100$ mm.) drainage of the second tier was laid by a drainlayer with narrow trench (the width of the trench 27 cm). It must be noted that for the first time in Georgia, during the construction of a closed draining network on the territory of Farm "Golden Fleece", tube drainage was arranged with filtering embankment. After arranging tube drainage network fissures were made on the area and it was ploughed and trenched in 50 cm depth. Trenching increased the non-capillary porous network in the whole profile of the soil which significantly improved its water-physical properties. Filter material was bulked on a drainage pipe by means of a self-propelled padding machine moving in parallel with the drain layer. After the stabilization of filtering embankment in the trench, the first tier – fissure drains filled with filer material – was arranged in 1990. Their arrangement was carried out by a trenchless drain layer in rectangular manner to tube drains. Fissures of 0.6 m depth and 0.15 cm width were cut in every 4 m distance and filled with filter material to the bottom of the tilled soil. The studies carried out have shown that during amelioration background of two-tier drainage, suitable conditions are created in the upper 40 cm layer of soil (the area of development of root system of yearling plants) where soil moisture changes and ranges between 36.5÷41.6% (out of the volume) average. The average air content in this layer of soil

equals to 17.5÷22.5%, moisture in the layer of the same thickness on the testing land plot has amounted to 46.4÷49.3%, and air content – to 2.8÷10.3%.

CONCLUSION

The areas of excessively moist soils in the central part of Kolkheti Plain must be cultivated with yearly plants. Due to soil-climatic conditions and unsatisfactory performance of the draining network the subtropical cultures cultivated on these areas are not provided with the optimal water-air regime necessary for normal growth and development. That is why it is necessary to reconstruct the existing amelioration systems and use such draining methods which comply with agro-biological requirements of yearling plants and create proper hydrological regime in the soil. In this case it is significantly important to provide scientific substantiation of the type and construction of drainage is and perfection of the method of calculation of the parameters which will fully envisage the natural conditions of the territories to be drained, the reasons of occurring excessive moisture and methods of their elimination.

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Construction and Architecture

DEFINITION OF MAXIMUM LOAD ON CIRCULAR AND RING PLATES

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ABSTRACT: Are studied both circular and circular, as well as having the initial curvature plates with plastic bending deformations accordingly of Mises plasticity conditions. The presented plate with a thickness of $2h$, load $P = P(r)$. In this paper are calculated values of the ultimate load for various cases of plate supporting. In order to simplify the nonlinear differential equation is also applied Treska-Saint-Venant plasticity condition, accordingly of that the ellipse is substituted by interim of circumscribed and inscribed hexagons ($\sigma_s^{'} \approx 1{,}08\sigma_s$).

KEYWORDS: plate, ultimate load, plasticity, boundary conditions, stress, deformation.

1. INTRODUCTION

The strength analysis of modern machinery and facilities often requires from engineer consideration of such factors and phenomena that are possible only due the theory of plasticity. At the same time carried out on the basis of modulus of elasticity would lead to over expenditure of material as well as unjustified increase in the weight of structure that is especially important in terms of requirements on aircrafts.

The critical analysis of possibilities of deformation theory assures us that its application for study of elastic - plastic equilibrium is appropriate only under certain restrictions related to deformation and loads. In particular, in order to determine the carrying capacity is justified the application of Saint-Venant-Levy-Mises theory, because it is destined for ideal plastic - rigid body.

The aim of task is consideration both for circular and circular, as well as having initial curvature plate's plastic bending deformations in the case of axis-symmetric loading. The values of maximum load for different cases for fixing plates would be found.

2. BASIC PART

Is considered the plane stress state of plate that thickness makes $2h$, load $P = P(r)$, and r is the radius vector of r, θ, z cylindrical system. The z axis is directed downward. Material is rigid – plastic. In the sections, where $r = const, \theta = const$ are acting only bending moments M_r and M_θ

$$M_r = \int_{-h}^{h} \sigma_r z dz; \qquad M_\theta = \int_{-h}^{h} \sigma_\theta z dz; \qquad Q = \int_{-h}^{h} \tau_{rz} dz; \qquad (1)$$

The differential equation of equilibrium will be as [1]:

$$\frac{dM_r}{dr} + \frac{M_r - M_\theta}{r} = Q \qquad (2)$$

The shear stresses on the circle $r = const$ are counterbalanced the external load, thus:

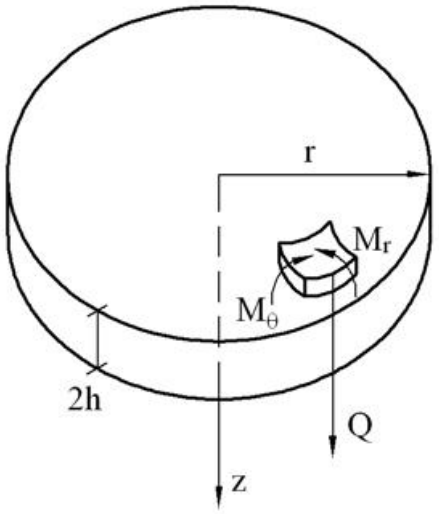

Fig. 1

$$Q = -\frac{1}{r}\int_{r_1}^{r} pr \cdot dr \qquad (3)$$

r_1 – is the inner radius of ring. In the case of ring plate $W = W(r)$ is a plate deflection velocity. Velocity component has the following form:

$$\xi_r = z \cdot M_r \qquad \xi_0 = z \cdot M_\theta \qquad (4)$$

The parameters of the plate's middle plane yielding rate are:

$$M_r = -\frac{d^2W}{dr^2} \quad M_\theta = -\frac{1}{r}\frac{dw}{dr} \qquad (5)$$

The plate bending equations (from the Mises yield condition) will be as [2, 3]:

$$\xi_r = -\frac{\lambda'}{3}(2\sigma_r - \sigma_\theta); \quad \xi_\theta = \frac{\lambda'}{3}(2\sigma_\theta - \sigma_r) \qquad (6)$$

The different from zero stress components σ_r and σ_θ satisfy the following condition of yielding:

$$\sigma_r^2 - \sigma_r\sigma_\vartheta + \sigma_\theta^2 = \sigma_s^2 \qquad (7)$$

(6) equations are written down as:

$$\xi_r = -\frac{\lambda'}{3}\frac{df}{\partial\sigma_r}; \quad \xi_\theta = \frac{\lambda'}{3}\frac{df}{\partial\sigma_\theta} \qquad (8)$$

Here as f is indicated the left side of yield strength state expression. In other words the vector of rate of strain is normal to yield locus (Fig. 2, dotted line). The ratio $\frac{\xi_r}{\xi_\theta}$ let's designate as η then from (6) we obtain that along the σ_θ normal is proportional to σ_r, but in this case, from the same yield condition are derived also the following equalities:

$$\sigma_r = \pm f_1(\eta)\sigma_s \text{ and } \sigma_\theta = \pm f_2(\eta)\sigma_s \qquad (9)$$

Here f_1 and f_2 are the certain functions of η.

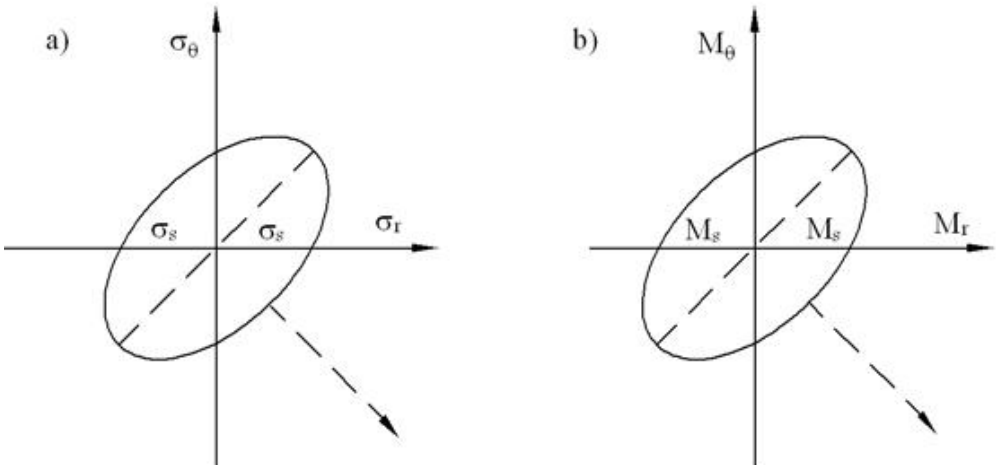

Fig. 2

Therefore the stresses σ_r and σ_θ along normal are constant for all positive z and change their signs for negative z. At the same time they have the discontinuity on middle plane (similar as beam's bending) and on the yield ellipse will be expressed by opposite points. Thus

$$M_r = -\sigma_r h^2 \; ; \; M_\theta = \sigma_\theta h^2 \tag{10}$$

Accordingly, we will have:

$$M_r^2 - M_r M_\theta + M_\theta^2 = M_s^2 \tag{11}$$

where $M_s = \sigma_s h^2$ is a maximum value of bending moment. This equation represents a particular case of the shells plastic bending according equation. If in (6) we substitute the stresses by corresponding moments, as well as strain rates by components of curvature η_r and η_θ, as a result of simple transformations we will obtain:

$$\eta_r = \lambda^* \frac{\partial F}{\partial M_r}; \quad \eta_\theta = \lambda^* \frac{\partial F}{\partial M_\theta} \tag{12}$$

Let's now by application of (11) exclude M_θ and introduce its value in the differential equation of equilibrium (2). We will obtain a nonlinear differential equation related to M_r.

$$\frac{dM_r}{dr} = \frac{1}{r}\left(\frac{1}{2}M_r \pm \sqrt{M_s^2 - \frac{3}{4}M_r^2}\right) = Q \tag{13}$$

The solution of this equation for corresponding boundary conditions determines the maximum load, due the transformations of (4) and (6) equations we will obtain the simultaneous equations plate bending rate:

$$\mu(2M_\theta - M)\frac{d^2W}{dr^2} - (2M_r - M_\theta)\frac{dW}{dr} \tag{14}$$

By integration of this equation (due application of known M_r and M_θ moments and the boundary condition) the (14) take the following form:

$$M_z - 2M_\theta = \pm\frac{2}{\sqrt{3}}M_s \tag{15}$$

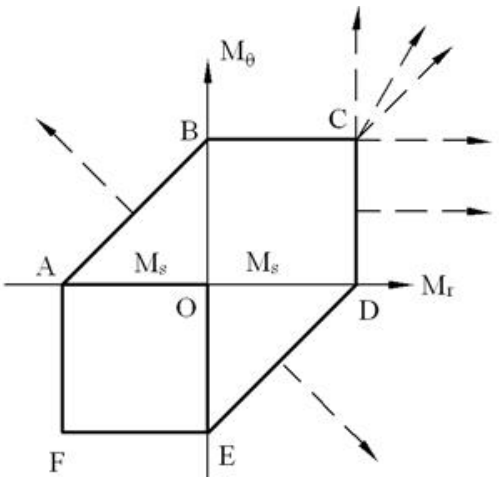

Fig. 3

The solution of (13) equation is associated with serious difficulties, to simplify of that gives the possibility the Treska plasticity condition, accordingly of that under which the ellipse is changing by hexagon. In such a case, the plate is divided into circular zones and in each zone the yield condition is expressed by linear law and integrating carried out without any complications. At the same time, the accuracy is not significantly violated. Also is possible the reduction of this error if we instead of inscribed hexagon will take interim of circumscribed and inscribed hexagons. For this is enough instead of σ_s to apply $\sigma_s^{'} \approx 1{,}08\sigma_s$ (Fig. 3).

The deflection rate would be continuous. The strain rates e ξ_r and ξ_θ in the general case would be subjected to discontinuity. The circumference where ξ_θ is subjected to discontinuity is called a finite circle. On this circumference $M_r = \pm M_s$ really ξ_θ is subjected to discontinuity and ξ_r is infinite. Accordingly of yield associated law

such state is possible for vertical side of hexagon, along of that $M_r = \pm M_s$.

Accordingly of rigid - plastic body scheme would be allowed that part of the plate (some regional areas) may be remains non-deformed and rigidly moved in the vertical direction. In this case, the above stated boundary conditions remain valid. In the4 case of support we will have $\frac{dw}{dr} = 0$ and $M_r = \pm M_s$.

As specific case are considered simply supported and rigidly restrained plate with P intensity. Maximum load values with application of Mises and Treska-Saint-Venant conditions of plasticity are given as table.

Table

Type of plate supporting	Maximum load	
	Mises condition of plasticity	Treska-Saint-Venant condition of plasticity
Simply supporting	$P^* = 6{,}5\frac{M_s}{b^2}$	$P^* = 6\frac{M_s}{b^2}$
Rigidly restraining	$P^* = 11{,}3\frac{M_s}{b^2}$	$P^* = 11\frac{M_s}{b^2}$

3. CONCLUSION

In the work are considered thin circular plates that in one case are simply supported, while in the second case rigidly restrained. In both cases the ultimate loads values in the plate with application of plasticity (Mises and Treska-Saint-Venant yield) conditions are defined. In the case of simply supporting the ultimate load is equal to $\frac{6{,}5M_s}{b_2}t$, and in the rigidly restraining case the ultimate load is equal to $11{,}3\frac{M_s}{b_2}$.

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Environmental protection

EVALUATION ECOLOGICAL CONDITION OF THE RIVER DURUJI

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ABSTRACT: The Duruji River considered as one of the most debris flow dangerous river of Georgia, which no one create danger for town Kvareli. For Kvareli danger is debris flow formed in river basin, that difficult is inert mass which is accumulated in the river bed. In article is considered modern condition of river Duruji basin and is provided recommendation about river bed cleaning necessity.

INTRODUCTION

The anthropogenic impact on the environment often became cause formation of the anomalies, particularly, debris flow, the result is dramatically changing the existing situation and Ecological balance.

Debris flows are geological phenomena in which water-laden masses of soil and fragmented rock rush down mountainsides, funnel into stream channels, entrain objects in their paths, and form thick, muddy deposits on valley floors. They generally have bulk densities comparable to those of rock avalanches and other types of landslides (roughly 2000 kilograms per cubic meter), but owing to widespread sediment liquid faction caused by high pore-fluid pressures, they can flow almost as fluidly as water. Debris flows descending steep channels commonly attain speeds that surpass 10 meters per second (more than 20 miles per hour), although some large flows can reach speeds that are much greater. Debris flows with volumes ranging up to about 100,000 cubic meters occur frequently in mountainous regions worldwide.

Debris flows in the Western and the North-Western Caucasus are formed in practically all catchments. The main causes of debris flow formation are intensive rainfall, snow melt, bursts of lakes, landslides and slope collapses. Debris flows are observed from March till November.

MAIN PART

In Caucasus, particularly in Georgia, on the background of the global warming and high energetic class tectonic processes importance disrupted gravitas stability of the high mountain zones. The Duruji River can be considered as one of the most active rivers with debris flow processes among the mountain rivers comprising the catchment basin of the Southern Caucasus. In the sources of the river Duruji intensively accumulated million cubic meter rock clastic. In the basin periodically developing destructive force of debris flow processes, it threatens Kvareli city and surrounding areas.

The catchment basin of the Duruji River is subdivided into two geographical parts: the Main Caucasian Range and Alazani Valley [1]. In accordance with the lithological section, the catchment basin

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of the Duruji River is subdivided into the following parts: 1) shale stratum; 2) strata with inclusions of clay-shales and sand-stones, and 3) quaternary sediments.

It is well known that the bed of Shavi Duruji is eroded because of the Shavi Mountain (2200 m above sea level), and the bed of Tetri Duruji is eroded because of the Southern range of the Pokhalo. The total area of the catchment basin of the Duruji river including its debris flow cone is equal to 116 km^2, among which the area of debris flow cone by itself is equal to – 36 km^2 [3].

According to the special engineering researches and stationary observations performed by the "Sakgeologia" in the Duruji River basin, on the average, over 1 hectare area about 1000-3500 tons of solid mass is moved out from the unstable slopes of the catchment basin annually. The amount of solid mass accumulated in the source area reaches up to 1.0-1.5 millions of cubic meters. A total, anticipated reserve of solid mass exceeds 500 millions of cubic meters.

Photo 1. River Duruji in rain weather

In the Duruji River basin, like in the whole Kakheti region Caucasus Mountains, high density (1.8-2.5 g/cm3) structural rheology flows of stone and mud are formed. In these flows, quite a big (2-5 meters and larger) stones can be found mainly in the transit-accumulation and sometimes in the accumulation areas. For example, in a result of the transformed disastrous mudflow in 1889, a 200 ton decide stone was moved to the accumulation area, in Kvareli, in the Duruji River. The stone is now on the Red List, as a unique geo-touristic phenomenon [2].

Currently the most effective measure performed for debris flow prevention in Kvareli is a river embankment. After its construction, debris flows have taken place for several times, but the town was not affected.

But, after cessation of regular riverbed cleaning actions in 1990, the river hypsometric level has raised and exceeded the topography of the town itself, which causes new risks.

It is known, that eroded mass of river Duruji is unique its containing, that create special micro zone for vine ,,Sapheravi" which is unchangeable for World known wine ,,Kinzmarauli". Also this debris flow colloids is good material for ceramic and building material.

Photo 2. The river embankment in Kvareli

CONCLUSION

For the effective protection of the population of the town of Kvareli in Georgia from debris flow formed on the Duruji River together of river embankment building is necessary to restore of river bed cleaning. Using of debris flow sediment for ceramic industry, building and agriculture increase demand of debris flow sediment and will be restore cleaning of river Duruji bed.

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Water management

THE ASSET MANAGEMENT PROBLEMS IN WATER SUPPLY AND WATER DISCHARGE SECTORS

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ABSTRACT: For the reforms of water economic sectorit is necessary to have a more precise idea about the system, particularly to master the information expresses physically and in values. For this reason it is necessary to implement the system asset inventory, reassessment, relevant registry creation and its management.

In the stage of development the system assets total registration, inventory and reassessment is of great significance in water economic sector. The above mentioned is important for the more integral presentation of the organization activities current picture as well as to cover the tax (amortization allotments) and financial problems (involvement of necessary investments):

In the organizations of water economy system there are currently accounted more than 189.0 billion AMD of fixed assets.

In the article there are presented complications related to asset management and the settlement of certain actions in water economy area.

KEYWORDS: water supply, water discharge, sector, water economy, property, asset, management.

On the basis of the development of drinking and irrigation water supply, waste water discharge and waste water treatment sectors of the Republic of Armenia there have been done economic, technical, financial, and institutional productive reforms. In the initial stage of reforms the assets and the intangible asset inventory, reassessment, the creation of the appropriate property registration and its management, as well as the realization processes of property acquisition certificates operating by the system's organizations have been of great importance. The above mentioned let us have a more precise idea about the system, in particular, possess physical and property data in values.

In the stage of development of drinking and irrigation water supply, water discharge and wastewater treatment sectors have been of significance, and one of the water sectors development cornerstones have become the system assets integrated accounting, inventory and reassessment. The above mentioned is substantial for the more complete presentation of the current picture of the organizations' activities, as well as to cover tax (depreciation allocations) and financial (involvement of necessary investments) problems [1].

The property of the organizations of the system has been completely inventoried and reassessed in 2002 based on the RA law on "RA State Committee on Water Economics in order to reassess the fixed assets and incomplete non-current tangible assets (hereinafter – fixed assets) of the companies managing the 50 or more percent shares"[2]. To follow the mentioned law by the resolution adopted by the Government of the Republic of Armenia it was decided to act according toRA State Committee on Water Economics, which announces to complete the reassessment of the fixed assets and incomplete non-current

tangible assets (hereinafter - fixed assets) of the companies managing the 50 or more percent shares and to present the results in the annual balance sheet of 2002 [3].

Later by the resolution adopted by the Government of the Republic of Armenia it was decided to establish the results of the RA State Committee on Water Economics in order to complete the reassessment of the fixed assets and incomplete non-current tangible assets (hereinafter – fixed assets) of the companies managing the 50 or more percent shares [4]. In the results the companies' equity capitals, which from the perspective of investment involvement becomes extremely important by the international donor organizations? Simultaneously it was decided to dispose and/or to liquidate the unused or unfit for further use property by the system companies.

The properties of thesystem companies have undergone some changes during the past years. It is true that companies tariffs don't includee depreciation allocations, but the companies participate in the profit tax calculation. The depreciation allocations are attempted to compensate due to credit and grant programs involvement by means of capital construction and acquisition of capital assets. The mentioned process cannot be eternal and at some stage of development the depreciation allotments must be included in the tariffs calculation.

In the organizations of drinking and irrigation water supply, water discharge and wastewater treatment sectors there are currently accounted more than 189.0 billion AMD of fixed assets (Table 1).

Table 1

About the organizations of drinking and irrigation water supply, water discharge and wastewater treatment sectors[1]

№№	Company name	Amount (thousand AMD)
1	RA TAM state committee of water economics, by which	82 046 209.9
1.1	Industrial property of the committee staff	15 459.6
1.2	given for rent to "Yerevan Jur" CJSC	29 357 222.0
1.3	given by the right of free of charge use to WUAs	52 667 299.7
1.4	Given to PIU of MoES "Arpa-Sevan" tunnel restoration for temporal operation	6 228.6
2	"Armenian Water and Sewerage Company" CJSC	33 644 809
3	"ShirakWater and Sewerage" CJSC	4 804 625
4	"Lori Water and Sewerage" CJSC	8 717 213
5	"Nor Akunq" CJSC	4 301 002.9
6	"Sevan-Hrazdan-Water Intake" CJSC	35 204 623
7	"Akhuryan-Araks-Water Intake" CJSC	13 535 969
8	"Melioration" CJSC	938 173.4
9	"Arpa-Sevan" Tunnel Restoration Program Implementation Office SA	5 416 995.6
	TOTAL	**188 609 620.8**

According to Table 1 and Figure 1 the property of drinking and irrigation water supply, water discharge and wastewater treatment sectors of the organizations in the form of ownership and management is divided into:

[1] Due to the data of the State Committee of Water Economics of the Ministry of Territorial Administration of the Republic of Armenia.

1. The balance sheet calculating property of the committee, including
   a) "Yerevan Jur" CJSC property for rent,
   b) property given by the right of free of charge use to WUAs.

2. Accounted property on the ownership right in closed joint stock companies' balance sheetsof the system, as well as property given by the right of free of charge use to WUAs.

3. The property of the companies realizing system credit and grant programs.

In this respect, asset management of water economic sectors is actual and requires coordinated actions.

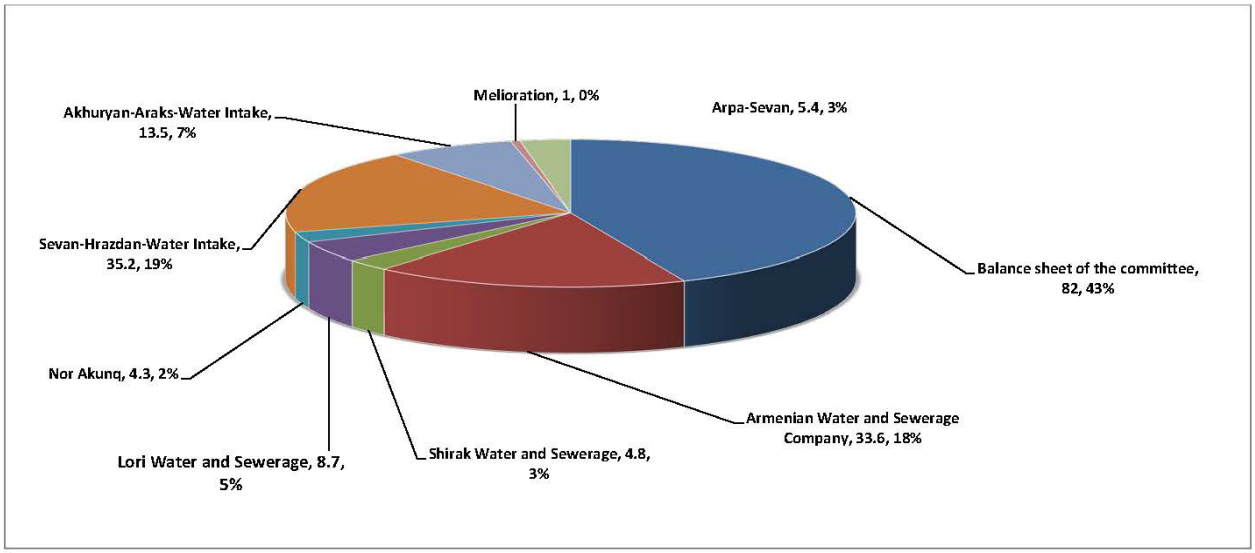

Figure 1. The current property in the water supply and water discharge sectors (bln. AMD)[2]

Asset management is associated with certain complications (in the system there are certain problems associated with accounting) [1] in the sectors of water relation management, in particular:

- In the result of various reorganizations having been realized in the sectors some part of fixed assets hasn't been formulated in the documents and has been drawn out from counting.
- The accounting in the result of reorganization in re-union or separation way has not been always correctly carried out.
- The accountancy in some cases has been carried out by separate units, in which available all fixed asset values are expressed as a single figure, which is the total value of the object.
- The capital investments realized in the purpose of the fixed asset as a part of the object have been increased to the total object value or as a separate line have been calculated as fixed asset.
- The similar fixed assets (of the same name and of the same technical condition) are often formulated in values very different from each other.
- The separate property ownership certificates are not available and require appropriate financial resources.
- It is necessary to make an inventory and reassess the current property.
- The property unfit for the operation should be written off, liquidated or disposed.
- To give appropriate accounting to newly created assets and water systems.
- To involve human and financial measures to solve the above mentioned problems.

[2] The figure is created by us.

Water area asset management is the integrity of water supply assets database creation and its management processes. For the database there can be used the following data: property name, property operation date, location, technical characteristics, balance sheet value, depreciation, certificate of state registration of rights towards the property, conclusion of property rights agreements and indication of the existence of the resolution adopted by the Government of the Republic of Armenia on property and other necessary information.

The existence of water sector property register is of necessity as it should serve in terms of technical and financial management.

The decision of feasibility and challenges for future policy formulation and implementation, which depends on an existing property purchase date, condition, and other technical characteristics, include:

- Sustainable and productive investment as well as planning of operation and maintenance costs, which is based on the property's age, condition, replacement / exhaustive information on new improvements need.
- Required level of services to the current and future customers.

Even in the format of public and private cooperation, contract clauses usually impose the service provider to the obligation to return the property at the end of the contract period in condition the agreement was reached (water systems rental agreement to "Yerevan Jur" CJSC). Besides, even if basic services rendered in terms of the relevant standard, the owner of the property needs to manage periodic monitoring on property effective management. It should also become clear which property is of a long-term rental (or concession) and return, as well as its rental and return dates. Property assessment information is also necessary for the calculation of tariffs and maintenance of correct tariff policy.

Water supply and water discharge of property management action plan should contain:

1. Preparation of operational specifications for the Estate National Register of water supply sector in order to meet the needs of investment and policy planning, for instance, which is the registry / database goal, who is to use the database, what kind of financial and technical information is necessary for respective functions.
2. Data collection and grouping (state-owned, community-owned and partially state property) from water companies service sectors.
   - computer program processing for property database,
   - work description processing of the staff of property registry operation and maintenance,
   - hiring and training of employees,
3. Data collection and grouping (state-owned and community-owned, partially state property, and community property outside the territories of the operators) from water companies maintenance territories and the outside territories.
4. The state registration of unregistered property at cadastre units in case of availability of financial resources.
5. Property inventory and reassessment according to the RA legislation in case of availability of financial resources.

In general, it is very important to have a complete picture of the property in management and operation point of view, which will allow us to make effective decisions. In the current phase the problem becomes even more significant in the context of drinking water supply sector reforms because in the near future it is envisaged to apply water systems rental method via WSOs enlargement. In this respect, the drinking WSOs property should be made state property in the way of separation, to maintain ownership certificates, to give them for rent and register calculating depreciation allocations.

Environmental protection

FURFURAL ADSORPTION FROM WATER SOLUTIONS BY ACTIVATED CARBON PREPARATION

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ABSTRACT: The emission of organic compounds into the environment must be controlled, because many organic chemicals are toxic, carcinogenic. One of the best way for water treatment is adsorption process using.

In this paper is presented the preparation adsorbents as activated carbon (AC) from agricultural wastes. It has proposed the ways for AC preparing from fruits / apricot, peach / seeds and date pits. This is the possibilities for reused of agricultural wastes also.

The yield of AC is defined as ratio of final weight of the obtained AC after washing and drying to the weight of dried dates stones initially used. It has been established, that the AC receives from agricultural by-products with a good yield in the absence of the any inorganic components with high yield. It has been measured the prepared ACs adsorption properties and surface areas.

KEYWORDS: organic compounds, adsorption, furfural, agricultural wastes, activated carbon.

INTRODUCTION

Contaminant removal is achieved through a process called adsorption by which contaminants adhere to the surface of the carbon and are thus removed from the water [1]. Organic compounds are often present in many industrial and environmental systems. The emission of organic compounds into the environment must be controlled, because many organic chemicals are toxic, carcinogenic.

Furfural is used as a solvent in petrochemical refining to extract dienes (which are used to make synthetic rubber) from other hydrocarbons. Furfural, as well as its derivative furfural alcohol, can be used either by themselves or in together with phenol, acetone, or urea to make solid resins. The main use of furfural is in the form of feed stock for furfural alcohol (accounting for 75 % of furfural sales), which in turn, is used as input for furan resin, which are used for foundry binders [2]. There are several processes to obtain furfural, some of which present the olive stone as a lignocellulose biomass from which 135 kg/t of furfural can be produced [2].

Adsorption became one of leading methods and means of chemistry, chemical technology, in the permission of ecological problems, in processes of the food-processing industry and others. Carbon adsorbents receive from every possible material which contains in largest or smaller quantity the difficult organic compounds capable under certain conditions to form the firm carbon rest. Active coals have well developed porous structure and the big specific surface (to 1000 m^2/g). Carbon adsorbents apply first of all for dryness, clearings and divisions of gases, treatment of waste and natural waters, in processes of extraction of precious metals, deactivations polluted radionuclide solution, to allocation of the harmful impurity which are in atmosphere in small concentration, as carriers of catalysts and even for the analysis of the difficult mixes differing only by isotope structure.

Activated carbons are used routinely in the drinking water and wastewater treatment industries to remove principally organic contaminants [1]. Activated carbon is manufactured from a variety of sources; primarily coal, wood, lignite, and coconut shells [3]. The process includes first carbonizing the raw material at low temperatures, and then activating the carbon in a high temperature steam process. Any volatile content inside the carbon is burned, leaving a beehive-like structured carbon with a high volume of pores and a large surface area. PAC (powdered activated carbon) is prepared by a pulverizing action, leaving a very fine powder. GAC (granular activated carbon), is in granular form and has great mechanical strength [3].

The process of activated carbon generation begins with the selection of a raw carbon source. These sources are selected based on design specifications since different raw sources will produce activated carbon with different properties. Some of the more common raw sources include wood, petroleum and agricultural residues.

MATERIALS, DEVICES AND METHODS

In the present study we use some fruits / apricot, peach / seeds based activated carbon. The effectiveness of agricultural by-products made activated carbon for the removal of organics by adsorption also is enhanced by its large surface area.

The samples used in this study:

1. Peach seeds breaking / crushing / (PSB);
2. Peach seeds based activated carbon (PSBAC);
3. Apricot seeds breaking / crushing / (ASB);
4. Apricot seeds based activated carbon (ASBAC);
5. Commercial carbon Carbonsorb – AB.

These carbons were selected as a control for this experiment as they have found to possess the desirable physical and chemical characteristics and were extensively used in water treatment furfural. The results of experience are introduced in table 1.

Table 1

The physical properties of sorbents

	Carbosorb – AB	Experimental sorbents			
		PSB	PSBAC	ASB	ASBAC
Surface area (m^2/ g)	755	230	420	210	430
Bulk density (g / m^3)	0.42	0.21	0.32	0.20	0.33

ACTIVATED CARBON FROM FRUIT WASTE

We have been used fixed bed reactor to pyrolisis of certain biomass waste (stones of date, apricot and peach) to prepare ACs suitable for some purpose [3, 4]. The stones were first ground and sieved to a particle size of 20…40 mesh and then dried at 100°C for 5 h. Then they are pyrolised the precursors at 450…480°C, at atmospheric pressure (AP) and reduced pressure (RPP). The result chars were chemically activated by soaking each gram of carbonaceous materials with a solution of (2 g Na OH + 10 ml distilled water, DW) for 24 h then the mixture was filtered and washed with a solution of 5 M HCl to neutralize the base and finally washed several times with DW to remove any trace of CI^- ion, next, the product was air

dried for 24 h, and thermally activation was performed at 750…800°C for 1 h by means of tubular furnace to obtain the activated carbons. The adsorption capacities of the prepared samples have been determined by standard methods using the iodine number (IN), methylene blue (MB), and p-nitro-phenol (PNP) adsorption values content, and humidity content. The iodine number was determined by the (GOST 6217 – 74, 1993) using the sodium thiosulfate volumetric method. The adsorption of M Band PNP (GOST 4453-74, 1991) was performed by agitating 0.1 g of adsorbent with (100 ml of 50 mg·L^{-1} MB) stock solution and (50 ml of 200 mg·L^{-1}) stock solution of PNP until precursor's equilibrium was obtained [3, 4].

The prepared ACs showed different adsorption properties and surface areas, and that produced from apricot stones had the highest porosity as indicated by IN and SA_{BET} (BET surface area).The analysis results of the products are given in Tables 2÷4 [4]. Those properties allow using those sorbents for water treatment process. The precursor first washed thoroughly with water to remove all foreign materials; mud and sticky sweet remnant of fruit, and then the stones dry indoors. The washed-clean stones then dried in drying oven at 110°C to facilitate crushing and grinding by a disk mill. At the second step the required amount of M chloride dissolved in 25 ml of distilled water, this solution then added to 25 g of crushed stones and mixed thoroughly. The mixture is left overnight before carbonization. At the third step the impregnated stones are loaded into suitable reactor and the reactor then placed in muffle furnace and start heating by adjusting the furnace temperature to the desired value. Finally the activator removed from the carbonization product by through washing [4].

The yield of AC is defined as ratio of final weight of the obtained AC after washing and drying to the weight of dried dates stones initially used. This investigation has shown that for carbonization time (Ct) = 0.5 h, the yield depended on carbonization temperature (CT) is the maximum yield (68.8 %) obtained at CT = 500°C and impregnation ratio (R) =1.0. The optimum conditions for producing AC with the highest percentage phenol removal 97.1%, are Ct =3 h, R = 0.5 and CT 700°C. Based on the percentage MB removal, the optimum conditions are Ct =1 h, R=2 and CT 500 to 600°C. The results of experience are introduced in tables 2 to 4.

Table 2

Percentage yields of the precursors

Precursor	Liquid%		Chars%		Volatile and loss **	
	AP	RPP	AP	RPP	AP	RPP
Date stones	47.0	52.2	33.0	27,3	20.0	20.5
Apricot stones	32.0	44.6	41.0	24.0	27.0	31.4
Peach stones	29.0	36.0	60.0	30.5	20.0	33.5

**The value is the average of two pyrolysis, ** Calculated by difference*
AP - atmospheric pressure, RPP - reduced pressure.

Table 3

Adsorption characteristics of ACs produced through pyrolysis pits

Precursor	IN mg l^{-1}		MB mg l^{-1}		Humidity %	
	AP	RPP	AP	RPP	AP	RPP
Date stones	586	600	338	150	8.7	9.3
Apricot stones	739	950	239	250	4.4	5.7
Peach stones	586	711	250	220	4.6	6.1

Table 4

Surface areas of the ACs prepared from various precursors

Precursor	Estimated BET, $m^2 g^{-1}$		SA_{PNA} $m^2 g^{-1}$		SA_{MB} $m^2 g^{-1}$	
	AP	RPP	AP	RPP	AP	RPP
Date stones	570	600	389	246	153	34
Apricot stones	741	850	331	438	139	60
Peach stones	570	610	492	584	85	32

Activated carbon preparation from date pits without any activators

Here is we have study also AC preparation from date pits. Date pits used for the preparation of the activated carbon was obtained locally from Abadan factory for dates. Percent of date pits obtained from some of the most commercial variety of dates in Khouzestan Province of IR Iran (Abadan) are shown in table 5.

Table 5

Percent of date pits obtained from some of the most commercial variety of dates in Khouzestan Province of IR Iran (Abadan)

Ghantar	Berhi	Zahedi	Deiri	Khazravi	hallavi	Ferssi	Sayer (Estamaran)
12.8	9.2	10.2	10.8	8.5	10.1	10.6	11.9

For experiments the date pits in the initial and granulated kind were used. The carbonization was conducted in a one liter corund crucible at and duration of process 3h in medium of nitrogen, and activation – in a millimeter metallically sleeve at and duration of process with usage of a water vapor. Moisture content is determined by GOST 12597-67) method and ash content by (GOST 12596-67) method of bonelets of dates in initial and activated condition, and also weight of liter of adsorptive (GOST 6217-52). The quality of the obtained products was controlled by measurement of their adsorptive activity on methylene blue (GOST 4453-74, 1991) and on Iodine (GOST 6217-74, 1993). For a number of assays the isotherms of an adsorption of nitrogen and water vapor were obtained. The experiments were conducted by a volume method on the vacuum-adsorptive installation. The adsorptive – structural parameters were calculated on equations BET and Dubinin-Radushkevich.

CONCLUSIONS

It has been shown the reused of agricultural wastes for activated carbon obtaining.

It has been established, that the AC receives from agricultural by-products with a good yield in the absence of the any inorganic components with high yield.

It has been shown that obtained activated carbon can be use for water treatment process.

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Environmental protection

THE USE OF VOLCANIC BUILDING MATERIALS FOR WASTE WATER TREATMENT

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ABSTRACT: The results of research are submitted in the field of oil product treatment containing water solutions by the volcanic building materials as Armenian natural zeolites and tuff. It has established that such materials are convenient for applying at waste water treatment from ammonia and organic impurities.

It has been established that the proposal method can be applied to the river water treatment processes by using domestic natural sorbents. It has been shown the advantages of natural zeolite-tufa and popular Armenian building stone as tuff in comparison with other sorbents, such as technological stability, low cost, availability and filtering properties. The application of the Armenian volcanic material in the mentioned processes has been scientifically approved according to the comprehensive evaluation of its mechanical, physical, physical-chemical and technological properties.

KEYWORDS: volcanic building materials, waste water treatment, organic pollutants, sorption, sorbent, zeolite and tuff.

INTRODUCTION

The communities and food, fish and other factories are situated mainly along the water basin cost. Under above mentioned conditions of water supply the waste water treatment on Sevan catchment basin should be effective after a corresponding pretreatment of raw water from the rivers by plant of a treatment technology. Here it is offered the use of a method of sorption treatment, taking into account the fact that technologically such process more corresponds to district. For sorption process it had been proposed the natural zeolite-tufa or residues from volcanic tuff. The increasing demand for ion-exchange materials as ecological problems simulated the intensive study of natural and modified zeolites, because they are considered to be cheap modified sorbents. The technological stability of building materials residues as sorbents is determined first of all by such characteristics as mineral and chemical composition, sorption ability and then mechanical, physical and following from them filtering properties [1-4].

Natural zeolites and building materials residues uses in the following fields of waste water cleaning-removal and recovery of NH_4, removal and storage of radionuclide and heavy metals, removal of organics [5].

The advantages of zeolite-tufa and volcanic tuff in comparison with other sorbents are their reserves in Armenia, a unique complex of technological properties /sorptional, molecular-sieving/ as well as their natural origin, possibilities of them modification in various directions, regeneration and utilization. The

application of the Armenian volcanic material in the processes of water preparation has been scientifically approved according to the comprehensive evaluation of its mechanical, physical, physical-chemical and technological properties. It has been established that the natural zeolites and their combination with other systems is necessary to remove metal ions from water. There have been established the regularities of extraction processes of ions, iron, magnesium, calcium, zinc, copper, nickel, cobalt, lead and ammonium from water. The dependence of efficiency and mechanism of sorption of components from water, filtering parameters, length of contact liquid and solid phase's ratio and other factors are obtained.

Chemical stability and mechanical-strength of natural Armenian zeolites – Mordenite and Clinopilolite meet the requirements of filtering materials.

MATERIALS AND METHODS

The problem of removal of hydrocarbons from water basin is an urgent task as well. Many manufacturing processes form organic pollutants (benzene, toluene, ethylbenzene, xylenes, phenol, aniline and their derivatives), which are toxic substances. Organic toxic substances are the main sources of anthropogenic pollution: agriculture (stock-breeding, farming, mineral fertilizers, poisonous chemicals), industry and household sewage waste waters.

Here is presented the National problem of RA as Sevan. The intensification of economic activity in Lake Sevan catchment basin is the cause of essential changes in the hydrocarbon chemical content of the rivers. The amount of dissolved organic matter in the water has grown up to 3 mg/l; the content of chlorides and sulfates has increased several fold; the concentration of nitrogen nitrate and ammonia forms have increased ten-fold; the total mineralization has grown from 130 to 190 mg/l. Noticeable changes took place in the concentration of mineral nitrogen, which is the consequence of mineral fertilizers and stock-breeding development. The most polluted rivers are: the Gavaraget, Masrik, Makenis, Argichi, Vardenik, Tsak-kar; the Lichk river is the cleanest one. Ammonia concentrations have been determined for Lake Sevan. The rivers Gavaraget, Vardenik and Masrik are most polluted with ammonia and heavy metals; the cleanest one in this respect is the river Arpa. All rivers are high in iron compounds (70-140 mkg/l) and low in manganese content (7-18 mkg/l). The estimation of the water quality judging from average values does not reflect the alterations in the ecosystem of Sevan during the process of eutrophication.

The growth of the tropic level in many lakes of the world is dependent on the growth of the load of organic elements, particularly, nitrogen and phosphorus, from the catchment basin. The eutrophication causes of Lake Sevan differ from those of other lakes of the world.

The ecological changes in Lake Sevan in the early 1990s established its ecosystem and, particularly, caused perceptible structural changes in fish symbioses (biological and population indicators have been changed).

Natural zeolite deposits of sedimentary origin are widespread in Idjevan /Clinopilolite/ and Shirak /Mordenite/ regions of Armenia. Tuff deposits are widespread in Arthik /Shirak region/. The natural zeolite-tufa - clinoptilolite and mordenite, and tuff were dehydrated at 110°C.

In this study clinoptilolite and mordenite were prepared by heated pile method, using 0.5 and 1 N solution of $CaCI_2$. Clinoptilolite modified by monoethanolamine were prepared according to [6].

The ammonia adsorption by zeolites was investigated by IR spectroscopy [7]. After sorption of ammonia vapour produced by 1 N NH_3 solution by natural zeolites and its treated forms for 10 days at room temperature the adsorption data were plotted.

Liquid chromatography is passed on HELCh /higher-effective liquid chromatography, detector Waters 486, controller Waters 600S, Pump, Waters 626, colon 250x4mm, Si-100 C 18, P 150 Bar, V 1ml/m, mobile phase acetonitryl-water (50:50), detector UV-254).

UV spectrometry is passed on UV-Specord spectrometer.

WASTE WATER TREATMENT FROM ORGANIC IMPURITIES BY ZEOLITES

The removal of organic substances is carried out as follows. The precisely weighed portions of sorbents are brought in to the certain volumes of organic substances in water, which initial concentration vary. The mix is carefully shaken up during 6 hours. Further test is settled. The quantity of the besieged substance on zeolites is determined by the precipitated organic fraction in the filtered solution by the methods of UV Spectroscopy, Highly Effective Liquid Chromatography and Refractometry [6].

RESULTS AND DISCUSSION

Waste water is often dumped directly into rivers. This fact is the primary cause of river water pollution in lake Sevan. Various attempts are now being made on a local scale to purify such waste river using simple methods. One of that includes the use of natural zeolites for removing of ammonia from wastewater.

Table 1

The adsorption of NH_3 [g] on the zeolite-tufa / natural and /modified and tuff /10g/

N	Zeolite	1 day	3 day	5 day	7 day	10 day
1.	Mordenite tufa	10.38	10.51	10.62	10.70	10.76
2.	Mordenite treated by 0,5N $CaCI_2$	10.86	11.02	11.15	11.22	11.38
3.	Tuff residues	10.24	10.52	11.00	11.24	11.63
4.	Mordenite modified by monoethanol-amine	11,05	11,56	12,15	12,86	12,95

Firstly, the ability of proposed sorbents is compared to purify river waste water with normal river gravel. The tested sorbents (even tuff) had superiority over gravel in the oxidation of ammonium ions through nitrite ions into nitrate ions. The higher activity for ammonia sorption shows also treated by aminoethanol. The mentioned amine has microbial activity as one of product of mutagenesis.

WASTE WATER TREATMENT FROM ORGANIC IMPURITIES BY ZEOLITE AND TUFF

In the present work the results of purposeful researches are submitted in the field solutions and waste water of application natural zeolites and tuff as sorbents for removal of organic substances from water. Polluted by hydrocarbons water passes through a column filled with adsorbents. Hydrocarbons are taken from water, remaining in limits of adsorption column. The cleaned water leaves a column for direct use or further treatment. The higher adsorptivity shows natural clinoptilolite modified by monoethanolamine - about 100 % extraction of phenol from 0.015M solutions, and also rather high sorption activity of benzene, toluene, xylene from water solutions /from 50 up to 70 %/. The quantitative adsorption takes place in case of the H-form natural mordenite. The linear dependence between concentration of phenol in a water solution and appropriate molar refraction is preset at 20°C. The measurements were carried out in concentration limits from 0.05 up to 0.3 mol/L. It was earlier established, that the sorption in these limits grows and has linear dependence on molar refraction. From graphic dependence the amount of adsorbed

phenol is determined. The results are given in the Table 1. It is necessary to note, that partial sorption of water /1-2 ml from 10ml of a solution for 4 hours sorption of a solution on sorbents/ takes place.

It's visible from the given tables with increase of concentration of solutions the amount of absorbed phenol is increased. Fairly active has modified clinoptilolite by monoethanolamine. The H-form of mordenite shows activity, where, on all probability, the formation of hydrogen connections takes place. The sorption of water-soluble oil products are compared between different samples of zeolites – zeolites tuff, treating zeolites, modified zeolites. As zeolites were used clinoptilolite containing tuff from Idjevan deposits in Armenia. They are modified by monoethanolamine.

The oil products content in water before and after the sorption was estimated by gravimetric method, after there was made a correction by gas-liquid chromatography. The results are presented in Table 3, 4. It has been investigated the phenol and other aromatic sorption from water solution. Phenols and aromatics /benzene, toluene, xylenes and others/ are discharged in open reservoirs, they destroy the microflora and have negative effect on human health. The major way to diminish the discharge of phenols dissolved in water is strong purification and reuse. The methods are offered for successfully sorption of phenols and other aromatics from waste water in natural and modified zeolites The given method can be applied at rather low initial concentration of phenols and aromatics. The oil products content in water before and after the sorption was estimated by gravimetric method, after there was made a correction by liquid chromatography.

Table 2

The sorption of phenol from a water solution on sorbents / Temperature 20°C, duration 4 hours /

Concentration of phenol in water solution	N_D^{20} initial	N_D^{20}after sorption on tuff g phenol./g sorption	N_D^{20} after sorption on Mordenite g phenol./g sorption	N_D^{20} after sorption on H-Mordenite g phenol/g sorption	N_D^{20} after sorption on clinoptilolite modified g phenol/g sorption
0,05	1,3324	–	–	Full sorption	Full sorption
0,10	1,3328	–	–	1,3314/ 0,0752	Full sorption
0,15	1,3342	1,3339/ 0,0017	1,3338/ 0,0019	1,3322/ 0,0846	Full sorption

Table 3

The distribution coefficient of the oil products K_a (mg/g) during the sorption on sorbents

Sorbent	K_a / light organic[b]	K_a/ heavy organic
Clinoptilolite-tufa	50	300
Clinoptilolite-treating	160	540
Clinoptilolite- modified by monoethanolamine	450	780
Tuff	110	420

b) Conditions t=2 days, concentration of oil product in water – 70 mg/*l*

Table 4

Sorption of the oil from water solutions on sorbents

Sorbent	Weight of sorpted oil product/ mg [b]	% of sorpted oil product
Clinoptilolite-tufa	20	30
Clinoptilolite-treating	32	45
Clinoptilolite- modified by monoethanolamine	75	89

b) Oil product concentration in water 70 mg/l, 100 gr sorbent, V water – 1000 ml

CONCLUSIONS

It has been found advantageous to go on with the researches in ammonia and organic pollutants sorption by Armenian natural zeolites and tuff. It has been offered the convenient method for successful sorption of ammonia and organic pollutants from water. The given method can be applied at river water treatment processes by using domestic natural sorbents. The advantages of natural zeolite-tufa and tuff in comparison with other sorbents, such as technological stability, low cost, availability, filtering properties, etc. are firstly determined for available use in the Sevan region.

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Water management

DIMENSIONING OF ROOF DRAINAGE SYSTEMS IN THE CONTEXT OF RAINFALL WATER RUNOFF MANAGEMENT

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ABSTRACT: The article analyzed the design guidelines drainage of rain roofs of buildings, recommended for different systems. There was a wide divergence of recommendations given by different manufacturers systems. They referred it to the guidance relating to the determination of the maximum rainfall, taking into account the characteristics of the rainy region's in Poland and the probability of occurrence of such rain. In the paper the conclusive rainfall for the region have been recommended. The importance of the correct determination of rainfall drainage system sizing and proper management of storm water runoff from urbanized areas.

KEYWORDS: rainfall water, roof drainage, drainage system, water management.

INTRODUCTION

Rainwater or thaw water in urban agglomerations runs off on the surface of construction facilities and across the ground to reservoirs, or natural or artificial watercourses, connected with the surface water drainage systems, or get absorbed into the soil. Finally, such water may be discharged to surface water by means of the conduits of rainfall water or general sewage systems, after their pre-treatment.

The management of rainfall water runoff is contained in the selection of construction and technological, organizational and legal solutions undertaken at the stage of planning, designing and maintenance of the facilities collecting, storing and discharging rainfall water or thaw water in the settlement units. The scope of management also covers defining of the implementation methods of the solutions adopted, including, in particular, the acquisition of financial resources necessary for their execution.

Recently, the climate warming effect has been observed. Specialists have not reached any consensus in relation to the assessment of this phenomenon so far; however, the fact of climate change is obvious. As a result of the growth of the average annual temperature of the globe, water circulation in the global hydrological circuit has been intensified, causing the manifestation of extreme weather phenomena (storms, hurricanes, etc.). In connection with the increasing value of the precipitation volatility coefficient and the frequency incidence ratio of convective type of clouding, the growing intensity of rainfall and increased frequency of extreme precipitation should be expected. Such phenomena may result in damages in construction in urbanized areas (flows, overflows and floods) [1]. This problem encourages launching of precautionary measures aimed at mitigation of the adverse effects of such phenomena. It is even more important in view of the fact that the constructed sewage systems should ensure efficient performance in the perspective of up to 2100 [2], and these aspects should be also taken into account in the rainfall water runoff management. The problem refers to all components of the drainage system, including the roof drainage systems of buildings.

Systems designed for rainfall water drainage make an inherent element of equipment of buildings and various facilities of urban infrastructure. In case of buildings, precipitation water accumulating on roof surfaces may be discharged by an external or internal drainage system. In the external, gravitational system, water flows to the gutters running along the roof edges, being subsequently taken over by the downpipes fixed to the elevation of the building. In the internal system water accumulates in roof dip trays or basins, from where it is captured by roof inlets directing it to the rainwater drainage system. Internal drainage systems may be of gravitational or vacuum nature, the latter operating under the conditions of negative pressure developing in the conduits. The external system is recommended for buildings of up to five floor height [3], with vertical dimensions reaching up to ~15 m above the terrain level. On the other hand, the internal systems may be used both in low and high buildings and they practically represent the only feasible solution in facilities with large surfaces of flat roofs.

While adjusting the method of managing rainwater collected from buildings and their surroundings, the principle of sustainable water management should be applied. The optimum management method of uncontaminated rainwater discharged from real property is its temporary storage, followed by usage on the area of the real property. The connected drainage system may contain special reservoirs from which the rainwater is used for residential purposes following the adequate pre-treatment. Such systems may be used in residential buildings, public utility buildings or industrial facilities where many technological processes do not require potable water. The retention and slow infiltration into the ground is also recommended or direct absorption by the ground. Such measures allow for retaining water in the basins, which is particularly important in urbanized areas where hardening of the surface and accelerated runoff of rainwater occurs.

The aforementioned measures enabling the reduction of tap water consumption, are classified as cost-saving and ecologically-friendly solutions.

The problem of rainwater management has recently started to be particularly significant in view of implementation of a fee for rainwater discharge from real properties in some regions. The fee, sometimes referred to as the "rainfall tax" is introduced on the basis of statutory provisions [4]. The level of the fee for the discharge of rainwater usually depends on the area of the roof, the plot, and sometimes also on the forecast precipitation quantity.

Accordingly, similar to designing of the drainage water system and elements used for rainfall water recuperation, it is necessary to adopt reliable environmental parameters describing the rainfall and the technical parameters of various elements of the rainfall drainage system.

1. PERFORMANCE OF EXTERNAL DRAINAGE SYSTEMS

The altitude limitations concerning the application of external drainage are associated with the maintenance conditions and physical phenomena which may lead to a number of undesired processes affecting the sustainability of the facility. The particularly hazardous factors include:

- overfilling of gutters during intensive precipitation, with the consequent overflowing and dampness of hoods, external walls and other elements by rainfall water running off in disorganized manner; in addition, dampness and blurring of the building surroundings may occur, as well as washout of the band at the foundation walls, etc.
- freezing of water in gutters and downpipes, occurring in autumn and winter periods during fluctuations of air temperature within a day, as a result of which the throughput is reduced, or even blocking of the system may occur; in such cases, flooding by water may also occur (originating from the melting snow or ice) and damping of external elements of buildings may take place; moreover, the water freezing in the drainage system may cause its unsealing or other impairments;

- impairment of elements of the system as a result of combined effects of several external factors, such as wind, temperature volatility and sun radiation intensity, chemical and mechanic contaminants, hail falls or snowfall.

The internal systems of rainfall water drainage from the roofs are not exposed to the majority of the aforementioned adverse effects which accompany the external systems, due to their incorporation into the roof surface and running of the conduits discharging water inside the building, thus, across the area protected against direct impact of external factors.

It is assumed that downpipes of the gravitational systems, both internal and external, irrespective of the rainfall intensity, operate properly when they are partially filled in with water. Such a performance of the downpipes may be only provided by the adequate adjustment of the gutter and downpipe throughput, so that the inlet of the downpipe remains unflooded during the water flow along the gutter or a draining tray. In other case, if the water stream covers the inlet to the vertical duct, the uneven (pulsating) flow appears. Water moves through the downpipes in the so-called water jams, separated by air bubbles. The air bubbles are occasionally interrupted, causing the vibration of the pipe. The vibration is not recommended since it is the factor which may damage the downpipes: on the joints, in the points of fixing to the wall, and in case of steel pipes, the protective coating may be interrupted, which consequently fosters the development of corrosion.

2. GUIDELINES ON DESIGNING THE EXTERNAL DRAINAGE SYSTEM OF A ROOF

The principle of the drainage system design is based on the relevant adjustment of the meteorological and hydrological parameters of the local rainfall to the hydraulic capacity of individual components of the drainage.

The individual steps of the designing process may be contained in the following points:

1. Defining of the so-called equivalent drained roof surface – *EPD*, which should also include, besides roof surface, other surfaces from which the rainfall water will be collected. This may comprise surfaces of elbow walls, attics and other elements protruding above the roof surface. The calculations are usually simplified, taking only roof dimensions into account. The *EPD* value is then equal to the roof surface, at the surface slope of $\leq 10^{o}$, and for slopes $> 10^{o}$ it is determined according to the formula:

$$EPD = L\,(W + \frac{H}{2}),\ \mathrm{m}^2 \quad \text{or} \quad EPD = L\frac{H}{\sin\alpha},\ \mathrm{m}^2 \qquad (1)$$

where: W – width of the roof surface plan (with the slope towards the gutter), m;
H – height of the roof surface, m;
L – length of the roof surface, m;
α – slope of the roof surface, ^{o}.

2. Determining of the concentration of inflow of rainfall water collected from the *EPD* - Q_d

$$Q_d = \psi \cdot EPD\,\frac{q_m}{10000},\ l/\mathrm{s} \qquad (2)$$

where: ψ – coefficient of surface runoff; usually in the range of 0.8÷1.0;
q_m – intensity of measurable rain, $dm^3/(s \cdot ha)$.

3. The selection of dimensions (diameters, cross-sections) of gutters and downpipes as well as location of downpipes (distance between inlets), arising from their throughput, is usually performed on the basis of specifications presented in tables.

The analysis of the design recommendations collected from the technical data of several producers or distributors of drainage systems on the territory of Poland, shows significant and unexplained discrepancies of the indications concerning maximum EPD_{max} drained surfaces. For the analysis, the guidelines related to the selection of the following drainage systems were adopted: Plastmo, Galeco, Gamrat, Kanion-Wavin, Plastmo-Plastal, Hunter, Marley and Raiko. In case of gutters, the maximum recommended EPD_{max} values were compared to the corresponding dimensions of gutter diameters (semi-circular or with a similar cross-section) of the analyzed drainage systems. These recommendations are usually diversified in terms of water inlet to the downpipe from one direction, i.e. the location of the downpipe in the vicinity of the edge of the drained roof surface and inflow from two directions, i.e. next to the location of the downpipe in the middle zone of the drained surface. Therefore, to specifications are presented in the form of charts, for a single direction inflow (Fig. 1) and for a double direction inflow (Fig. 2). Comparison of the guidelines of various producers related to the selection of the gutter diameter to the drained roof surface indicates very high dispersion of the EPD_{max} value, exceeding even 100%.

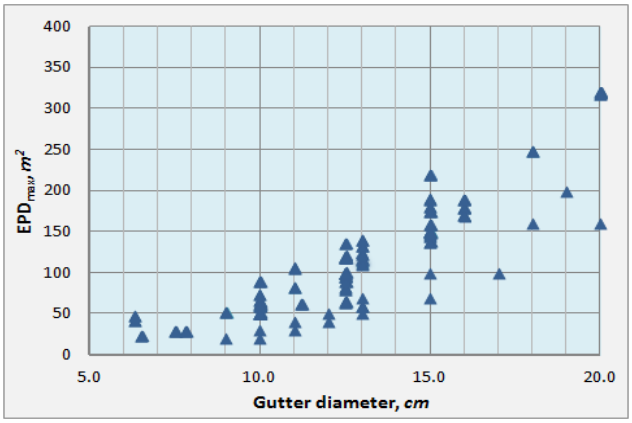

Fig. 1. EPD_{max} dependence on the gutter diameter at the water inflow to the downpipe from one direction, according to the guidelines of various manufacturers of drainage systems

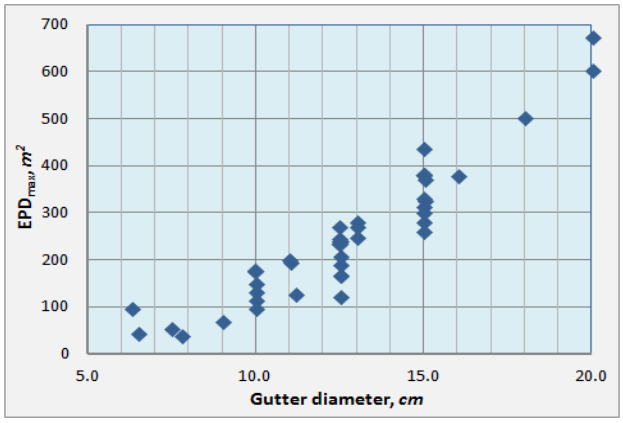

Fig. 2. EPD_{max} dependence on the gutter diameter at the water inflow to the downpipe from two sides, according to the guidelines of various manufacturers of drainage systems

In case of the guidelines concerning the adjustment of the downpipe diameter to the drained roof surface, the comparison was also made for two situations: the first one – inflow to the downpipe from a single direction (Fig. 3), the second one – inflow from two sides (Fig. 4).

Comparison of the guidelines on the selection of downpipes indicates even higher dispersion of the EPD_{max} value than in case of gutters. This refers, in particular, to the case of water inflow to the downpipe from a single side. For example, for a pipe diameter of 9 *cm* (single side inflow), guidelines recommending the application of pipes of this size from 50 to almost 250 m^2 EPD_{max}, and from 116 to 355 m^2 EPD_{max}, for double-sided inflow, can be found.

Such a significant discrepancy in the EPD_{max} values referred to in the guidelines, depending on the diameter of a gutter or a downpipe, may result from assuming of various drainage system load with the value of measurable rain intensity q_m in the calculations. Although, on the other hand, in several cases, the value of measurable rain intensity of 75 *mm/h* is provided in the guidelines, which corresponds to the rainfall of intensity $q_m = 208\ l/(s \cdot ha)$. At this point, it should be noted that standards [3, 5] recommend adopting $q_m \geq 300\ l/(s \cdot ha)$ value for the calculation of rainfall water drainage, thus, much higher that indicated before.

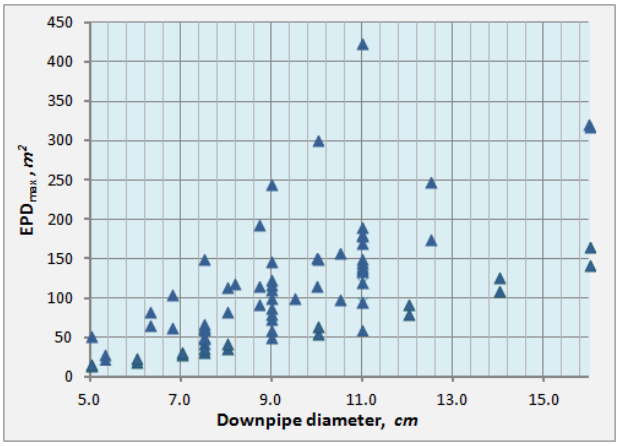

Fig. 3. EPD_{max} dependence on the downpipe diameter at the water inflow to the downpipe from one direction, according to the guidelines of various manufacturers of drainage systems

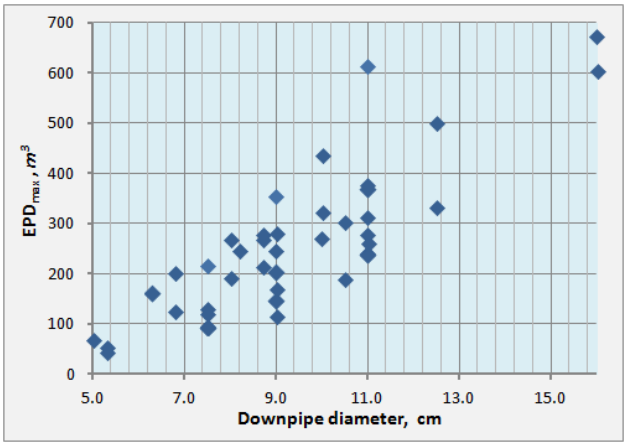

Fig. 4. EPD_{max} dependence on the downpipe diameter at the water inflow to the downpipe from two directions, according to the guidelines of various manufacturers of drainage systems

The runoff ratio and the slope of roof surface may have some impact on the differences in the EPD_{max} values in various drainage systems, however, these factors should not result in 3÷5 – fold discrepancy in the equivalent value of the drained roof surface. The inaccurate consideration of the longitudinal slope of the gutters seems to be more important, as well as various speed of water flow on the inlet to downpipes and, as a consequence, the expenditure of the flow on the pipe inlet. Unfortunately, the guidelines under discussion do not take the slope of gutter arrangement into account while determining EPDmax. It seems that it is a significant drawback of the guidelines analyzed, which may lead to irrational selection of the system elements and, as a result, to the ineffective performance of the drainage systems of roofs of the buildings.

2. INTENSITY OF MEASURABLE RAIN

Due to the fact that the drainage systems should ensure fast discharge of the rainfall water in order to protect the building and its surroundings against being flooded with water, the heavy rainfall, i.e. occurring within a short period of time, appearing with a specific probability, should be taken into account. Rain with short duration is accepted to the calculations since this type of precipitation shows the highest intensity at the initial stage when the runoff of rainfall water is at the level posing the risk of flooding to the building elements. As a rule, the intensity of rain easing in the period of 5 minutes is adopted for the calculations.

An important parameter determining the intensity of measurable rain is the adopted probability of its ceasing. Parallel to the decreasing probability of the rainfall ceasing, the protection of the system increases in terms of exceeding the assumed intensity of the rainfall. The probability of 1% indicates the possibility of recurrence of the rain of the intensity assumed, thus, the possibility of its exceeding, once in 100 years, whereas the probability of 100 % indicates the possibility of the rain recurrence once a year, consequently, the possibility to exceed its intensity in the following year. The probability expresses how many times per century the assumed rain intensity may be exceeded, thus, it defines the level of the drainage system protection against the activity without overload. In the external roof drainage, usually the probability of 50% is accepted, i.e. the repeatability of the rainfall once in two years. German standards [6] assume a similar level of probability for external drainage systems, however, for internal drainage systems, creating potentially higher risk for the facility and conditions of its maintenance, they assume probability of 1% (rainfall once in 100 years).

The relationship for determining of the measurable rain intensity for the territory of Poland, commonly quoted in various types of guides, is Błaszczyk's formula,

$$q_m = A \cdot C^{0.333}\, t^{-0.667},\ dm^3(s \cdot ha) \qquad (3)$$

where: A – parameter dependent on the value of the average annual sum of rainfall (at the average annual total rainfall equal to 600 *mm*, $A = 470$);
C – frequency of a single exceeding of the specific rain intensity, *years*;
t – duration of the rainfall, *min*.

For the five-minute rain, occurring once in two years, the intensity of the measurable rain according to Błaszczyk's formula is 202 $dm^3/(s \cdot ha)$, which is close to the value of 208 $dm^3/(s \cdot ha)$, corresponding to 75 *mm/h*. However, currently the Błaszczyk's ratio is assessed as imprecisely reflecting the intensity of rainfall for the territory of Poland [7]. The studies of Bogdanowicz and Stachy [8] indicate that the maximum rain intensities for various regions of Poland demonstrate other dependence towards the duration of the rainfall and its intensity, than the relation arising from Błaszczyk's ratio. The equation they propose has the following form

$$q_m = \frac{1000\,[1.42\, t^{0.333} + a\,(-\ln p)^{0.584}]}{6\, t},\ dm^3(s \cdot ha) \qquad (4)$$

where: p – assumed probability of rainfall incidence,
a – parameter dependent on the location and duration of rain, for the rain of $t = 5 \div 30$ *min*, for a part of the country (except the Sudetes and the Carpathians – for the needs of this article, defined as R_1 rainy area, figure 5), and the time of rain occurrence $t = 5 \div 120$ *min*, the relation:

$$a = 4.693 \ln(t+1) - 1.249,\ mm \qquad (5)$$

and for the north-western rainy region (R_2 rainy region, figure 5), limited approximately by the line Zielona Góra – Poznań – Olsztyn, the relation:

$$a = 3.92 \ln(t+1) - 1.662,\ mm \qquad (6)$$

The differentiation of the calculated intensity of rainfall on the territory of Poland is an adequate approach, since it better reflects the real climate conditions in the scope, which can be observed in the maps of rainfall distribution in Poland (Fig. 6).

Fig. 5. Division of the country into rainy zones according to [9]

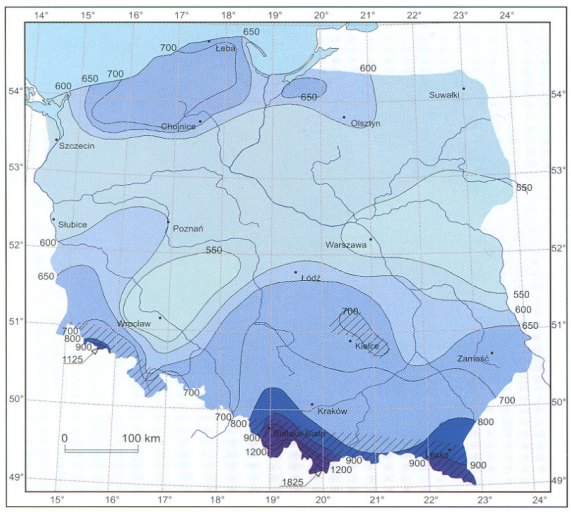

Fig. 6. Average annual level of rainfall in 1996 – 2000 according to [10]

The nature of the dependence of rain intensity on its probability for region I and II, according to the Bogdanowicz-Stachy formula, is illustrated in the chart (Fig. 7). The chart presents the results of calculations of the maximum rain intensity for 50 % probability of incidence (rainfall once in 2 years). For zone I it amounts to 276 $dm^3/(s\ ha)$, and for zone II - to 227 $dm^3/(s\ ha)$. These values are higher than 202 $dm^3/(s\ ha)$, the value obtained from the Błaszczyk's formula. Results of calculations of the q_m value for the 1% probability (rainfall once in 100 years) have been also included; they are much higher than 300 $dm^3/(s\ ha)$, the value which is adopted for the dimensioning of the internal rainfall drainage systems.

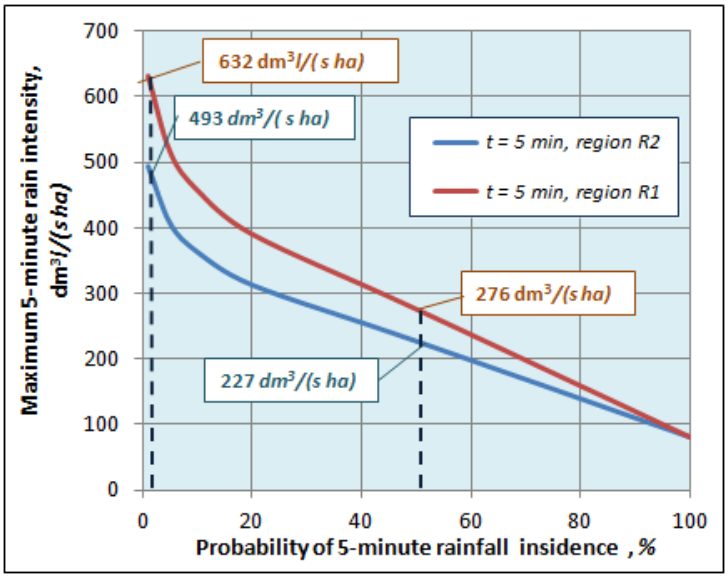

Fig. 7. The dependence of the maximum 5-minute rain intensity on the rainfall probability according to the Bogdanowicz-Stachy formula

CONCLUSIONS

1. The appropriate management of rainfall water runoff requires a good knowledge of the characteristics of water flow in every section of the drainage system performance. It refers, in particular, to the initial stage, when, depending on the assumptions, the relevant part of water runs off from the real property to the sewage system, and the remaining part is retained for use. In this context, the sustainable rainfall water management should be strived for.
2. The guidelines for designing of roof drainage rainfall water systems used at present, do not take into account the relevant current characteristics of rainfall and the recommendations of manufacturers concerning the dimensioning of the systems indicate an extremely high discrepancy. The design guidelines referring to various systems do not demonstrate consistency in the adjustment of the meteorological and hydrological parameters of rain to the hydraulic parameters of the drainage systems.
3. The significant discrepancy in the design guidelines of various manufacturers of drainage systems seems correlated with the lack of their relationship with the longitudinal slopes of gutter arrangement and the associated gutter expenditure or flow expenditure created at the inlet to the downpipe. The drawback of the guidelines analysed, may lead to irrational selection of the system elements and, as a result, to the ineffective performance of the drainage systems of roofs.
4. For the determining of the maximum rain intensity (measurable intensity) it is recommended to use Bogdanowicz and Stachy formulas instead of Błaszczyk's formula. These relationships reflect the

volatility of rainfall characteristics on the territory of Poland more precisely. The calculation values of rainfall intensity for the external drainage systems are different for various regions of the country, and, based on the aforementioned formulas, they amount to q_{mI} =276 $dm^3/(s\ ha)$ and q_{mII} = 227 $dm^3/(s\ ha)$, respectively.

5. The urban areas demonstrating the specific character of microclimate conditions, including those associated with the rainfall, require special care in adopting the calculation meteorological data and the adjustment of hydraulic parameters of the drainage systems of buildings. This problem may be particularly important in face of implementation of a fee for discharging rainfall water from real property in some cities and a possible waiver of such a fee, as well as the reduction of tap water acquisition costs due to the application of rainfall water recuperation and its use for residential, technological purposes, etc.

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Construction and architecture

WATER CONSUMPTION ON THE BACKGROUND OF THERMAL MODERNIZATION

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ABSTRACT: The thermal protection of buildings and rationalization of water consumption are directly related with energy savings but also with other aspects. The article presents the real results of the thermal modernization activity based on the monitoring of their effects in fourth educational buildings. The analysis includes water, electricity and energy consumption of these buildings. It was found that after thermal modernization the reduction of the consumption of water, electricity and gas has been noticed. The significant decrease in rates of consumption of media attributed to one student, the learner in a year, in the analyzed schools has been registered.

KEYWORDS: thermal modernization, water consumption, electrical power consumption, gas consumption, utility costs.

INTRODUCTION

In Poland, in the perspective of the year 2025 it is expected to implement the idea of sustainable production and consumption in relation to the use of water for industrial, municipal and agricultural, to introduce rules for the application of best available techniques (BAT – Best Available Techniques) in systems abstraction, treatment and distribution of water and achievement of indicators of water consumption per unit or value of production and per capita does not exceed the average values for OECD countries. [1]. Activity aimed at more efficient use of water is closely associated with the activities in the area of energy efficiency. Water preparation technology from its collection to final use requires the use of energy. In addition, water often has to be heated to a suitable temperature and for further use in domestic or industrial purposes. For the construction industry it is primarily energy for preparation of warm water.

The energy efficiency is one of the leading issues considered by members of the European Union in strategic documents determining the development direction of the Union [2, 3].

Due to the increasing need for access to clean water and a growing amount of energy used for warming it, the solutions to solve this problem are searched. Among other things, one of the main goals of the UN World Water Day 2014 was to draw attention to the technologies that would meet the demand for water, while using less energy.

Realization and exploitation of buildings involves in European Union almost 40% of total energy consumption [4]. The issues of thermal protection of buildings and rationalization of water consumption are directly related with energy savings but also with other aspects.

1. EFFICIENCES ENERGY AND WATER IN BUILDINGS

Building stock of European Union covers about 200 million buildings, out of which 6 million are located in Poland. Around 70% of energy is consumed for heating and domestic hot water needs [4, 5]. The largest heat consumers in Poland are the households, consume about 54% heat. The heat consumption in Poland has shown a slight declining tendency in the recent years (Fig. 1) [5].

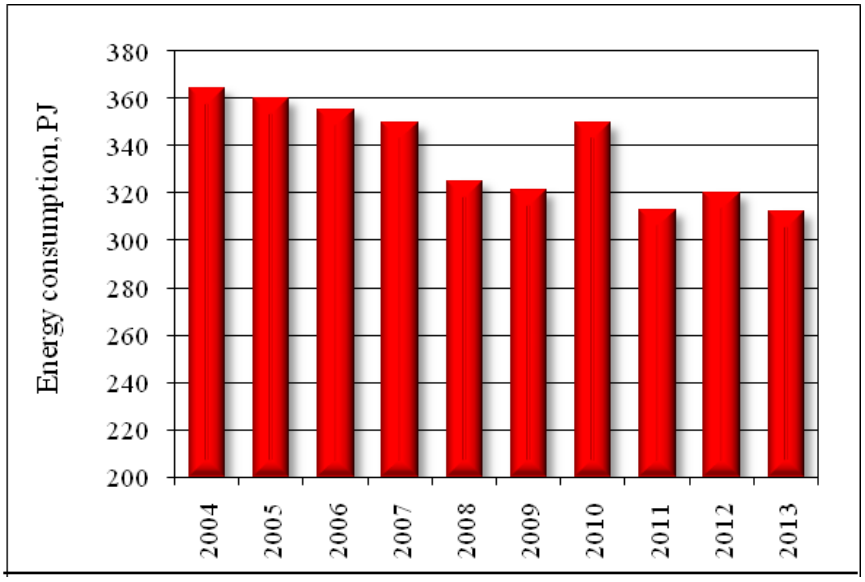

Fig. 1. Energy consumption in Poland in the recent years [5]

The provisions of the directive [2] impose an obligation, inter alia, to elaborate national, long-term strategies are supporting the modernization investments covering the specification of optimal ways for improving energy efficiency of buildings and specification of instruments mobilising the investments. Thermal protection of buildings in Poland and rationalization of water consumption is based on the provisions of the Polish Construction Law and on the technical and construction conditions.

The energy efficiency pointed out in the directives constitutes an important basis for reduction of greenhouse gas emissions. Starting from 2021 all newly constructed buildings will be required to have very low energy consumption, covered mainly by the renewable energy resources. Therefore, it is necessary to promote and implement environmental friendly technologies based on the renewable energy resources.

Non-renewable fuels used in Poland for generation of energy are as follows: hard coal (58.8%), lignite (17.7%), fuel oil (18%) and natural gas (5.6%) [5]. Poland is one of the biggest primary energy producers in the European Union (about 8.5% in 2012) [6]. As far as energy from renewable sources goes, relation of RES production to total energy consumption has been growing both in Poland and in the European Union during recent years (Fig. 2) [5].

One of the elements of improving energy efficiency and reduction of emissions are the undertakings related with thermal modernization of buildings. It has been estimated that through the modernization of an average building in accordance with the currently valid regulations up to 40% of energy may be saved. The implemented in Poland provisions constitute a basis for performing these activities in a complex manner and cost-effectively, considering the investment and utilization expenses.

In the total operating costs of the provided services the main share accounted were costs related to payments for central heating and warm water [7]. The average share of the costs of heating and preparation of hot water in the total operating costs of exploiting buildings (Fig. 3) stood at 59.5% in 2006, and decreased to 53.1% in 2012.

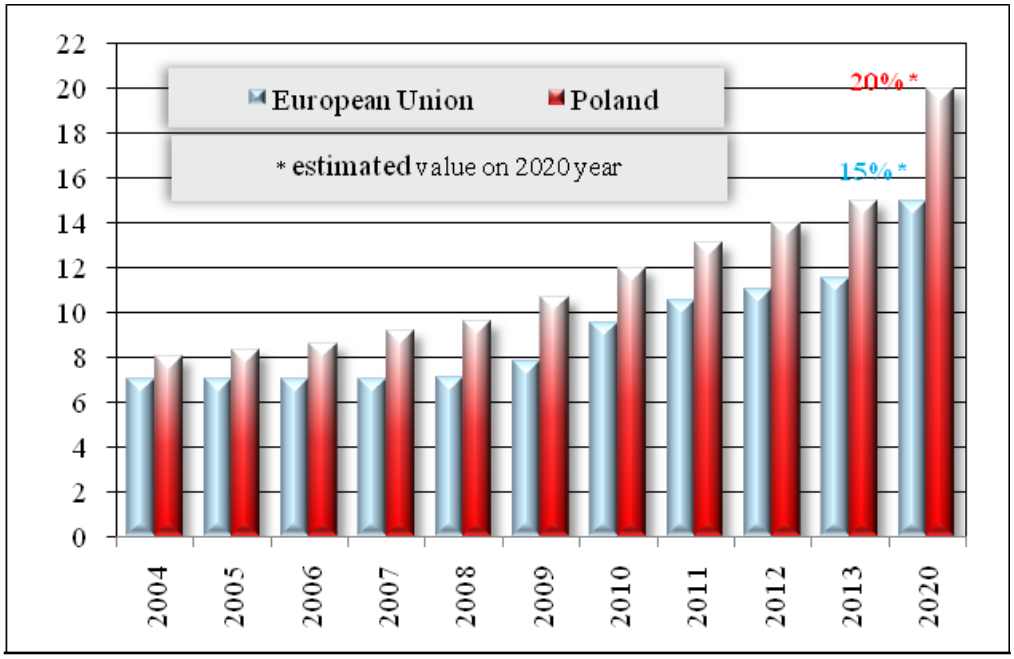

Fig. 2. Share of renewable energy in gross final energy consumption [5]

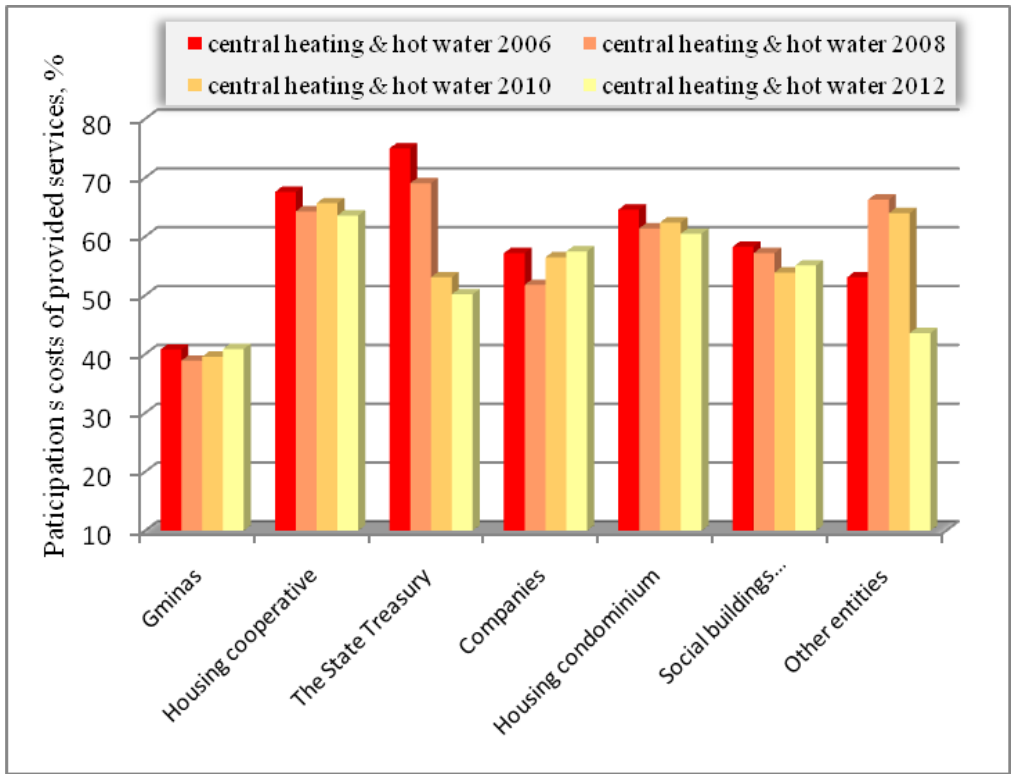

Fig. 3. Structure of share of central heating and hot water costs of provided services as per the forms of ownership in Poland [7]

The average share of cold water and sewage discharge (Fig. 4) increased from 30.4% in 2006, to 33.3% in 2012. It indicates a clear trend declining of the cost of heating buildings and increase in the cost of water in the operation of the various buildings, in Poland.

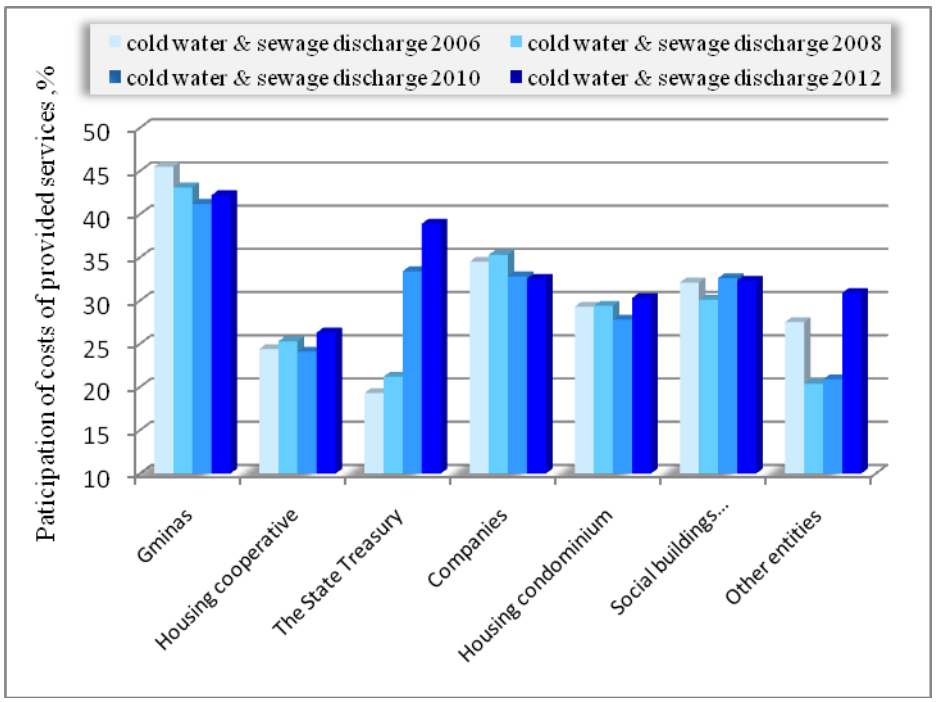

Fig. 4. Structure of share of cold water and sewage discharge costs of provided services as per the forms of ownership in Poland [7]

2. EXAMPLES OF THERMAL MODERNIZATION AND THEIR EFFECTS

There are four school buildings, located in the province of Silesia, in the villages Gieblo, Ogrodzieniec, Podzamcze and Ryczow are the examples of buildings for which an assessment of the changes in basic media consumption and the related costs, before and after the thermal modernization. Objects have been audit analyzed where from 2010 to 2012 the thermal modernization was carried out. The following improvements have been done: the thermal insulation of the external barriers and replacement of some equipment of the buildings. Activities were aimed at improving the efficiency of the energy use for heating and preparation of the domestic warm water.

The monitoring of the results from conducted modernizations showed that average energy reduction effect was at the range of 38÷45%, reduce gas and carbon consumption and associated costs.

Apart from that other components of media consumption and associated costs have been monitored. An evaluation of price changes on individual media in a given period of time has been done. Then the change in the price of media consumption in the analyzed period of time has been compared. The principle of an average price of water, electricity and natural gas in the year, before and after the thermo, which stemmed from the annual accounts for the type of media have been taken into account. Another aim was to determine the consumption of a given type of media per student learner in a year in a school.

The average price of cold water increased in the period from 2009 to 2013 (Fig. 5). In the analyzed objects in the period before thermal modernization stood at 1.23 €/m^3, and after the thermal modernization it was increased to 1.65 €/m^3. In the same period, after the thermal modernization the annual water consumption per student in most sites and years was decreased (Fig. 6). Before thermal modernization the average water consumption was 4.32 m^3/(per student·a), and after the thermal modernization dropped to 3.85 m^3/(per student·a).

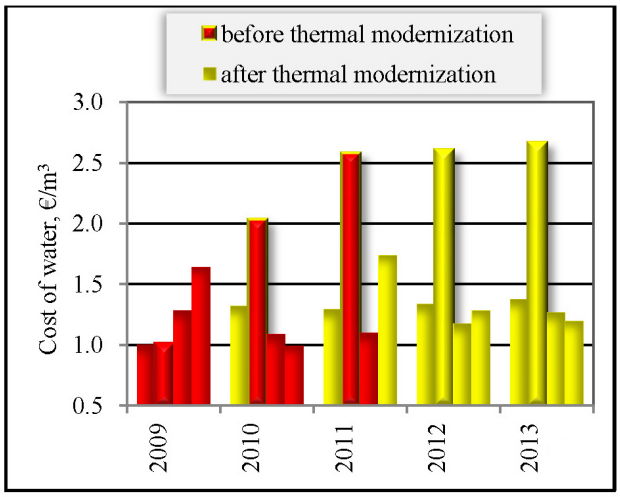

Fig. 5. Cost of water

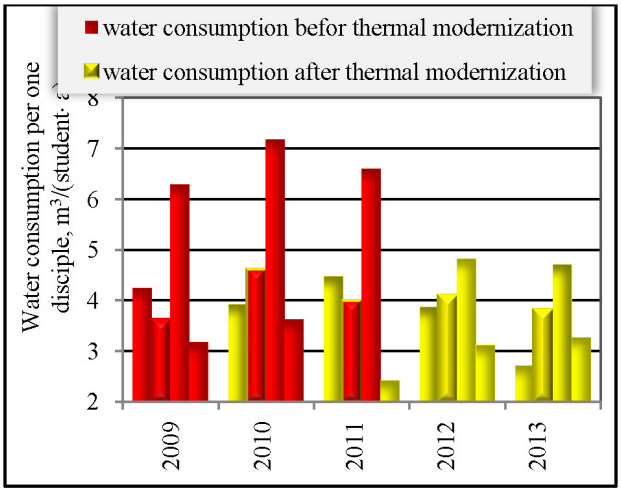

Fig. 6. Water consumption per one student

The average price of electricity increased in the period from 2009 to 2013 (Fig. 7). In the analyzed objects in the period before thermal modernization it stood at 0.16 €/kWh, and after the thermal modernization it increased to 0.18 €/kWh. In the same period, after the thermal modernization the annual electricity consumption per student in most sites and years significantly was reduced (Fig. 8). Before the thermal modernization the average electricity consumption in the analyzed objects was 169.4 kWh/(per student·a), and after the thermal modernization dropped to 143.3 kWh/(per student·a).

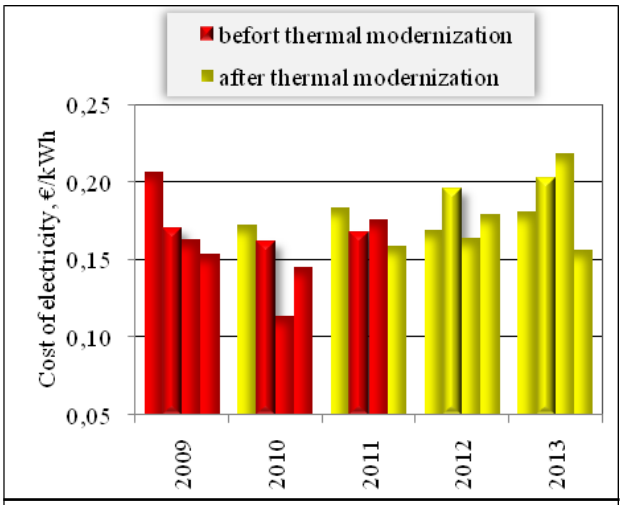

Fig. 7. Cost of electricity

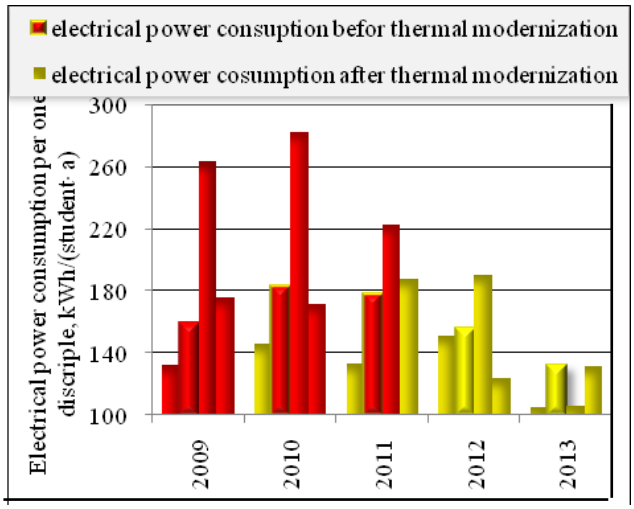

Fig. 8. Electrical power consumption per one student

The average price of natural gas increases significantly in the period from 2009 to 2013 (Fig. 9), in the analyzed objects in the period before thermal modernization stood at 0.47 €/m^3, and after the thermal modernization increased to 0.62 €/m^3. In the same period, as a result of carrying out the thermal modernization the annual consumption of natural gas per pupil in most sites and years was significantly reduced (Fig. 10). Before thermal modernization the average consumption of natural gas in the analyzed objects was 175.4 m^3/(per student·a), and after the thermal modernization dropped to 116.1 m^3/(per student·a).

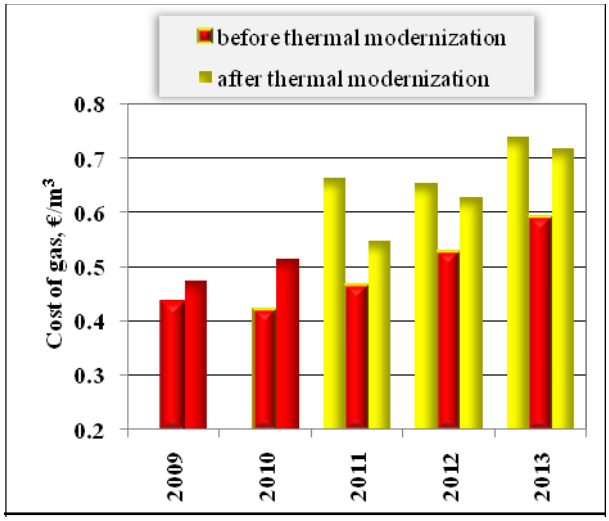

Fig. 9. Cost of gas

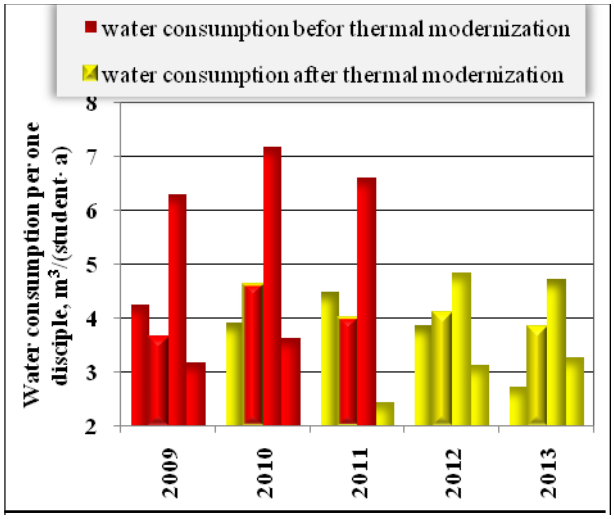

Fig. 10. Gas consumption per one student

CONCLUSIONS

In Poland, in the recent period, the decrease in costs associated with the heating of buildings and increase in costs related to the provision of water and sewerage discharge have been noticed.

In this article a case of comprehensive thermal modernization of a educational buildings was described. Comprehensive thermal renewal of buildings brings the greatest effects and the shortest time of return on invested capital. The study showed that the thermal modernization initiatives contribute different effects related to sustainable development of construction industry and contribute to the improvement of energy efficiency.

Thermal modernization and observance of the rules of sustainable building allows reduction natural resources: water, gas and carbon. These activities contribute to the reduction of gas emissions and decrease of buildings operation costs. Average reduce energy in monitored period in these buildings was at the level of 38÷45%.

In the analyzed objects there was found that after the thermal modernization not only energy consumption for heating was lowered, but also there were obtained other interesting effects including economic results . Despite rising prices for water, electricity and natural gas the consumption rates of these media, per student were lower than before the thermal modernization. Reduction of water consumption per student was approximately 14% and the electricity 25%.

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Economics of Melioration and Water Economy

SOME ISSUES OF MANAGEMENT OF FINANCIAL RESOURCES DIRECTED TO THE CONSTRUCTION OF NEW AND REHABILITATION OF EXISTING WATER STORAGE BASINS

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ABSTRACT: For water supply problem of Georgia reclamation objects one possible way is regulation of water resources of Eastern region of country by new water reservoirs building and existing rehabilitation. As a result of this works will be avoided water shortage for irrigation soils and suitable planned reduction of agricultural harvest.

In this regard definition interest is money recourses management, which toward this field, among them taking into accounts risks factors in planning their return interest. In the article is proposed methodic for evolution of investment projects, which use give possibility reliably assessment of water reservoirs building (rehabilitation) effectively, will define of water management building priorities, will be receive planned profit and suitable timely return of money resources invested by potential investors.

KEYWORDS: water management, economy, money resources management, taking into account risks.

INTRODUCTION

Natural and climatic conditions of Georgia dictate the necessity of wide-scale application of irrigation representing one of the most important factors of highly efficient agricultural production. At the same time, it is necessary of mention that distribution of water resources, including irrigational ones, across the territory of the country is featured by irregularity of the flow and, correspondingly, uneven anthropogenic load. Thus, out of total volume of water resources (102.6 km³) 74.5% relates to Western Georgia and only 25.5% – to Eastern Georgia. If in Western Georgia the quantity of water satisfies all the demands of the industry, agriculture, and municipal economy, then in Eastern Georgia the problem of water remains extremely acute, and requires obligatory solution. One of the possible ways of solution of the given problem is regulating the water resources of eastern region of the country by means of construction of new and rehabilitation of existing water storage basins. As a result of these operations, the risk of failure of watering of irrigated lands, and, correspondingly, the danger of failure of obtaining of planned harvest of the crops may considerably reduce.

Proceeding from this, management of financial resources being directed into this capital-intensive field, including the planning of their payback with the consideration of risk factors, is of definite interest.

MAIN PART

Quantitative assessment of the risk of the failure of obtaining of planned level of productivity of irrigated agricultural lands can be carried out by the formula:

$$R=H_p \times P$$

where H_p is the value of losses of agricultural product;

P is the probability of failure of obtaining of planned volume of agricultural product.

Thus, the degree of the risk of loss origin is determined by the product of the probability of occurring of this event and the value of losses of agricultural product.

To determine a criterion of quantitative evaluation of the risk of deficiency of agricultural product in case of extraction of irrigation water from natural not regulated sources, two indicators can be applied:

- average expected value (χ) – possible result, which represents average-weighted value of all possible results;
- standard deviation (σ) – as the measure of variability of coming of corresponding results.

In practice it is possible to apply the factor of risk (r), defined as the ratio of maximal losses of agricultural product (H_{nmax}) to the volume of financial resources used by farmers:

$$r = \frac{H_{n\max}}{k}$$

Under the conditions of market economy, especially in the period of its formation, investment into development is connected with the risk of non-obtaining of expected results in planned periods. In this regard it is necessary to quantitatively evaluate the risk of investment in order to make a potential investor have in advance the real picture of payback of invested funds. Under these conditions for the evaluation of advisability of an investment project it is necessary to envisage the minimal guaranteed level of its profitability, level of purchase power of money with the consideration of inflation changes, risks, connected with the terms of payback of the project.

For the achievement of set purpose, the world practice applies the so-called method of cost discounting. The process of cost discounting of the project at the basic point of time (the current one or the one specially defined) is carried out with the aid of the compound interest formula. The connection between the present and future cost of the project looks as follows:

$$C_t = \frac{C_a}{(1+K_d)^t}$$

where C_t is the present cost; C_a is the future cost; K_d is the discount factor; t is the time interval between the present moment and initial year of the investment project.

As a result of the implementation of the project, the value of accumulated discounted pure profit is calculated in correspondence with the expression:

$$NV_d = \sum_{t=1}^{T} \frac{NV_t}{(1+K_d)^t}$$

where NV is the pure profit obtained as a result of implementation of the project within the time period t.

Pure receipts obtained as a result of implementation of the project are calculated as the sum of depreciation charges and pure profit.

$$NV_t = V_r + A$$

where V_r is the value of pure profit of the project; A is depreciation charges.

The reviewed indicators allow of calculating the value of the present cost of future profits, whose value is connected both with the rate of inflation and the interst rate of bank credits. Analogically, it is possible to calculate the cost of the project in the future; at the same time, the numerator of the calculation formula should contain the distribution of investments according to corresponding period of investment.

A number of criteria are applied for the evaluation of investment efficiency internationally, which are based on the concept of change of cost of money in time. While doing this, among the applied indicators the following indicators have gained the greatest spread:

NVP (Net Present Value) – obtained pure (discounted) income;

IRR – Internal Rate of Return;

PBP – Payback Period;

PI – (Profitability Index) – investment profitability.

The obtained pure profit from the implementation of the project is calculated as the difference between aggregate value of monetary receipts and value of initial investments in the implementation of the project:

$$NVP = \sum_{t=1}^{T} \frac{NV_t}{(1+K_d)^t} - \sum_{t=1}^{T} \frac{U_t}{(1+K_d)^t}$$

where ***NPV*** is pure given income, and ***U*** is investment charges (capital investments, circulating assets, process costs).

Payback of capital investments is achieved at the expense of the value of additional pure given income, which will be generated by these investments in the prospect of a number of years. If the total sum of discounted values of pure income is higher than assumed capital outlays, i.e. the value of ***NPV*** is positive, then the project is considered as an efficient one, and it can be implemented in practice.

The value of the offered method of evaluation of investment efficiency lies in the fact that the methodology of its calculation allows of determining the period of payback of invested funds, i.e. of determining the period of time, within which the obtained pure given income will be equal to nought, as the sum of the discounted receipts will become equal to the value of investment outlays.

One more indicator, with which it is possible to evaluate the efficiency of investments is the indicator of their profitability, representing the ratio of discounted pure receipts to initial investment outlays.

$$PI = \frac{NV}{U},$$

where ***NV*** is the obtained pure income, and *U* is investment outlays.

If the value obtained as a result of the calculation will be more than one, then the considered project is considered as efficient, and it may be financed. It should be noted that the consideration of risk factor is the most important point of establishment of the discount factor. In the investment project, the value of the risk depends on particular content of the project, and, ultimately, it makes the results of calculation most close to reality. In this regard, with the purpose of ensuring of minimal risk of obtaining of expected income there appears the necessity of making corresponding corrections into the discounting factor. Establishing the discounting factor is possible according to the formula:

$$k_d = P + I + r,$$

where ***P*** is the minimally possible norm of profit; ***I*** is the tempo of inflation; ***r*** is the risk of obtaining of expected income.

Let us introduce some markings. Let us assume that the value of the risk of failure of obtaining of irrigation water taken from the non-regulated source is equal to r_1, and of the one taken from the regulated source is r_2. It is clear that $r_1 > r_2$. Then the discounting factor of expected receipts during the extraction of water for irrigation from non-regulated sources will be equal to:

$$k'_d = P + I + r_1.$$

Analogically, during the extraction of water from the regulated sources (water storage basins):

$$k''_d = P + I + r_2.$$

Correspondingly, $k' > k''_d$.

It is necessary to mention that to create (rehabilitate) water storage basins, the latter require along with capital investments (***K***) annual expenditures for operation, maintaining them in technically operable condition (***Q***), i.e. $U = K + Q$.

At the same time, the construction of water storage basins is accompanied by withdrawal of flooded lands from economic return and resulting corresponding economic loss.

The value of the economic loss (***Y***) can be calculated by the formula:

$$Y = S_3 \cdot m + a \cdot S_n \cdot m = NV\left(S_3 + a \cdot S_n\right)$$

where ***m*** is the loss of production from land flooding and impoundment;

S_3, S_n are the areas of flooded and impounded lands in hectares;

a is the coefficient less than one, which considers reduction of productivity of agricultural lands as a result of their impoundment.

Thus, the pure given effect of land irrigation from the non-regulated sources constitutes:

$$NPV_1 = \sum_{t=1}^{T} \frac{NV_t}{\left(1 + K'_d\right)^t}.$$

Analogically, for the lands irrigated from the regulated sources:

$$NPV_2 = \sum_{t=1}^{T} \frac{NV_t - Y_t}{\left(1 + K'_d\right)^t} - \sum_{t=1}^{T} \frac{U_t}{\left(1 + K''_d\right)^t}$$

Correspondingly, the effect from the creation of water storage basins constitutes:

$$E = NPV_2 - NPV_1.$$

In case, when $E > 0$, the project is considered as efficient.

The period of the project payback comes when the total sum value of the effect for *n* number of years gets equal to the total sum value of investment outlays, i.e.

$$\sum_{i=1}^{n} E_i = \sum_{t=1}^{T} \frac{U_t}{\left(1 + K''_d\right)^t},$$

where ***n*** is the period of payback of investment outlays.

CONCLUSIONS

Thus, the offered methodology of evaluation of efficiency of investment projects from the position of system approach allows of evaluating with enough reliability the efficiency of construction (rehabilitation) of water storage basins, determining the priorities of water economy construction, reducing the risk of failure of obtaining of planned profit, and, correspondingly, of non-timely compensation of the invested funds by potential investors.

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Environmental protection

ISSUES OF ENVIRONMENTAL PROTECTION AND ECOLOGY IN CONDITIONS IN THE PRESENT STAGE OF DEVELOPMENT

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ABSTRACT: The article discusses a number of issues relating to the protection of the environment and ecological balance in the present stage of development of society and production.

KEYWORDS: environment, production, industry, fuel and energy resources, technology, pollution.

Охрана окружающей среды

ВОПРОСЫ ОХРАНЫ ОКРУЖАЮЩЕЙ СРЕДЫ И ЭКОЛОГИИ В УСЛОВИЯХ СОВРЕМЕННОГО ЭТАПА

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Для удовлетворения своей потребности человечество постоянно расширяет арсеналы и наращивает использование полезных ископаемых и др. природных ресурсов. В процессе использования применяются все более совершенная техника, технология и механизмы, требующие для эффективной эксплуатации новые материалы. Современные достижения науки и техники значительно расширяют возможности ресурсного обеспечения хозяйственной деятельности за счет освоения труднодоступных ресурсов территории суши, морей и океанов, глубоких горизонтов Земли.

В процессе добычи, обогащения и промышленной переработки минерально-сырьевые и др. природные ресурсы переходят в новое состояние, изменяя первоначальные физические и химические свойства. Например, каменный уголь, антрацит, природный газ, нефть, железная руда трансформируясь из одного вида в другой принимают форму рассеиваемой и тепловой. Такой процесс происходит за счет денежных затрат, труда, энергии и материалов. Преобразование природы обычно сопровождается выделением газа, тепла, пара, энергии, при котором возникает целый ряд негативных явлений для природы и здоровья людей.

Борьба с такими последствиями осложняется из-за значительных расходов на рекультивацию нарушенных земель в городах, районах добычи полезных ископаемых, строительных площадках, утилизацию твердых и жидких отходов в отвалах, хвостохранилищах. Проведения мероприятий по

локализации или предотвращению выброса отходов в природную среду также требует больших капитальных вложений, энергии и материальных ресурсов. Газо-угледобывающие оборудования и сооружения по очистке сточных вод высокой мощности являются крупными энергопотребителями. Сброс теплых вод, дымовых отходов из промышленных предприятий, бытового обслуживания и др., использующих органическое топливо, становятся причиной изменения температурного режима. Однако отходы, загрязняющие природную среду, представляют собой средство дополнительного ресурсопотребления, как и накопители определенных видов ресурсов, использование которых дает немало продуктов для хозяйства.

Безусловно, технический прогресс играет важную роль в увеличении топливно-энергетических ресурсов, в изменении структуры энергетической базы, но именно это и оказывает значительное влияние на использование топливно-энергетических ресурсов и на характер загрязнения природы.

Современная техника потребует развития межрайонных, межгосударственных торгово-экономических связей, а также значительного роста и водного, в частности, морского транспорта. Мощный танкерный транспорт осуществляет перевозку сотен миллионов тонн нефти между отдельными районами и странами мира, обеспечивает доставку топлива, стройматериалов, промышленных, продовольственных товаров, пассажиров с наименьшими расходами, по сравнению с авиационными и железнодорожным транспортом. Однако водный транспорт не лишен недостатков. Например, из-за аварийных случаев, утечки топлива, сбросов в воду огромного количества загрязненных, мазутом, сточных вод происходит интенсивное загрязнение Мирового Океана и внутренних морей. Флот современных рыбопромышленных судов, оборудованный рыбопоисковой техникой, эхолотами, гидролокаторами, шумопеленгаторами, воздушной разведкой, механизацией основных процессов добычи и обработки рыбы, позволит увеличить улов рыбы. Вместе с тем это оказало отрицательное влияние на животный мир морей и океанов.

С развитием транспорта связано освоение новых районов, размещение производства и процесс расселения. Следует отметить, что освоение новых районов, рост населения, создание водохранилищ, аэродромов, развитие железнодорожного, автомобильного, трубопроводного транспортов, проведение линий электропередачи отнимают из сельхозоборота огромные земельные площади.

Следует отметить, что площадь, занятая транспортными коммуникациями, к общей земельной площади страны относительно невелика. Однако, по мере строительства новых трубопроводов, железных, шоссейных дорого, ЛЭП покрытая ими земля будет увеличиваться, причем большая часть падает на сельскохозяйственные угодья. В целях уменьшения отхода сельхозугодий под транспортные коммуникации следует выделить для этого малопригодные участки, совершенствовать работу транспорта. Для этого необходимо увеличить скорости транспортных средств и пропускную способность дорог, повысить производительность подвижного состава. Немаловажное значение в этом направлении имеет рациональное размещение производственных сил с учетом потребности каждого региона и максимального удовлетворения их нужды в народнохозяйственном грузе за счет собственного производства.

В индустриально развитых странах и густонаселенных районах мира продолжается интенсивное загрязнение окружающей среды, в частности земельных участков, механическими примесями в виде шлаков, шламов, хвостов обогащения, золы, пыли, сернистых газов, некондиционных строительных материалов, пустых пород, извлекаемых при добыче полезных ископаемых. Массовый характер носит процесс замусоривания земельных угодий различными отходами, особенно вдоль железных дорог, автомагистралей, территорий морских и речных портов.

Все виды транспорта, работающие на органическом топливе, наряду с соединениями серы выбрасывают в атмосферу в большом количестве окислы азота, фтора, хлора, соляную кислоту, частицы свинца, кадмия и др. Эти активные и агрессивные вещества не только отрицательно воздействуют на животный мир, но интенсивно разрушают металлические конструкции, лакокрасочные

покрытия и даже бетонные и каменные сооружения. Веками стоящие исторические памятники, сделанные из бронзы, стали, мрамора, под воздействием названных веществ подвергаются коррозии, разрушению. Значительный вред испытывают мосты, здания, транспортные сооружения и др. Выбросы свинца, ртути, кадмия, серы опасны для почвенного покрова, особенно в тех районах, где их концентрации превышают допустимые нормы.

Серьезную опасность для Планеты составляют тепловые отходы, повышающие температуру крупных городов и промышленных центров на 3-6°С по сравнению с удаленными от них в атмосферу в городах, промышленных узлах огромного количества теплового отхода. Значительное влияние на потепление в черте крупных городов оказывает "парниковый эффект", когда загрязнение углекислым газом атмосфера относительно легче пропускает излучение солнца к земле и существенно хуже – инфракрасное (тепловое) излучение от нее в воздушное пространство.

Наряду с промышленностью и энергетикой, крупным "поставщиком" углекислого газа в атмосферу городов является автомобильный и воздушный транспорт. Устранение или уменьшение такого негативного явления ставит перед химиками задачу для поиска и внедрения новых видов топлива и создания специальных машин с совершенствованными системами, способными работать на электроэнергии, полученной из солнечной батареи, гидротермальной энергии и др.

Следует отметить, что учеными и специалистами выдвигаются и другие, противоположные этому, мнения о том, что происходящий процесс интенсивного запыления, загрязнения атмосферы Земли способствует уменьшению прозрачности атмосферы и проницаемости лучей Солнца. Такое опасное для экологии явление приведет к определенному похолоданию на Земле.

Антропогенное влияние человека на его окружение могло практически быть тождественным влиянию местных ресурсов – живой и неживой природы, если человек соблюдал бы взаимоотношения между собой и природными элементами в рамках их непосредственного контакта с природой. Людей было бы не так мало, а мир столь очевидно велик, что было бы странным, если бы им пришло в голову задуматься о собственной численности и о судьбе природных ресурсов. В течение долгого времени последствия цивилизации, антропогенное воздействие человека на природу утрачена значительная часть богатств. Достаточно сказать, что из общих утвержденных запасов полезных ископаемых – твердых и жидких, рудных и нерудных – при эксплуатации и переработке, более половины теряются в недрах, уходят через трубы и идут в отвалы. Это десятки миллионов тонн промышленного сырья.

Восстановление безвозвратно потерянных сырьевых ресурсов просто не под силу современному обществу, так как цель взаимосвязанных причин и следствий приводит к таким нарушениям и сдвигам, которые уже нельзя устранить. Кардинальное решение проблемы предотвращения загрязнения природной среды возможно путем повсеместного внедрения малоотходной или безотходной технологии, вписывающейся в экологический природный цикл промышленных и сельскохозяйственных производств.

Современный человек своим трудом получает от природы все необходимое для жизни – электрическую, тепловую энергию, продовольствие, промышленные продукты, строительные материалы, эстетическое и духовное восприятие. Природа служит источником удовлетворения эстетических потребностей людей. Однако нельзя забывать, что взаимодействие человека с природой приводит к антропогенному изменению в окружающей среде, в большинстве случаев носящему позитивный характер. На месте естественного или так называемого "дикого ландшафта", появляются "культурные ландшафты" с шумными, в большинстве случаев, экологически не приспособленными промышленными предприятиями, городским транспортом, коптящими трубами заводов, фабрик, а также растущими среди загрязненных мазутом болотных земель, труднопроходимыми от протянутых в разные стороны заброшенных труб. Природные, в частности, земельные ресурсы

вовсе не были ресурсами, пока их не тронул человек и не стал их использовать для своего существования, социально-экономического развития. Способность человека выявить, добывать и использовать природные ресурсы развивалась как непрерывный процесс, находящейся постоянно в совершенствовании.

По мере совершенствования орудий труда, форм и методов деятельности людей, расширяется номенклатуры извлекаемых из природных ресурсов и продуктов. В современном этапе потребности в ресурсах возрастает очень быстро. Человек выступает важнейшим фактором во всех процессах природопользования и в системе загрязнения природной среды. Но при этом необходимо сделать так, чтобы человек не брал функции биосферы на себя, а своим разумным воздействием, целесообразным трудом облегчил ход ее развития. Объединенное усилие человека и природы может способствовать формированию стабильных биогеоценозов в измененной человеком среде.

Проблема окружающей природной среды охватывает широкий круг вопросов, основой которых является создание правильного соотношения действий между обществом и природой, основанное на рациональном природопользовании. Проблема эта прежде всего должна учитывать следующие принципы: а) формы и масштабы деятельности общества должны быть соизмеримы с выявленными запасами полезных ископаемых; б) все минеральные ресурсы на современном этапе развития должны подвергаться комплексной переработке с учетом утилизации отходов, применения малоотходной и безотходной технологии; в) отходы производства должны попадать в биосферу в форме концентрации, безвредной для жизни; г) с разработкой и определением «экологической нормы человека», позволяющей наметить формы и качества человеческой деятельности при получении различных величин полезной продукций без нарушений жизненно важных экосистем.

На наш взгляд, нецелесообразно увеличивать мощность, развивать новые предприятия, где уже имеется их большая концентрация, да еще с большими выбросами загрязняющих веществ, из-за необеспеченности предприятий очистительными сооружениями. К загрязнению природной среды в таких районах к которому можно отнести Абшеронский и Гянджинский промышленные узлы, способствуют и медленное развития малоотходных технологических процессов, недостаточная экономическая заинтересованность целого ряда предприятий в выполнении природоохранных, ресурсосберегающих мероприятий. В такой ситуации выход один необходимо резко повысить производственную и экологическую дисциплину.

Вопросы касающиеся об охране окружающей среды охватывает очень большой круг проблем, но в одной статье не возможно охватить все проблемы. В статье мы попытались привлечь внимание общественности к некоторым вопросам окружающей среды и природопользование.

В современных условиях природопользователи должны действовать в таком направлении, когда бы задача повышения эффективности производства были тесно связаны с заботой о благосостоянии и здоровье населения. Нарушение экологического равновесия в природе приводит весьма к нежелательным, порою непоправимым последствиям.

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C O N T E N T S

International Symposium "Floods and modern problems of fighting against them" led by the director of Georgian Water Management Institute, Prof. G. Gavardashvili and with assistance of Government was held in 23-28 September 2009, under the aegis of UNESCO, it was dedicated to the 80TH anniversary of the founding of Water Management Institute. Scientific experts of 22 countries took part in the Symposium and it was praised by UNESCO, in witness whereof the Resolution adopted at the Symposium has been recognized as a guidance document for UN member countries.

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