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and
HYDRAULIC ENGINEERING

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BOOK OF ABSTRACTS
&
PROCEEDINGS ON CD

Zagreb, 2007

Table of contents

Topic II: Sanitary engineering and sustainable water utilization

Topic III: River engineering and coping with floods and droughts

Topic IV: Geotechnical aspects of hydraulic engineering

Topic V: Integrated water resources management and EU Water Framework Directive

Preface

The scientific Symposium "Water Management and Hydraulic Engineering" is the Xth anniversary Symposium. Over the last 23 years the Symposium has been organizing the regular meetings of numerous groups of hydraulic and environmental engineers, as well as water-managers and other professionals dealing with water, from many friendly countries. Water management deals with realization of water supply, water demand, and reducing of environmental damage caused by water, or to waters and the bodies of water. This management uses hydraulic and other engineering structures to influence water demand, use, conservation, protection and reduction of damage caused by water. Because of that, the main objective of the Symposium is the creation of a proper forum for discussion and exchange of knowledge on water-related topics, among water managers and engineers involved in solving complex water problems today. This symposium tries to contribute to this objective by inviting experts from Central Europe, from the countries which have been the members of the EU since a decade and even longer along with the countries, which have joined the union recently. There are also countries, especially from the South-Eastern Europe, which are not yet member states. The main idea is to exchange experiences in the field of water management and hydraulic engineering. This is especially important in Europe where major river basins are shared by several countries, obviously demanding for the sustainable development of a shared vision and an integrated approach.

The symposium started 1984, as a bilateral activity between the faculties of the Universities of Gdansk (Poland) and Zagreb (Croatia). Since 1998, participants from the Slovak University of Technology, University of St. Cyril and Methodius from Skoplje (Macedonia) and the BOKU-University of Natural Resources and Applied Life Sciences in Vienna (Austria) have been contributing regularly to this two-annual symposium.

The basic goal in solving water-related problems is to establish and maintain continuously balanced relations between the man and nature. It is possible to satisfy human requirements by rationalization of water use and protection from water excesses. At the same time, it is necessary to apply adequate measures in order to protect and conserve water resources. In that sense, the field of water management may be defined from the standpoint of territory, time and knowledge. Water management is a dynamic process of balancing relations between the man and water in nature. The principal task in planning and developing of water management activities is to find an optimal solution

to water-related problems, keeping in mind both the present and the future conditions. Experience has shown that only correct water management solutions may be further improved and adjusted to changes depending on the real circumstances and requirements.

The realization of water management solutions is mainly a task of hydraulic engineering. Very often, in solving water-related problems the cooperation between water managers and hydraulic engineers is necessary or even indispensable. Therefore, the International Symposium on Water Management and Hydraulic Engineering is organized with a good reason. The interest of professionals and authors for the Symposium confirms the necessity of its realization. Thus, the Scientific Committee has accepted 92 papers to be presented at the Symposium and published in the Symposium Proceedings on CD-ROM. All together, 193 authors and co-authors have participated in presenting symposium papers. The papers are divided into five thematic groups:

- Hydraulic engineering and environmental impacts - 24 papers
- Sanitary engineering and sustainable water utilization - 18 papers
- River engineering and coping with floods and droughts - 24 papers
- Geotechnical aspects of hydraulic engineering - 10 papers
- Integrated water resources management and
  EU Water Framework Directive - 16 papers

The Symposium is organized by *University of Zagreb, Croatia - Faculty of Civil Engineering* in co-operation with: *Gdańsk University of Technology, Poland - Faculty of Civil and Environmental Engineering; Slovak University of Technology in Bratislava, Slovakia* **-** *Faculty of Civil Engineering; BOKU – University, Vienna, Austria - Institute of Water Management, Hydrology and Hydraulic Engineering; St.Cyril and Methodius University, Skopje, Macedonia - Faculty of Civil Engineering,* under the auspices of: *IAHS – International Association of Hydrology Sciences* and *Croatian Association of Civil Engineers*

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The organizers of the Symposium would express their sincere thanks to all those who have contributed to the scientific and professional success of this meeting. Thanks is also due to Prof. Hanna Obarska-Pempkowiak, Prof. Hans Peter Nachtnebel, Prof. A. Soltesz and Eng. Fritz Neuschitzer for presented keynote lecture. Finally, thanks are given to all authors and conveners.

Prof Josip Petraš

Editor in chief

Šibenik, September 04-09, 2007

Topic I

Hydraulic engineering and environmental impacts

I-01

Local Structural Protection for Buildings as Environmentally Sound Mitigation Measures

Markus Holub[1]

ABSTRACT

During the last decades, settlement activities increased not only in the Alpine regions of Austria. Due to the scarceness of areas suitable for development, settlements, commercial parks and especially infrastructure facilities were extended into areas which are endangered by natural hazards, such as floods or mass movements. As a result, private and economic losses occurred.

Integral risk management strategies, including hazard mapping, aim at the assessment of such endangered areas. Within the risk management framework, hazard maps serve as a basis for the implementation of mitigation measures.

Comprehensive protection concepts usually include structural measures in the catchment area and along the torrent. Typically, these structures fulfill the functions of dosing and retending water and sediment and therefore influence the environmental processes strongly. Thus, methods of protection against natural hazards should not only influence the natural process, but also reduce the impact at the values at risk. A possible way to reduce those impacts is to decrease the vulnerability of values at risk, above all by means of local protection measures.

According to different torrential and river-related processes (flash floods with bedload transport, debris flows, lateral erosion) and the structural elements of buildings, local protection structures can be classified in terms of relevant impacts and protection objectives. Based on this classification, structural measures are suggested not only for new buildings, but also for upgrading existing settlement structures. This will lead to a considerable decrease of damage to tangible assets without influencing the landscape and its natural processes too intensely.

Usually object protection measures are designed for a single object, but this design has to consider the alignment of the surrounding buildings, so that damages to third parties caused by local protection measures can be eliminated. For events with low intensities, it is possible to diminish the dimension of comprehensive mitigation measures or even to replace them. But even for events with a higher magnitude, where torrential check dams and retention basins are indispensable, they fulfil still the function of decreasing the vulnerability considering the residual risk.

Furthermore, local protection measures are at a lower price and fit often more aesthetically in the landscape than traditional mitigation measures.

Keywords: *natural hazards, hazard mapping, structural mitigation, local protection measures, environmentally sound mitigation measures*

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I-02

The Problematic of Sewage System Reconstruction in Urban Areas

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ABSTRACT

Sewage systems are designed and constructed for a certain project-period, usually from 25 to 50 years. However they remain in use even after the end of that period, so to keep them effective it is usually necessary to make reconstructions.

In this paper the problem of reconstruction of sewage systems is analyzed. The reconstruction can be done for the whole sewage system or just some sections of the system.

If the pipes of the sewage system are not very damaged, or just short sections are damaged and the parameters on which the system design was based do not differ much from the parameters that would be used today the reconstruction can be done using different methods like the traditional excavation – substitution of pipe – backfilling, or modern technologies from reparation of cracks, „relining" - creating a new watertight surface at the inside of the pipe to methods for substitution of pipes without excavation like „pipe bursting" and „pipe eating".

If the project-parameters on which the sewage system was designed and constructed in the past differ much form the parameters that would be used today it is necessary to make a new calculation based on actual parameters. These parameters can differ from the old ones because the urban structure changes with time due to the development of the area, increasing of population density, new buildings, more watertight asphalt and concrete areas, etc. Methods for calculation also change in time. Today there are many types of software that can be used for design of sewage systems.

In most cases the dimensions of actual sewage systems are to small to drain all the rain and waste water that is needed. The problem is usually in the rain water, because by increasing the percentage of the watertight areas and determining the intensity of the rain from IDP (rainfall intensity, duration, returning period) curves using longer return periods the flow of rainwater that ends into the sewage system also increases. The quantity of wastewater also changes but these changes are less significant in comparison with the rain water quantity.

Also, every day more severe conditions about the quality of wastewater released in the environment after treatment require consideration of different types of sewage systems (combined, separated, partly separated,…). If the treatment of wastewater requires more

than just the mechanical phase than passing from combined to separate system is usually done.

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The problematic of sewage systems reconstruction from the above mentioned aspects is shown on the example of analysing solutions for reconstruction of a part of the sewage system in Rijeka City (Croatia).

Keywords: *sewage systems, reconstruction, project parameters*

I-03

Numerical Implementation of Adomian Decomposition Method for Burgers Equation

Eva Ocvirk[1], Mladen Meštrović[1]

ABSTRACT

Burgers equation is a very important fluid dynamical model. It appears customary to test new approaches in computational fluid dynamics by applying them to Burgers equation. In this study, for Burgers equation which is used a model problem in turbulence and shock wave teory was given a solution via Adomian decomposition method (ADM).

The semi-analytic Adomian decomposition method is proposed to solve Burgers equation with different Reynolds number. The Adomian decomposition method provides the solution for given initial condition without using any discretization, in successive components that will be added to the rapidly convergent solution. This method is applied on Burgers equation with small and high Reynolds number. The solutions are calculated with reducing the computational work. The Adomian decomposition method is successfully implemented for numerical calculation of Burgers equation.

In this paper, we have improved numerical solutions of Burgers equation through an accurate, efficient and convenient form of the Adomian recursive scheme. The proposed improved decomposition algorithm resulted with reliable and efficient computational method for governing equation.

Key words: Burgers equation, Adomian decomposition method, Reynolds number.

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I-04

Potential Adverse Environmental Impacts of Engineering Deep Structures

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ABSTRACT

Geotechnical information obtained from site investigations and groundwater levels are powerful tools in planning of deep structures, with respect to anticipating hazards and design problems. The difficulties due to the uncertainties of the geological characters can determine huge consequences such as the environmental and safety negative effects.

Related to environmental impacts of engineering deep structures there are some questions: when is necessary to deep the groundwater level what it happens with groundwater's drainage patterns, doesn't exist the risk of pollution of groundwater and the soil during the construction, how affect water the structures in their working life?

The paper emphasizes some studies related to deep structures situated in Bucharest city and the solutions proposed to minimize the adverse environmental impacts.

Keywords: *deep structure, groundwater, environmental impact.*

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I-05

Feasibility Study of Danube - Sava Multipurpose Canal

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ABSTRACT

The construction of Danube - Sava multipurpose canal is defined in spatial documentation of the Republic of Croatia. The canal's multipurpose significance is contained in three major functions – irrigation, navigation, drainage and a series of minor operations. The strategic objective encompasses not only the irrigation of agricultural soil and the increase of so far highly productive traditional soil, but aims also at the change in vegetation crops structure. It refers to marketable plant cultures such as vegetables, fruits, cash crops, medicinal herbs, and seed grains.The canal navigation comprising a combined river – railway connection would cover a 560 km long Danube region-the Adriatic (Podunavlje-Jadran) traffic corridor. The canal watershed drainage leads further to the planning of Biđ-Bosut field surface drainage and aims to ensure conditions for extension of subsurface flow on agricultural land. The next goal is the elimination of temporary uncontrolled floods from the Spačva-Studva basin, and its discharge control according to forest vegetation demands.Small water enrichment goes along with the irrigation of agricultural areas and with the flood protection of the settlements along canals. The canal ensures the potential use of technologic water. The analysis of DSMC's economic weight was carried out through three scenarios. The scenarios simulate possible final phases of canal's construction, figuring as functional units. The *Scenario I* schedules the construction of the first 15km canals from the Sava river direction for the purpose of irrigation, the *Scenario II* plans the canal construction in its full length, and *the Scenario III* includes also the construction of the port of Vukovar on the canal. The given scenarios result from the development strategy and programme, with the emphasis on agricultural land irrigation, Vc corridor construction and enhancement of forests' water regime for the benefit of growth and increased environmental requirements.The cost analysis was done according to scheduled scenarios, sections and planned construction phases. The project's real cost effectiveness comprises, next to most accurate calculation of preparation, construction, equipment and maintenance costs, and also the evaluation of its benefits. Most of the benefits can be expressed in terms of money, some even in details, but some of them can only be estimated. Some benefits can not be defined by financial indicators; however, they can be clearly discerned. The profits fall into the following categories: direct (the benefits for the future canal's owners in terms of money gained by selling of products and services on the market, or by charging the ceding usage), indirect (benefits that can not be realized on the market, or get the earnings to the owners, but in the framework of other actions, or by avoiding damages) and potential (benefits that can assume different shapes in near future). The investment analysis, income and costs estimation and economic assessment were conducted on the basis of costs and benefits according to the scenario.

Key words: *Danube - Sava multipurpose canal, feasibility study, costs and benefits*

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I-06

Hydraulic Design of Biocorridors –
Possibilities of Water Level Effecting

Lea Hašková[1], Ján Rumann

ABSTRACT

Article is presenting possibilities of water level increasing in fishpasses by boulder elements design. Fishpasses are constructions for ichthyofauna, which enable passing of the gradient created by a water structure and restore stream continuity for migration of fishfauna. They include technical (vertical slot fishpass, pool fishpass, Denil fishpass) and also natural types (rocky chutes, ramps, biocorridors) of construction. Biocorridor is a substitute pathway, whit the character of natural stream, which forms longer bypass river bed with natural surface imitation. It is formed as a boulder bed with continuous river bottom, spreaded by coarse gravel sand, with sloped banks, slow flow and cascade water surface.

Single stones represent efficient means which allow the increase of depth without discharge change. Their big advantage is their natural look and easy installation into river bed, as well as their simple refilling in the case of need. These stones positively influence water level and velocity regime in biocorridors, because they can increase depth about ca 35 %. Their design is very positive not only from the hydraulic, but also ichthyological viewpoint. Another possibility for water level and velocity regime effecting represent boulder sills. Sills are constructed across the river bed. They are created from different boulder sizes, placed vertically and horizontally. Vertical position creates a weir and horizontal position forms a overfall. Several boulder sills ordered one after another create a pool structure of the river bed, which is very suitable for creation of fish rest areas (refuge possibilities).

Optimized biocorridor design, containing mentioned boulder elements, certainly creates required water level and velocity regime for specific ichthyofauna.

Key words: *Biocorridor, Water Level Regime, Single Stones, Boulder Sills*

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I-07

Determination of Minimal Flow of Selected Sections of the Váh River Considering its Ichthyofauna.

Andrej Škrinár[1], Marek Ando[1], Ladislav Pekárik[2],
Jaroslav Andreji[33], Ivan Stráňai[3], Viliam Macura[1]

ABSTRACT

There is a cascade of water-plants built on the river Váh and the natural channel is used to drain flood discharges. During most of the year discharges are regulated by water-management structures. These discharges are not used for energy-related purposes; therefore, it is important to find out the optimal discharge that will not negatively affect the ecosystem of the stream. Minimal flow was determined on the basis of modelling the studied area by decision-making method – IFIM using the RHABSIM model (Riverine Habitat Simulation System - Payne, 1998). The input data of three reference sections on the Váh River in the area of Piešťany – Nové Mesto nad Váhom located in the northern part of Slovakia were obtained by field measurements. The hydraulic characteristics of the stream were extrapolated from three measurements during various discharges. The habitat quality is represented by ichthyofauna. The criteria curves were determined by a diving technique, which used a video-recording of the stream. A result of the modelling is the quantification of a discharge influence on ichthyofauna, which is the bioindicator of the habitat quality, from which follows the minimal flow during the summer period.

Key words: *minimal flows, IFIM - Instream Flow Incremental Methodology, criteria curves, RHABSIM - Riverine Habitat Simulation System*

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I-08

Assessment of Water Retention Curves by Different Methods

Jana Skalová[1], Milan Čistý[1]

ABSTRACT

Measurement of the water retention curve (WRC) points, its drying or wetting branch in the laboratory is very expensive, time consuming and labor intensive. During last ten years we can find relative high number of works, which are devoted to determination of WRCs from available soil properties as particle size distribution, dry bulk density, organic C content in literature. This methodic procedure is based on supposed dependence of the soil water content from previously mentioned characteristics. For these procedures, which use up regression analyses it is introduced term pedotransfer functions (PTFs).

There are presented two methods, which makes possible to simplify and to speed up the estimation of the water retention curves for the soils of Zahorie lowland, which is the part of west Slovakia, in the paper. First method is using multiple linear regression and second artificial neural networks. These methods are based on supposed dependence of the water content on the percentage content of the 1st, 2nd, 3rd and 4th Kopecky grain categories, and on the dry bulk density. The representative set of the drying branch of water retention curves was measured on soil samples of Zahorie lowland region in laboratory for pressure head values -2.5, -56, -209, -558, -976, -3060 and -15300 cm in the overpressure equipment. Particle size distribution and dry bulk density were also determined. Determined functions were verified on another data set of measured water retention curves from the same territory with close agreement. Advantages and disadvantages of this methods are discussed in paper.

Keywords: *water retention curve, particle size distribution, dry bulk density, pedotransfer function, neural networks, soil water regime*

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I-09

Deterministic and Heuristic Algorithms in Optimal Design of Pressurized Water Distribution Systems

Milan Čistý[1]

ABSTRACT

In paper will be demonstrated new model for determining the minimum cost for rehabilitation of water distribution system, based on a combination of linear programming methodology and genetic algorithms approach.

Optimal design of looped hydraulic pipe networks belongs to the class of large combinatorial optimization problems that are difficult to handle using conventional operations research techniques. Although much research effort was made in sake of reaching optimal design of large loop water distribution networks, there is still uncertainty of finding generally reliable method. So author of paper is proposing completely new method in which complementary usage of deterministic and soft computing methods will ensure new level for quality of outputs. Method will be based on a combination of linear programming methodology and genetic algorithms approach. In paper was applied linear programming (LP) in combination with genetic algorithm (GA) method to network rehabilitation. Because GA uses also simulation model of the network, calibration by original method developed by authors is also performed and described. The GA method is used first for decomposing complex looped network to group of possible branched networks. The mathematical models using LP are then set up for each member of this group of the branched networks for rehabilitation optimization. Given the investment costs minimization requirement, the objective function of LP sums the products of individual pipeline prices and their required lengths. Four possible diameters are selected for each section of the network(s). The first possible option is the diameter that is identical with the original one in that section, and other three diameters are larger as options for the same section. When rehabilitation optimization is formulated, the objective function should provide economical advantage for the choice of original diameters, however it should not discriminate against the choice of a larger diameter if the hydraulic situation requires so. In the objective function the program assigns to original diameter a minimum unit price and real prices to other diameters. After evaluating (by LP) of high number of possible branch networks (produced by GA) optimal solution will be find for original looped network.

Method is indented to use for drinking water systems and pressurized irrigation systems rehabilitation as well.

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I-10

The Impact of the Kozjak Water Reservoir as the Psycho-Social Factors

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Abstract

The human behavior has an impact to the environment in a lot of ways, but the environment has an impact to the human behavior too. The environmental psychology is based in the intercommunion of the physical world and the human behavior. The objects of study of the environmental psychologists have always been such problems like the air pollution, the noise, the temperature, the floods or overpopulation (population raise).

The topic that we touch is about the impact of the water accumulation in the lake of Kozjak, a place that is situated 30 km away of the city of Skopje, on the flow of river Treska, where a barrage is built by material of the area with an height of 126m and it also is the highest barrage in the Republic of Macedonia. From the building process of the barrage the citizens of that area and also the villagers of villages around like Sallareva, Merova etc. are impacted in a psycho-social aspect.

People are territorial beings, so if we want to understand fully our behavior, we should firstly understand the nature and the functions of our territories.We intercommunicate in situations with different physical characteristics and also in different places, in noise, in different temperatures, in distance etc.

The social psychologists are also interested to understand in the way how to rate our social world also. These rating reactions oftentimes are impacted from our concernment (if we like or not an object or an occurrence). Those are the basic concepts of the social psychology. When our deeds do not fit with our concernments, we experience an psychological stress known as knowing dissonance. In this study we will talk about for the standings and the prejudice of the citizens of Kozjak and area, impacted or not by the building of the barrage and the change in their environment, which has also impacted in their way of life.

Keywords: *Kozjak reservoir,impact,influence,psycho-social factors*

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I-11

The Pressure Effect to Water Flow within Water Distribution System

Martin Faško[1], Jozef Kriš[1]

ABSTRACT:

The article describes pressure conditions, methods of pressure management and impacts of pressure changes in water supply distribution systems of Slovakia. Furthermore, it describes the use of separately measurable districts in active detection of water leaks as well as research activities of the Department of Sanitary and Environmental Engineering dealing with the changes in pressure of distribution system and their impact on water discharge and water consumption. These changes have an impact on effectiveness and reliability of water supply systems operation. There is a relationship among pressure, rate of changes in pressure, water leaks and water consumption that can be described using mathematical terms. This relationship is currently revaluated in operating conditions of the distribution systems of Slovakia. The results of the research on relationship among pressure, water leaks and water consumption obtained during pressure regulation in the separately measurable districts zone of water distribution system Lučenec are presented in the article.

Keywords: *pressure management, impact of pressure changes, water flow, water leakage, separately water meters district zones*

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I-12

Operation, Maintenance, Re-construction and Repairs of Concrete Swimming Pools

Jozef Kriš[1], Ivona Škultétyová[1], Martin Baláž[2]

ABSTRACT

The article describes causes of swimming pool failures and methods of their re-construction and repair of the defects of walls and bottoms of pools and pipes, sealing of contraction joints, water tightness and technological part. The item deals with the most frequent causes and locations of cracks. In the article is also describe possibilities for provide repair of foil and application of lining.

For construction or re-construction of pools it is necessary to use such materials and constructions that guarantee compact shape, relevant water-tightness and smooth but not slippery surface. The article describes recipe for suitable concrete mixture of swimming pools.

In pool operation and maintenance it is important take into consideration also reduction of operational costs. Costs for pool water heating represent the largest portion of operational costs. Water can be heated using several methods. Therefore it is important to consider carefully a selection of the most suitable method with respect to investment and operational costs as well as other aspects. This article also includes some methods for saving operational costs, etc.

Re-constructions and repairs of swimming pools are carried out because of construction material failures (cracks occurrence and resulting water leaks and thus secondary defects of the pool structure and its surrounding), failures of technological part (filters, pipes, etc.), and eventually for lowering the operational costs (new technologies, solar panels, heat pumps, thermal insulation of pools and pipes, covered swimming pool).

Key words: *Swimming pool, re-construction, repair, cracks, insulation, concrete, foil, lowering the operational costs*

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I-13

Simulation of Unsteady Groundwater Flow in the Vicinity of Snow-up Lakes in Mountain Region.

Dana Baroková[1], Andrej Šoltész[1], Peter Malík [2],

ABSTRACT

The goal of the contribution is by means of numerical modelling of groundwater flow to define the optimum water pumping from snow-up lakes in mountain region of High Tatras. For design of such lakes (gravel pits) and determination of changes in groundwater level regime when pumping the water from them, a conceptual model has been elaborated by means of numerical modelling using finite element method for groundwater flow simulations [1]. After calibration and verification process an unsteady groundwater flow model was the best tool for optimisation of surface and subsurface water system with respect to the environment in National Park of High Tatras.

Presented contribution is dealing with a series of calculations, their results as well as with recommendations for the decision makers. Contribution has to be considered as an applied numerical modelling case study for groundwater flow, its analysis, prognosis and determination of pumping scenarios on groundwater level regime in mountain region. For finite element modelling a TRIWACO Simulation Package for Groundwater [2] has been used.

Keywords: *groundwater level regime, finite element modelling, optimum water pumping for snow-up of hills,*

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I-14

Investigations of Drainage and Submerged Water Intakes in Southern Poland

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ABSTRACT

In the years 2001–2006, investigations carried out in Southern Poland concerned drainage and submerged water intakes. Drainage water intakes are ones whose inlets are drains in the form of perforated pipes laid in most cases under the bottom of a watercourse using the cut-and-cover method. Drains may be laid directly in the aquifer and in packing or placed in concrete flumes filled with filter material. Submerged water intakes may be of a heavy or light type, depending on their casing. Inlets may be placed in the bottom of a watercourse or installed on supports. The objective of the project was to estimate the reliability of the investigated water intakes. Surface waters (small and large watercourses) were the actual water sources. In the reliability assessment, the water source together with the technical facilities was taken into consideration. The material collected during the field investigations made it possible to determine reliability indices for some elements of the investigated water intakes. The resultant reliability parameters of the investigated water intakes were used in calculation programs. The developed programs were based on the theoretical foundations of hydraulics, economics and reliability. These programs are intended to facilitate finding the best technical solution for a water intake in the range of acceptable solutions to ensure the required level of reliability and minimum capital expenditure.

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I-15

The Unsteady Flow Through a Centrifugal Pump After Its Rapid Shut-Down

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ABSTRACT

During the shutdown of a centrifugal pump, it slows down rapidly which leads to the inversion of flow direction inside it when the pump impeller still rotates. The return flow depends on the moment of inertia of the pump impeller, the whole impeller system, and the inertia of the non-return flap. The paper discusses relations between the unsteady motion of the pump impeller and the non-return flap, and the water hammer generated in the pipeline. On the basis of the presented computational model it is possible to show how big the flow inversion and under-pressure in the pipeline can be.

Key words: *centrifugal pump, pressure pipelines, unsteady flow, water hammers*

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I-16

Hydropower in the World and in the European Union

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ABSTRACT

Electricity generation from hydropower makes a substantial contribution to meeting the increasing world electricity demands. In the mid 1990s the installed capacity of hydropower plants amounted to 22% or about 700 GW of the total installed capacity for electricity generation and 19% or about 2.500 TWh/year of total electricity production worldwide. The installed capacity of hydropower in 2005 was 750 GW + 100 GW for pumped storage plants and may increase even more for meeting peak requirements and be multiplied by 3 up to 2.500 GW. Today, hydropower, which is actually the only large scale renewable alternative to fossil fuel generation, provides approximately 16,5% of the electricity produced worldwide, i.e. 2.889 TWh/year. There is now 120 GW of capacity under construction worldwide, i.e. 16% of the installed capacity, and 300 GW more is planned.

Total installed capacity of RES in EU-25 in 2005 was 196.802 MW, of which the installed capacity of hydro-energy was 131.440 MW, i.e. 66,8%. The electricity production by RES in EU-25 in 2005 was 437.225 GWh, of which the share of hydro was 303.883 GWh (69,5%).

The European Union aims at having renewable sources provide for 21% of the electricity consumed in its 27 Member States by 2010. This target has been formulated in the Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market, which has also differentiated targets for each Member State.

Hydropower has several advantages beyond its direct benefit of providing clean renewable power and should be viewed within the context of total watershed management. The storage may be annual, but will more often be used for daily or weekly peaks in power grids. Another advantage is the ability of hydro plants to adopt quickly changes in supply needs, thus improving the frequency control. Hydropower is therefore very attractive source of renewable energy within a regional, national or international grid.

One of hydropower's greatest benefits is that it does not consume the water it uses and this characteristic has led to the development of multipurpose water storage schemes to provide services such as flood mitigation, water supply, irrigation, water quality control, navigation and recreation, as well as power generation.

The key positive characteristics of hydro-electricity can be summarized as being a low-cost, effective, sustainable and renewable energy resource which can be stored in large quantities and which plays a major role in power system management. However, it should be noted that hydro-power have also be known for their negative effects concerning environmental and social problems.

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The paper presents renewable sources of energy (renewables) for electricity production and the electricity generation from hydropower with their potential for future in the world and in the European Union.

Keywords: *renewable energy, hydropower, the world, the European Union, installed capacity, production of electricity, potential for future.*

I-17

Development of Fast Pumped-Storage Schemes by Means of the Hydraulic Model

Roman Klasinc[1], Markus Larcher[1]

ABSTRACT

Changing conditions in the European energy market have brought about a rising demand for peak energy. In the light of the general energy shortage and the problems faced in meeting peak loads there is a constant need for the construction of new pumped-storage schemes. Pumped storage has come to be the environmentally most compatible method of balancing sudden drops in demand or unexpected production increase from wind power stations. Present-day electricity generating plant is characterised by optimal utilisation of hydrostatic head and turbine efficiency. As the available numerical simulations of the complex hydraulic processes involved tend to be limited to one-dimensional analyses whose results are not sufficiently reliable, unsteady processes are studied in physical models.

The particular case discussed in this article is a pumped-storage station equipped with three pressure surge tanks, for which the dynamic processes in the tailwater portion were studied. A pressure above atmospheric of 2 or 3 bar lowers the water level in order to ensure sufficient clearance for the Pelton turbine. Another problem is the surge waves caused by the increasing rapidity of the mode changes between the pumping and generation modes. The sophisticated design of the hydraulic scale model (equipped with process control) presented in this article has provided valuable general information on the complex behaviour of surge waves.

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I-18

Investigation of Unsteady Flow in Closed Pipe Generated by Discontinuous Initial Condition

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ABSTRACT

The communication presents the results of experimental investigation of the particular case of the unsteady pipe flow. It deals with the flow generated in pipe having closed both ends. The pipe is divided into two parts by the valve located at its mid-length. Initially both parts are under different hydrostatic pressure. The measurements carried out using the experimental installation show, that the head oscillations are relatively quickly damped. This fact suggests that the intensive dissipative processes are presented in the considered phenomenon. To model this kind of flow the classical water hammer equations with the source term in Darcy-Weisbach form, representing friction force in the momentum equation, were used. It seems that this model cannot reproduce the observed phenomenon, since the formula applied for the friction factor holds for steady flow. Whereas in the considered case the unsteady flow is generated as the velocity is caused due to compressibility of the water only. Consequently the friction force cannot ensure the expected effects of damping and smoothing of the calculated head oscillations. This conclusion is confirmed by the results of the numerical tests which show, that the required damping and smoothing of the pressure wave cannot be obtained by modification of the friction factor only.

Keywords: *unsteady pipe flow equations, discontinuous initial condition, friction factor*

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I-19

Vortex Drop Shaft on Hydro Power Plant Ombla

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ABSTRACT

In order to satisfy the increased demand for electric power in the Republic of Croatia, the construction of hydro power plant (HPP) Ombla is being planned. The specific feature of the hydro-power plant design is that dam, storage reservoir, evacuation units and turbine hall are placed in the rock, that is below land surface. As a consequence of such plant disposition some technical solutions not typical in engineering practice have occurred. On the upstream side of the dam forming a storage reservoir is a collector on top of which a spillway with capacity of Q = 120 m^3/s needed for evacuating high waters, is anticipated. From the collector water is spilling over the weir in the spillway ending with a vortex chamber. In order to conceive the flow of water for the adopted form and dimensions of particular spillway elements a hydraulic scale model was constructed. On the model, the water level on weir, velocity and depth in spillway and vortex chamber capacity was measured. Special attention was made on measurements in spillway and vortex chamber aimed at achieving even spiral introduction of water into vertical pit with the existence of air nucleus and satisfying the set condition of flow rate. In the paper, the laboratory studies of the spillway and the vortex chamber were described.

Keywords: *vortex drop shaft, hydraulic model, hydro power plant*

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I-20

Correction of Hydrological Regime in Slavonia by Hydrotechnical Structures

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ABSTRACT

Slavonia is eastern region in Republic of Croatia. It is bounded by three big rivers Drava, Danube and Sava River. Water management in this region has been well organized for more than 130 years. There is very rich experience in flood protection, drainage of excess water from watershed and protection of water resources.

The region is abundant with water (average precipitation is about 675 mm/year), but deficits of water also appear due to nature. Main economy in this region is agriculture (agriculture, vegetable and fish farming), which may prosper through better built of irrigation systems.

Ideas and solutions regarding impact on overland water regime have been existing for long time, but relatively few of them have been realised.

The paper gives overview of actions that are conducted towards redistribution of water volumes. The paper analyzes dimension and magnitude of performed action, actual development and further perspectives. Mountain accumulations are crucial for correction of hydrological regime. Slavonia is region where water couldn't be restrictive element of its development.

Key words: *hydrlogical regime, hydrotechnical structures, Slavonia*

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I-21

Repair of the Upper Reservoir of the
Hydro-Electric Power Plant of Żarnowiec

Bohdan Dołżycki[1], Piotr Książek[2],
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ABSTRACT

The article describes the repair of the upper reservoir of the hydro-electric power plant in Żarnowiec. Its parameters, damages and repair methods are presented in short.

The hydro-electric power plant in Żarnowiec was put into operation in 1983. It is a pumped-storage power plant, equipped with four hydro-units which enable a 716 MW 5.5-hour-long power supply to the power system. Individual units are arranged in a system making four separate and independent power outlets. The upper reservoir of the power plant is man-made and has a total capacity of 122 ha and usable capacity of 13,600,000 m3 of water. The power plant's natural reservoir is the postglacial lake of Jezioro Żarnowieckie. The water level in the lake changes as the power plant operates, and the difference between the highest and lowest water level amounts to about 1 metre.

The basin of the power plant's upper reservoir has been faced with asphalt layer. The construction facing comprises the following layers:
- 30-cm-thick gravel drainage layer 5/40,
- 7-cm-thick asphalt concrete layer,
- 7-cm-thick asphalt concrete leak-proof layer,
- Top mastix layer.

After an over 20 years' operation the reservoir's surface sustained substantial damage. There began to appear erosion spots, chipping, ageing of asphalt concrete and local damage. These were later repaired during a reservoir's annual overhaul.

In 2005 a decision to repair the reservoir was made. The repair works included:
- Partial 2- or 3-cm-deep milling of the old leak-proof layer in order to remove mastix and the most damaged parts of the layer,
- Applying of a bitumen emulsion binder layer,
- Applying of a new 7-cm-thick asphalt concrete leak-proof layer,
- Applying of a 3-mm-thick top mastix layer.

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The surface of the reservoir's embankments subject to the renovation amounted to 195,600 m^2, the surface of the basin bottom and the embankments near the intake chamber amounted to 42,600 m^2, the surface of access roads amounted to 27,700 m^2. The total surface amounted to 265,950 m^2.

The works started in May 2006 and finished in July 2006. They took three months to complete. It was a very short period considering the amount of all necessary work and the logistic difficulties which resulted from the inability to move freely around the reservoir.

I-22

Practical Application of Dam Breach
due to Overtopping

Jan Jandora[1]

ABSTRACT

The existence of the dams retaining water is always connected with the risk of their failure. The failure of a dam gives rise of a flood wave that advances through a valley below the dam. The effects of a dam break wave originated in this way may have disastrous consequences and may cause numerous fatalities and a financial loss exceeding many times the price of a hydraulic structure itself.

The analysis of embankment dam failures shows that most failures were caused by overtopping and by piping. Overtopping occurs when the water level of the reservoir behind the dam rises above the dam crest. It can be caused by an insufficient spillway capacity, improper manipulation, a landslide in the reservoir or when the design discharge is exceeded. So, the paper is dealing with a dam breach due to overtopping. Practical application of evaluation of maximum breach discharge is carried out in a case study (the Koryčany dam).

Based on the estimate of a probable maximum flood (PMF) and the spillway capacity in the Koryčany dam, the most probable cause of the Koryčany dam failure is due to its overtopping. The place of the overtopping and the probable location of the breach opening are in the lowest place of the dam crest. In a simplified way the dam crest is assumed without the wave deflector.

The results of the Koryčany dam failure modeling included the maximum peak discharge, the time of the failure duration, the discharge through the breach (the hydrograph of the breach outflow) and the water level in the reservoir and that of the geometrical parameters of the breach during the failure. The result of the statistic modeling included the critical hydrographs expressing realistically potential extreme values (the minimum and maximum) of failure parameters (the maximum breach discharge, the time of the failure duration).

Keywords: *overtopping, dam failure, flood wave*

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I-23

The technical and environmental impact of expanding Kelag's Fragant Hydropower Scheme through the 70 MW Feldsee pump storage plant

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ABSTRACT

The foundation and growth of KELAG (The Carinthian Electricity Company) started at the beginning of the last century. After the Second World War, the southern province of Austria began to expand its electricity grid and built hydropower plants such as can be found at Freibach, Schuett, Fragant, Kamering and Koralpe. These plants now help to meet the energy demands of our current customer base of 200,000 households. The annual consumption of more than 3.0 TWh (Trillion Watt hours) is guaranteed to 30% by more than 60 hydropower stations owned by Kelag. In the mountainous part of northern Carinthia, the 334 MW Fragant hydropower scheme was constructed in sections and designed to meet the demands on KELAG's power generation between 1965 and 1985. It should be noted that the increase in peak load demand is the reason why this scheme is KELAG's most important facility. On completion of this project, the supervision of all hydropower plants was centralised at the headquarters in Klagenfurt. Great efforts were made to optimize surveillance and to guarantee the safety of all dams, one of them being over 100 m high. Environmental restraints complicated further construction of hydropower schemes in Austria. Nevertheless Kelag was able to invest in further hydropower projects and the latest expansion of the Fragant scheme through the 70 MW Feldsee pump storage plant is the result of careful negotiation to gain acceptance from the public. In order to fulfil the requirements of environmental legislation and to gain approval for construction, eighteen scientists conducted studies in the proximity around the planned tunnels and pump power station. This Environmental Impact Assessment procedure is compulsory for power plant projects with an output over 15 MW in Austria. KELAG has responded by making efforts to maintain a balance within this high mountain region. KELAG's hydro power schemes meet the requirements of sustainable energy supply. Profitability of these investments is determined by consideration of cost of investment and the uncertain assessment of profits for the total length of operation. There is no question that the Feldsee – Wurtenalms' additional contribution of more than 20% per year to the power supply produced by the Frangant Hydro Power Scheme will become increasingly important for KELAG and Carinthia.

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I-24

Water Flow Inertia in Long By-Pass Filling Systems of Navigation Chambers

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ABSTRACT

Time of filling and emptying of lock chambers is an important factor of operation and economy parameters of water ways. It directly effects transport capacity of water ways and it can effect navigation safety at navigation locks, as well. Performed computations and terrain measurement results prove that the filling time of lock chambers is due to water flow inertia in the chamber filling system over 10% shorter compared to results of theoretical computations, which do not take the flow inertia into account.

Keywords: *navigation chambers, long by-pass filling system, water flow inertia*

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Topic II

Sanitary engineering
and sustainable water utilization

II-01

Long-term Changes of Sewage Sludge Quality Stored in Reed Basins

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ABSTRACT

In the last years methods using reed beds for the utilisation of sewage sludge gain the popularity. This method is similar to traditional sludge beds. A presence of reed and a simulation of conditions characteristic for wetland systems cause that this method is more effective and safe as regards sanitary. Until now it was proved that sewage sludge dewatering in reed beds are stabilized. Chemical composition of an obtained product is similar to humus, so it can be used in agriculture. The problem is the presence of heavy metals which accumulated in sewage sludge can be dangerous for the environment.

In Poland in the last years reed objects dewatered sludge have only pilot character. The coopertion with Danish Hadelskabet Company made possible to study of changes in quality of sewage sluge dewatered in reed beds which has been in operation during 7 and 15 years. The material to investigations was taken from objects located on WWTPs served from 9000 pe in Rudkobing and 33000 pe in Naskov, dewatered amounts of sludge: 300 t d.m./a and 870 t d.m./a, respectively.

Samples of sewage sludge was collected along the profile which was divided on 10 cm equal parts. Layers of sewage sluges from points of a collection were averanged.

The investigations included determinations of changes of dry matter and organic matter content as well as nutriens (P and N) and heavy metals (Cd, Cu, Cr, Zn, Ni, Pb) concentrations along the profile of sewge sludge layer from selected basins.

Basing on obtained results it was found that contents of dry matter incerased (from 20.2 to 29.7%) and organic matter decreased with depth (from 51.4 to 41.3 %d.m.).

In case of phosphorus it was indicated that this nutrien was accumulated. Values of an averange concentration increased from 3.56 do 5.16 %d.m. While the concentration of Kiejdahl nitrogen decreased from 2.8 do 1.9%d.m.

In sewage sludge from analysed objects the metal with the higest concentration was zinc. Concentrations of Zn changed from 391.22 to 577.83 mg/kg d.m. While in analysed objects it was observed that cadium had the lowest concentration. The concentration of this metal changed from 0.67 to 1.32 mg/kg d.m.

Key words: sewage sludge, reed basins, utilization, nutriens, heavy metals.

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II-02

Heavy Metals in Water – Health Risk and Removal by Sorption Materials

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ABSTRACT

Increased pollution of water resources leads to deterioration of surface water and groundwater quality and it initiates application of various methods for water treatment. Passing the Decree of the Ministry of Health of the Slovak Republic No. 151/2004 on requirements for drinking water and monitoring of drinking water quality have resulted in reduction of heavy metal concentrations or for the first time in defining the limit concentrations for some heavy metals (As, Sb), respectively. Based on this fact some water resources in Slovakia became unsuitable for further use and they require appropriate treatment.

The present research related to removal of heavy metals is focused on introduction of natural materials as well as industrial and agricultural waste that can be used as cost-effective sorption materials. The objective of the study was to verify sorption properties of some new sorption materials for removal of antimony (Bayoxide E33, GEH) from selected water resource and compare their efficiency.

Technological tests were carried out at the facility of the Slovak Water Company, Liptovský Mikuláš in the locality of Dúbrava. Technological tests with groundwater from the Dúbrava have proved that the new sorption materials can be used for reduction of antimony content in water to meet the values set under the Government Regulation No. 354/2006 on drinking water – 5 μg.l^{-1}.

Keywords: *groundwater treatment, sorption materials (GEH, Bayoxide E33), removal of antimony from water*

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II-03

The Physical, Physical-chemical and Chemical Parameters Determination of River Water Shkumbini (pena)

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ABSTRACT

In this paper are determinate some physicals, physical-chemical and chemical parameters of river Shkumbini (Pena) to determinate the rate level of pollution. The parameters are measure in four sample-places: the village Brodec, Banja, under the Tetova`s City Hospital and in the village Saracino in the period January-December 2002. We have conclusions about the influence of pollution in the water ecosystem as well as about precaution for his protectingly. The measured (investigated) parameters were: air temperature, water temperature, turbidity, conductivity, pH, general failure after evaporation, dissolved oxygen, chemical consumption of oxygen (CHCO), BOD_5, total hardness, calcium, magnesium, amonia sach as nitrogen, nitrites such as nitrogen, nitrates sach as nitrogen, clorides, sulphates, orthophosphates sach as phosphorus, iron, manganese, zinc, copper, lead, cadmium, crome(VI) and total crome. From the measure, results that the river water is of the first class after ECUNE (Economical Commission of the United Nations for Eourope) and according tu the official paper of the Republic of Macedonia, the water is not poluted. In general, the samples of the water from the last sample-place in Saracino, 0.5 km before th inflow of Shkumbini River into Vardar are more polluted. This refers to: the wash aout of the ground from the river and from the rainfalls (erosion); the remains and the rubbish waters from the settlements which going towards the last river folw huddle the more; outgoing waters from the city`s factories (although they work in reduced capacities), as well as to the overall pollution of the vital environment in the region of Tetova`s Municipality. Metals like: Zn, Pb, Cd and Cu are measured with potentiometric stripping analysis (PSA), and only zinc was detected in the river water. From the results we can summarize that the water of SHkumbini River is overloaded with contaminantsat the village Saracino, respectively after the out of town`s flow all the way to the inflow in Vardar River. The water of Shkumbini River is not polluted yet, which introduces an aqua and a proper ecosystem for the life of the beings as well as for the different economical and vital actvities. However, along one-year determinations very often we have met throwing of different rubbish in the bottom as well as in the water of the river. This is certainly an additional pollution beginner, and for the higher levels of some ratings (parameters) which shows the lov level of ecological culture of the population.

Key words: *surface water, quality of water, river, physical-chemical parameters, spectrometric analysis, potentiometric stripping analysis (PSA), atomic absorbtion spectroskopy (ASS).*

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II-04

Sulphate Reducing Bacteria in Groundwater and Water Network in Gdansk Region in Poland

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ABSTRACT

Gdynia region is situated in the area with good hydrogeological conditions. The urban development and intensive take off have caused the increase of water exploitation and as a consequence of the changes of hydrogeological conditions the deterioration of chemical and bacteriological quality of water has been observed. Routine bacteriological control of water quality includes only evaluation of pollution with faecal bacteria, while specific groups of bacteria, as sulphate reducing bacteria (SRB), characteristic of groundwater environment and in many cases responsible for deterioration of physical and chemical parameters of water, are not examined. In the study occurrence of SRB in groundwater and in water network was investigated. It was indicated that SRB are commonly found in raw water and in treated water after aeration and filtration on quartz sand beds. Moreover SRB are present in distributed water in water-pipe network.

Keywords: *sulphate reducing bacteria, groundwater, drinking water*

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II-05

The Quality Standards of Water for Swimming Pools in Slovakia

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ABSTRACT

The quality of pool water is a limiting factor of these objects. The water used for the first filling and recharge must show the properties of drinking or supply water. Mineral waters have higher natural content of salts than other waters, which are used for pool filling. The treatment of water used for filling in individual facility shall be considered especially in case, when the determined limits are exceeded.

Present requirement for quality and saving of water lead necessarily to technological, economic and hygienic measurements, requiring technical and projecting solutions.

The quality of water used to filling of pools shall meet the hygienic and aesthetic requirements. For water quality assessment we use the parameter of limits concentration given in relevant newest national standards, regulations and provisions and it should be assessed by the following properties.

It is known that there are differences in water quality monitoring and maintaining conditions between natural bathing waters and swimming pools. Therefore it is important to adapt legislation, parameters, limit values and frequency of water samples analysis.

The water quality requirements are physical (temperature, colour, turbidity and odour, pH, ORP,…), chemical (iron, manganese, chlorides, nitrates, ammonium nitrogen, calcium-carbonate equilibrium and carbon dioxide content), biological properties (cyanobacteria, algae, bacteria and many other organisms) and bacteriological (mesophilic bacteria and psychrophilic bacteria.).

The suitable water quality for natural bathing waters is in the following cases: microbiological parameters, pH value, oxygen, colour and odour do not exceed limit values in 95 percent of analysed samples, coliform and thermotolerant coliform bacteria do not exceed limit values in 80 percent of analysed samples,other parameters do not exceed limit values in 90 percent of analysed samples, listed parameters shall not exceed their value by more than 50 percent.

Key words: *Water quality, water standard, swimming pool*

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II-06

Specific Problems By Waste Water Disposal
From Small Urban Areas

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ABSTRACT

This paper describes some actual specific problems by sewage systems in small urban centres. It is dilemma to find compliance with measures, which is following the strict requirements of EU by discharging of waste waters in receiving waters with lack of funds required for the construction of new sewage systems and WWTPs in small municipalities. In 2004 a new Water Act came into force in Slovakia. It is in line the requirements of Directive Nr. 91/271/EEC. The harmonisation of the waste water treatment in Slovakia with the requirements of this Directive will require substantial amount of funding for construction of new and reconstruction of existing WWTP's. This problem concerns especially municipalities with the equivalent population over 2,000 (EO). This paper discusses some possibilities to address this problem, as well as technical design of solutions for sewage systems in small municipalities. Under a small municipality we understand smaller urban units. In terms of water management Slovak Technical Norm (STN) 756402 Small Waste Water Treatment Plans, this group includes municipalities or urban centres, which produce up to 100 m³/day of waste water, assuming specific consumption of 200 litres/day per head of population. This concerns municipalities with population up to 500.
Since 1,174 out of a total of 2,891 municipalities in Slovakia belongs in the small municipality category and predominantly they are located in areas with less affected environment, the sewage solution needs to meet the technical and financial requirements, but also the aforementioned dilemma must be reduced to the acceptable degree and the sewage network must be integrated sensitively with the environment. Preferred approach is sewage network – Waste waters treatment plant (WWTP), as well as sewage – natural environment – life environment. These links need to be given a priority not only in terms of design planning, execution and operation of the construction, but also in terms of contradiction waste water – surface water. Whereas the waste water, carried off via a sewage network represents progress for the society, mainly in terms of improved health and hygiene, the waste water is detrimental to the surface water and subsequently also to the natural environment.

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II-07

Sewage System Exploitation as the Information Carrier

Štefan Stanko[1]

ABSTRACT

The characterization of the every system is the communication. Doesn't exists information without communication and the communication is nonsense without information. The present age offers very effective tools for defining the system e.g. internet, and possibility of implementation. The best one technical carrier for communication is the optical fiber.

Implementation of optical fibers in the cities involves excavations of the city streets. These cause pollution, traffic hold-ups, economic loss, and unsafe conditions to the inhabitants in every city. Even worse, the repair of the streets after excavation rarely left the streets in acceptable condition. These forced mayors to issue moratoriums on new open cut excavations involved in the "Last-Mile" work. The "Last-Mile" is the section of a network that connects from the basement of an end-user building to the city-area network that surrounds a city. The new idea of leasing space inside of existing sewers by telecommunications companies has a rather interesting appeal in that owners of existing sewers get to generate a new revenue stream and telecommunication companies could install their optical fiber cables in attractive costs. Paper describe the implementation advantages of optical fiber networks inside existing sewers, base conditions for this implementation and briefly describe the interactions between the pipe, cable and liquid. The computer simulation of various cross-sections of the sewer was executed by hydrodynamic model MOUSE with focus on the discharge reduction, with boundary conditions.

The present era produce every day many people, users, which expect the fast internet and expect the immediately service for connection to the internet. The users "live" in virtual space and first condition of connection is connection speed. Connectivity increases the productivity and quality of life significantly. This will also save natural energy sources for useless travels, reduce pollution, and re-distribute the wealth and real estate values. For this to happen, we need to turn to existing underground infrastructure to build our communication networks, so that we can avoid additional congestion underground. Civil engineers have been responsible for planning, designing, constructing, operating, and maintaining this extensive network of pipes below our feet. Civil engineers need to start planning now toward working more closely with telecommunication engineers in making the information age come into full bloom so that any obstacles can be removed with the team approach. This will involve sharing the underground so that the same sewers are used for multiple functions. The implementation is possible simultaneously with rehabilitation of the sewers, which are in high percent in Slovakia.

The water and telecommunication companies need some government Act in Slovak republic, which would be helpful for interactions between them.

Keywords: *sewage system, informatics, robot, pipe, optical fibers, trench-less methods of rehabilitation, excavation*

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II-08

Integrated System for Sewerage Networks Design

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ABSTRACT

Design of sewerage system is in Slovakia very actual problem. The present state of connections to public sewer system in Slovakia is 57% connected inhabitants. Design of waste-water pipelines - sewerages is interesting process, because it depends on iteration methods, which use the graphical and numerical procedures. The main decisions depend on designer, who control all this processes. Design managed by manual approach produce many mistakes, because designer has to take consider for too many restrictions of design, which needs an expert approach. So if we want to do the perfect plan of structures, which consider technical and economical approaches, we have to exploit the expert knowledge by designers, and in maximum exploit the computer system with perfect computer literacy.

The article focuses in the graphical-numerical compute system for complex design of pipelines, which consider in each time the required restrictions. The describing system SeWaCAD offers the solution. The system is developed for designers in praxis, which need a fast and perfect design of sewerage situations in exact scale with the exact labels, longitudinal profiles with the exact labels and hydraulic calculations. System generates the database of results, which are the support for the technical and economical experts, and for implementation.

The graphical output of the system uses DXF format, consequently editing in known CAD systems and produce outputs of the system fully compatible with expert hydrodynamic modeling system - MOUSE. We can says, that after design by rational method, we can immediately simulate design with the various limits.

System was developed in computer language by author of this article, from first imagine to the final version. The developing took a few years with praxis verification in commercial design offices, and was updated to the reliability version. System offer full editing dialog boxes with graphical workspace, which focused on sewerage design. It is possible to design gravity and pressure pipelines. The pumping stations, the CSO structures are also implemented. System contains the rainfall data generator, which obtain the 68 rainfall observed stations. The rain designs use the rain curves with necessary rainfall periodicity.

The hydraulic design is possible for combined and dry weather flow network design. The power of the system is fast design with repeating design, after requirements changes. The system is possible in using before fiber optics implementation as assessment of discharge reducing.

Keywords: *software, design, sewerage, CAD, waste waters, pipeline, rainfall*

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II-09

Water Supply Systems on Islands – Susak Island

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ABSTRACT

Demanded quantities of fresh-water for supply of inhabitants on islands can be provided in different ways – catching the water from the island aquifers (from fresh-water lens formed on sea-water), catching and accumulating the rain-water, desalinization of sea-water or providing transportation of fresh-water from the mainland using tankers or pipelines.

The selection of the best solution for the water supply problematic on a certain island needs considering the demands of water and all available water resources on the island (including the possibility of sea-water desalinization) and also possible ways to transport fresh-water from the mainland.

Water demands on islands vary significantly during winter season in relation to summer periods, when water demand quantities increase due to the increase of the number of users (tourists).

The analysis of different alternatives for providing necessary water supply quantities must be based on the analysis of all available data related to water resources on the island. If it is necessary, field research (measurements, tests, evaluations etc.) is done in order to collect all data needed for a detailed observation and elaboration of the problem. Thereat the problem of water supply on the island must not be considered only on the island area but it must be analysed in the context of a wider area (including surrounding municipalities, the county, surrounding counties …).

Based on all collected data (including data from done field research), from a set of all possible alternative solutions for the problem of water supply on islands, a set of alternatives that can be really applied for the analysed island should be sorted out. Among them the best solution should be selected using existing methodologies for alternatives assessment and best-alternative choice (e.g. multicriteria optimisation), that is choosing the alternative that achieves best the priori set goals.

In this paper, as an example of a possible approach in solving the above explained problematic, the procedure for designing the water supply system of Susak island is presented.

Keywords: *water supply systems, island, water resources, Susak*

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II-10

Determination Of Phisyco - Chemical Parameters and Control Pollution in The River Sateska With Low and Sociologic Aspectcs

A.Aliu[1], S. Aliu[2], E.Aziri[1], Z. Idrizi[2], M. Ismaili[2]

ABSTRACT

On the world conference for the conservation of the environment hold in Stockholm year 1972, organized by UN, the main conclusion was that "One world exists. In that we live".It is necessary for us and the other generations to create convenient living conditions. The next generation has to obtain healthy and useful environment on heritage.

The aim of this paper was analysis and determination fisico-chemical and pollution control parameters, like pH, sulfates, clorides,nitrites, nitrates, amonia, phosphates,DO, BEO$_5$, CDO. Studed water samples were taken in different locations of River Sateska and one lakeshore where the water of these river pour in the Ohrid lake.
This occurrence occur in the lower part of river 6.9 km before dumping when erosive material of 112.907 m^3/year, from 1960 enter in the Lake Ohrid, who is characterised with richest biodiversity, resulty of ancient ages it has, betwen two – three million years. Peculair characteristic of this lake is its ability to selfregeneration.

Determination of analysed parameters was done using pH–meter(WTN–Multilab 540). Conductivity of water was done usig conductometer SEBA model F1.Sulfates are determined with gravimetric methodes, clorides with titrimetric standard methodes (Ruthner 1975 58; Wetzel 1972 40. APHA–AWWA–WPCF 1980 60). Determination of analysed, NO_2^-, NO_3^- NH_4^+ PO_4^{3-} was done using UV-VIS spectroscopy using CAM-spec M 330. Determination of analysed DO, BEO$_5$, was done using Winkler methodes and CDO was done using permanganometric methodes.

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II-11

Appraisal of CSO Structures Operation Impacts on Recipient Water Quality in Slovakia

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ABSTRACT

Sewerage systems in Slovakia mainly consist from combined sewer systems from last era. The significant function belong the CSO (combined sewer overflow) structures, with function rainfall discharge decreasing to WWTP, to decrease the unstable loading of pollution, next one to eliminate the huge profiles diameter for design the sewerages at under catchments. The negative of CSO is the pointing source of pollution. The Slovak legislature took some changes in last years.The regulation STN 756261 – "Rainfall water-tanks" recommends to design the CSO structures by boundary rainfall method, which use the marginal efficiency of rainfall intensity from $q_m = 7,5$ to 25 $l.s^{-1}ha^{-1}$, depending of inhabitants density and recipient quality and quantity. This regulation has many disadvantages, which Urcikán & Rusnák eliminated in modification of design process. Urcikán-Rusnák recommend the limits rainfall intensity from $q_m = 3$ to 20 $l.s^{-1}ha^{-1}$, depend on defining conditions. For appraisal of CSO structures operation impacts is defining the Government Act SR No. 296/2005, which used proportion of mixture as the base condition, from 1:4 to 1:8 (DWF : Rain discharge). The expert appraisal of storm-water conditions is possible by measurement on the catchments; by measurements; mathematical modeling of storm-water runoff process; using the easy methods (hydrological, based on statistical elaboration and rainfall data evaluation). The faults in Government Act SR No. 296/2005 goes from a) old used method of mixture proportion; b) doesn't take consider on time and volume of overflow, or amount of pollution.

Urcikán a Rusnák published the method uses a) number of overflows per year; b) total time of overflow per year; c) the volume of overflow waters (m^3) per year; d) amount of pollution in kg per year. The way of compute is easy for use, base on 5 years observation of rainfall data from 14 observation stations in SR The methodology allows to determine a) intensity of rainfall boundary; b) average DWF to CSO; c) discharge time to CSO structure; d) average of long-time of rainfall amount/total or sea level in given locality

The given method is useful for preliminary determination in studies. This method is easy for use, doesn't need too much time, save money for observation data collection, which are needs in mathematical modeling by storm water managements models. Methodology omits the difficulties with digitalization of catchments and sewer system, the observation of rainfall data and discharges in sewerage system, calibration and verification of the model.

Keywords: *CSO structure, DWF – dry weather flow, preliminary design***,** *sewage system, rainfall data, pollution, impact on recipient*

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II-12

The Changes of Groundwater Quality as an Effect of Intensive Exploitation on the Marine Terrace - Gdańsk

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ABSTRACT

Marine terrace is a narrow piece of land between Gdańsk and Sopot, spreading from the shore line of the Bay of Gdańsk to the edge of the Kashubian Lake District. It's area covers about 15 km^2. The region is abundant in groundwater; it is a part of the Gdańsk hydrogerological system, one of the most rich in groundwater in Poland. The system consists of three aquifers: Cretaceous, Tertiary and Quaternary. The Quaternary aquifer is of greatest importance for water supply in Gdańsk. On the marine terrace it is built of fluvioglacial sands and gravel 15 – 30 thick, covered by Holocene sands and in some places by a 0,5 – 1 m thick layer of peat. Owing to high resources and good groundwater quality the Quaternary aquifer has been exploited for almost a hundred years. The first intake was built just after the First World War, another two - in 60. of the previous century. The most intensive pumping, exceeding 2000 m^3/h, took place in 70. and 80. As a result a regional depression cone was developed and natural directions of the aquifer recharge were changed. This included salt water intrusion from the Bay of Gdańsk and percolation of surface contamination to the main usable aquifer. Some undesirable changes were also induced by variations of aeration zone thickness caused by irregular pumping rates in wells. The alteration of hydrodynamic conditions, has led to deterioration of the exploited groundwater quality. The hydrogeochemical background for such compounds as SO_4^{2-}, Cl^-, N/NH_4^+, total hardness has considerably changed in comparison with the approximate natural background determined for the period before high exploitation. It was partially due to the way of the land use in the surroundings of the wells – roads of heavy traffic, waste disposal plant, petrol stations, hospital, transport base and allotment gardens which had existed for about 20 years in the closest surroundings of one of the intakes. The gardens may had constituted a risk of pollution due to excessive use of fertilizers and also due to the existence of incorrectly constructed shallow wells used as cesspools or compost tanks. All the mentioned threats including the vicinity of the sea, together with high and variable pumping rates in the past influenced the quality of the groundwater exploited from the Quaternary aquifer on the marine terrace. It should be emphasized though, that the changes don't disqualify the exploited water to the drinking purposes, but show some undesirable processes taking place in the aquifer The water is still of good quality and meets the standards except for the concentrations of Fe and Mn, which is typical feature of water from Quaternary aquifers. In order to preserve good quality of groundwater on the Marine Terrace it is very important to exploit it in a rational way and protect the aquifer from contamination.

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II-13

Accuracy of Stream Division Calculations

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ABSTRACT

A need of stream division appears in many hydraulic objects. One can distinguish two general kinds of fluid distributing systems:

- when discharges of outlets are forced (e.g. by pumps) and we are interested in hydraulic consequences of this fact;

- when we have to determine the flow conditions, proper for desired discharges of outlets.

As a typical example of a task, belonging to the first category, an uptake of the recirculated activated sludge from the secondary settling tank can serve. Intensity of this process influences conditions of sedimentation and sludge thickening. Quite often the servicing personnel of the water treatment plant tries to compensate the drop of the sludge concentration in the re-cycling medium, enlarging its discharge, what usually worsens the object efficiency (up to the "short circuit" in the settling tank, what can eliminate its usability).

Problems from the second group, in turn, are typical for the water distribution systems (mainly water-pipe networks, but also water attractions, like fountains or cascades).

One can state, that the accuracy of hydraulic calculations, necessary in the technical practice, is a very important factor. There are two main sources of inaccuracies:

- hydraulic loss coefficients;
- applied model of the system and method of calculations.

As it is seen after comparison of calculated and measured results, the influence of the loss coefficients determination is very strong. Equally important is a choice of the flow model. Usually the specialists are fond of very simple, uniform patterns of the fluid motion, even if the considered phenomenon evidently changes along the stream, what means, that the state variables are functions of the flow distance.

In some systems it is very important to maintain constant values of chosen variables (e.g. velocity, when a fountain is designed). Empirical investigations, presented in the paper, led to the conclusion, that the main parameter of this kind of installation is a proportion between two dimensions – of the main stream (D) and of the outlet (d). Uniformity of the stream division increases together with the rise of the quotient D/d.

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II-14

Seasonal Changes of Pollutants Removal Efficiency in Hybrid Constructed Wetlands

Hanna Obaeska-Pempkowiak[1], Magdalena Gajewska[1]

ABSTRACT

It has been reported so far that Hybrid Constructed Wetlands (HSH) provide more effective and stable contaminations removal from domestic wastewater. In HSH beds with horizontal flow (HF) enable effective organic matter and total suspended solid removal and may constitute convenient conditions for denitrification. Beds with periodical vertical flow (VF) assure additionally wastewater aeration. Then, convenient conditions for nitrification and accumulated organic matter removal are created. Single-stage VF beds may provide effective organic matter removal even for loadings of 20 g/m^2d.

The aim of this paper is an estimation of functioning of five local hybrid constructed wetlands in the region of Gdańsk, with a particular regard to seasonal changes of contaminations removal efficiency.

The investigation were carried out at five local hybrid constructed wetlands (HCWs), which served biological treatment of household wastewater from 15 to 750 pe after septic tanks.

Monitoring of the systems was to define wastewater quality in inlet, outlet and after all treatment stages. Averaged samples were collecting with the frequency of once a month in the years 1998-2006. Wastewater samples were collected in the vegetative period (from April till October) and in the non-vegetative period (other months). In treated wastewater measurements of total suspended solid concentrations, organic matter concentrations (COD, BOD) and organic P concentrations were taken. Measurement of nitrogen compounds concentrations required measuring of organic (Norg) and inorganic nitrogen ($N-NH_4^+$, $N-NO_3^{-2}$). Analyses were carried out according to the methodology in the Polish Standards and recommends given in the Environment Ministry Decree. Analyses of wastewater flow rate, based on pumps timework meters, were also carried out.

Based on carried out investigation it was assumed that HSH provide efficient and stable either organic matter removal (expressed in COD and BOD) and suspended solid removal in a wide loadings range: $1,5 – 17,0$ $gCOD/m^2d$ irrespectively to the configuration applied. The efficiency of total nitrogen compounds removal changed highly and oscillated from 23,4 to 79,2% in loadings ranges from 0,2 to 3,0 g Nog/m^2d.

Analysed hybrid systems were divided into 2 groups depending on contaminants concentrations supplied with wastewater during the vegetative and non – vegetative period. Systems that were supplied equally throughout the year were characterized by higher concentrations of contaminants supplied in the non - vegetative period comparing to the vegetative period. The second group was formed by constructed wetlands loaded with much higher contaminants concentrations in the vegetative period than in non – vegetative period.

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It has been proved that the removal efficiency of organic matter (presented by COD and BOD$_5$), suspended solid and organic phosphorus did not depend on the season unlike the removal efficiency of nitrogen compounds. There was 10% difference in the case of organic nitrogen in the vegetative period's favour.

Key wards: *hybrid constructed wetlands, efficiency of pollutants removal, configuration, seasonal changes.*

II-15

Optimization of the Coagulation Process at the Surface Water Intake for Gdańsk to Reduce the Contents of Residual Aluminium and Decrease the Corrosivity of Water

Zbigniew Maksymiuk[1], Stanisław Mikołajski[1], Roman Jurec[1]

ABSTRACT

World's resources of water, which can be used for consumption purposes, have been constantly decreasing. On the other hand human activities result in extending contamination - including appearing new types of contaminants - of potentially available resources. Therefore organizations responsible for water treatment face new challenges connected with elimination of harmful substances.

Most important process in Gdańsk's surface water treatment station is coagulation. Its main aim is to remove organic and chemical contaminants existing as suspensions and colloids. Currently we use aluminum coagulant (polyaluminum chloride) known as PAX XL-61, which was implemented in 2003 after numerous tests of various preparations. Technological aim is not only the maximum elimination - over 50% of oxydability ($KMnO_4$ index) - of contaminants, but equally elimination of secondary contamination and negative physical and chemical changes following the use of coagulants (e.g. corrosivity, pH, aluminum).

Saur Neptun Gdańsk possesses integrated management system QSE, which obliges us to permanent improvement of carried processes and work safety and to take actions aiming at environmental protection. Among others, this is the reason why we have been constantly working on optimization of coagulation process. Searching for new products, we have also taken into consideration economic factors and specificity of our infrastructure – fully automated technological line adjusted to use of liquid coagulant. As an effect, there were three changes of used chemicals between 1993 and 2007. This resulted in greater reduction of oxydability ($KMnO_4$ index), reduction of residual aluminum content, limitation of water pH decrease and its corrosive properties. Additional advantages are flexibility and fast reaction to changes of raw water quality as well as increase of employee's work safety.

Saur Neptun Gdańsk face further challenges connected with searching the market for new polymerized coagulants, from which we expect: considerable decrease (at least 50%) of dosage, better technological effects, decrease of corrosivity and residual aluminum content. This would allow us to take further actions aiming at economic optimization e.g. costs of transport of chemicals, and improve environmental conditions in accordance with limitation of amount of technological wastewater. Constantly changing environment, especially in terms of drinking water quality and environmental protection needs, will oblige us and producers to continue search for new, better solutions.

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II-16

Design and Optimization of Sedimentation Tank in Slovakia with CFD Modeling

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ABSTRACT

Sedimentation, or settling by gravity, is a common method to separate water and solid particles in water treatment plants. An investigation has been carried out using the FLUENT software, which uses the finite-volume method to study the concentration and velocity of solids in the settling tanks at the Hrinova Water Treatment Plant in Slovakia. The FLUENT Computational Fluid Dynamics (CFD) software based tank modeling technology was used to explore an optimized modification package in order to enhance the performance of the existing quality treatment system by improving tank hydraulic behavior and solids flocculation within tanks while satisfying the requirement of a low construction cost. The model, in its present form, are applicable to flocculent particles (Type II) settling. The effect of inlet configuration on the flow field as well as on the settling characteristics has been investigated. The standard k-ε turbulence model is used to compute the turbulent motion, and our CFD model accounts for buoyancy flow. The sludge settling velocity was measured as a function of the concentration, and we have used the double-exponential settling velocity function to describe its dependence on the concentration. The comparison of model predictions with the subsequent field data indicates that the significantly improvement of tank performance was obtained by using the minor modifications based on the 2-D computer modeling.

Keywords: *CFD, flocculent concentration, horizontal sedimentation tank, baffle, water quality.*

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II-17

Reliability Analysis of Krakow Water Supply System

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ABSTRACT

This paper contains the preliminary reliability analysis of the water supply system (WSS) of Krakow city. It regards the influence of the failures of the water production subsystem elements on the whole system usage. The water-supply subsystem operation in the damage conditions computer simulation results, regarding current exploitation parameters, are presented. Individual scenarios, reflecting hypothetical situations of interference for correct water supply system operating, cover random event, i.e. water source contamination, lack of electricity, technological errors influencing water treatment effects, failures of transit water-pipe networks and others. That allowed pointing out critical points in water production and distribution subsystem. Their failures would cause the biggest threat to fail to comply with the basic system task, that is to provide consumers with continuous supply of suitable quality and quantity water.

Keywords: *water supply system (WSS), production subsystem, distribution subsystem, failure, reliability, computer simulation*

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II-18

Numerical Modelling in Wastewater Collection Systems Optimization

Dražen Vouk[1], Davor Malus[2],

ABSTRACT

Common practice in Croatia regarding the design of wastewater collection systems is still primarily dependent on generally accepted practice based on simplified conventional calculation methods. The simplicity of its application, reliable results (mostly over-dimensioned systems) and engineering familiarity (long-standing experience) strive against any change and acceptance of new methods that require additional efforts and financial investments.

Since sophisticated numerical models with quality software support have been developed, any further application of conventional calculation methods is considered as irrational and unreasonable especially for complex and large systems. Present tendency of maximum financial rationalization inside the each segment of social and economic development as well as of wastewater management sector results with inevitable need for numerical modeling in design of wastewater collection systems. These numerical models are capable of operating large numbers of complex dynamic simulations quickly and easily. Solving such complex algorithms with conventional calculation methods is almost inconceivable. The mentioned is not only related to design of planned systems but also to reconstruction and optimization of existing ones.

This paper is applied to hydraulic optimization of planned wastewater collection system. For that purpose a hypothetical example was defined with layout and input values that describe real state conditions. The focus is placed on analysis of different channel (conduit) capacities and dynamic controls in operation of pumps regarding the system capability to retain a certain volumes in upstream sections. The final goal is applied to inter-related comparison of results given from application of different methods – conventional and numerical modelling.

Initially, brief description of conventional method is given following the main aspects of numerical modelling implementation in wastewater collection system optimization

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Topic III

River engineering and coping with floods and droughts

III-01

Integrated Flood Risk Management and the New European Flood Risk Directive

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ABSTRACT

Between 1998 and 2004, Europe suffered over 100 major floods, including the catastrophic floods along the rivers Danube and Elbe in 2002. These floods caused some 700 fatalities, the displacement of about half a million people and insured economic losses totalling at least € 25 billion (Commission of the European Communities, 2006). A case study from the Rhine indicated that more than 10 million people live in areas at risk of extreme floods with a potential flood damage of about €165 billion. Only the flood event of 2002 that hit Austria, major parts of the Czech Republic and the region of Saxony, Germany caused 43 victims and the estimated damages totalled up to 15-16 billion €. The subsequent drought period in 2003 and the floods in 2005 increased the awareness of the broad public about natural hazards and disasters

As a response to these disasters a draft version of the directive on the assessment and management of floods (Commission of the European Communities, 2006) was elaborated. At the national level several activities were initiated to provide a framework for identifying risk mitigation measures. In this context flood risk is understood as the probability of harmful consequences or expected losses (deaths, injuries, property, livelihood, economic activity disrupted or environmental damages) resulting from interaction between natural processes and human induced hazard and vulnerable conditions. In general, the objective of flood risk management includes three main elements: 1. minimizing economic losses (€): property, production, transportation, etc., 2. minimizing casualties, and 3. minimizing ecological losses. Obviously the consequences of a natural hazard are characterised by a vector including monetary and non-monetary values but in practice, mostly the economic objective is dominating and the other two may be considered as constraints.

This implies that probabilities of extreme events or scenarios together with their respective likelihood are estimated and that the consequences are analysed at different spatio-temporal scales. This would provide the basis for any rational disaster mitigation strategy. Additionally this requires that the various uncertainties inherent to this process are quantitatively expressed.

The objective of this paper is to summarise the experiences gained from the last catastrophic floods, to re-analyse the flood management strategies and to discuss a "new" flood risk management approach. This approach should be based on four steps. First, the flood frequency has to be assessed under consideration of trends due to human intervention or due to climate change. Further, a vulnerability analysis is required to assess possible

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damages under existing land use and future land use patterns. Based on this information the flood risk can be assessed. In the second step disaster mitigation measures are elaborated including technical measures like flood protection dikes and temporary flood barriers, and non-technical measures like restriction for land development considering risk zonation maps, and the preservation of the retention capacity in the basin. The next important aspect is in risk sharing and financing. The damages from the last flood were covered by catastrophic funds funded by the federal government, by contributions from the provincial governments, partly by insurance companies, by EU funds and by private donations. It is necessary to identify the most appropriate strategy for compensation measures. In the forth step, accompanying measures are analysed referring to improved flood forecasting and warning systems, improved disaster response and emergency plan, and the coordination among all involved institutions independent from administrative boundaries and institutional settings. Finally, to select and implement any risk management strategy the risk associated with any alternative strategy has to be communicated and the concerned public has to be integrated into the decision making process.

The paper is organised in four chapters. It starts with an overview of the flood event and its consequences in Central Europe. It analyses possible impacts on the formation of floods like the role of climate change and direct human interventions in the basin. Next, the strategies for flood protection and risk management are reviewed and finally an integrated framework is proposed for flood risk management.

III-02

Hydrological and Hydraulic Analysis
of the Upper Vardar River

Cvetanka Popovska[1], Violeta Gesovska[1], Dragan Ivanoski[1]

ABSTRACT

Major watersheds in the Republic of Macedonia are Vardar (Aegean See), Crn Drim (Adriatic See) and Strumica (Black see). The largest one is Vardar River basin that occupies over 80% of the total area of the country. This river basin is divided into the following sub-basins: Upper Vardar, Treska, Crna, Middle Vardar, Pchinja, Bregalnica and Lower Vardar. The Upper Vardar river basin covers the area of 1489 km^2. Recently the lower part of this watershed, especially the villages Tudence, Raotince, and Kopance, have been flooded frequently. In order to solve the problems the Ministry of Agriculture, Forestry and Water Economy recently has implemented the development of a technical documentation on riverbed regulation. The main goals of the project are: to assess the overall state of the natural riverbed flooded section, to estimate the critical flooding discharge and/or the change in hydrological and hydraulic regime, and to design flood protection measures. To achieve these goals within the abovementioned technical documentation a hydrological analysis and hydraulic modeling were carried out as a base for technical solution design. Besides this, one of the project objectives is to propose actions in river monitoring improvement. This paper will present some output results from hydrological analysis, as well as the calibration results out of hydraulic modeling of the steady flow in natural riverbed.

Keywords: *hydrology, flood, probability, hydraulic modeling, calibration*

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III-03

Application of Instantaneous Unit Hydrograph (IUH) to Uncontrolled Catchments Runoff Estimation

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ABSTRACT

Analysis of possibilities and limitations of application of Instantaneous Unit Hydrograph (IUH) to a determination of the outflow from uncontrolled catchments.
An overview of the idea of an 'uncontrolled catchment' as one of the basic concepts which is defined in hydrology is given. The idea of uncontrolled catchments is explained and the most common forms of IUH used for runoff simulation are mentioned: Nash's model and the alternative IUH (the detailed survey of models used in simulations are reported).
  Finally the two approaches to the problem of identification of the IUH parameters are discussed – on the basis of the catchment's characteristics and by using optimization techniques. The following methods of identification are presented:

- first which leans on the identification parameters on the basic of physical and geographical characteristics of the catchments, it is worked out regression connections between the accept parameters of model and physical and geographical factors which have the most important influence to estimate the outflow from the catchments and are also possible to estimate from any catchments to the basic of maps or direct measurements in the terrain. In this case the results presented by Bajkiewicz-Grabowska (1985) were used as a comparison to the next approach.
- second problem (optimization methods) is solved in the way that the values of parameters are searched in the given range with the assumed time step. A criterion which evaluates the correctness of the received results - also called the objective function is least square error. This approach optimises the parameters of the models what leads to find value which final solution of analytical calculation is the closest to the real one.

  Conclusions of above two problems were discussed with several example results received from the simulations. An input data for calculation based on the measurements (effective rainfall and runoff) taken from the following catchments: Jasiołka (Poland), Czarna Maleniecka (Poland), Loće (Slovenia) and Botonega (Croatia) are presented.Calculation are carried out for two mentioned models and the final results are shown on the graphs individual for each catchment.

Keywords: *uncontrolled catchemnt, Instantaneous Unit Hydrograph, Nash's model, alternative IUH, regression connections, optimization methods*

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III-04

Determination of the Probability of Genetically Non-homogeneous Extreme Annual Flows – the Method of Alternative Events

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ABSTRACT

The purpose of paper is to present a new approach to annual maximum floods analysis for countries that have both types of floods, i.e. snowmelt and rainfall origin. That is the prerequisite condition to employ the presented procedure for estimation of annual maximum flood with given probability of exceedence (T-year return period) for water management structures designing.

The proposed method of calculating annual maximum discharges with given probability of exceedance $Q_{max,p}$ is based on the following major assumptions:
- Correctness of annual maximum discharge of summer and winter seasons, defined on the grounds of reliable rating curves;
- Maximum use of non-statistical information to verify the reliability of measurement series for statistical calculations;
- Maximum use of information about the statistical properties of measurement series to select the most credible function of probability distribution.

The measurement data analysis procedure includes the following:
- Examination of homogeneity of maximum discharge series with the use of genetic (physical) methods;
- Examination of homogeneity of maximum discharge series with the use of statistical tests.

In case of recognising nonhomogeneity of the series, such series cannot be subject to further processing, i.e. it cannot be used as a basis for calculating $Q_{max,p}$.

The $Q_{max,p}$ calculating procedure may be used solely for homogeneous measurement series of size $N \geq 30$ years of observation:
- The following four types of probability distribution functions have been adopted as models of statistical properties of each studied series: Gamma, log-Normal, Weibull, log-Gamma;
- For all the above listed types of distributions a condition was assumed that left side lower bound may adopt values from the interval between 0 and the lowest value of maximum discharge observed in the studied series;
- Estimation of two remaining parameters, with defined different values of lower bound, is carried out with the use of the maximum likelihood method;
- Testing of the hypothesis of goodness of fit of theoretical probability distribution function with the empirical distribution, with the use of χ^2 Pearson test, at $\alpha = 0.05$

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significance level, leads to selection of non-rejected distribution functions which form a set of uncontradicted probability distribution functions, acceptable as theoretical distributions of the studied measurement series;

- Selection of the best fitted distribution function, one for each adopted type of distribution, is done with the use of minimum D_{max} Kolmogorov distance criterion, between the theoretical and empirical distribution;
- Selection of one most credible function of probability distribution, from the set of best fitted distribution functions, is done with the use of Akaike Information Criterion (AIC);
- The function of probability of exceedance of annual maximum discharges is defined as a probability function of alternative of two non-eliminated independent events, based on the most credible function of probability distribution of the annual maximum discharges of the winter season and the most credible function of probability distribution of the annual maximum discharges of the summer season;
- The upper bound of interval of confidence, resulting from randomness of maximum discharge series, is calculated by simulation method;
- Checking whether the size of the measurement series is sufficient to calculate the annual maximum discharge with probability p, i.e. $Q_{max,p}$, where the error resulting from sample randomness does not exceed 20 %;
- Procedure is completed with estimation of zone of uncertainty of quantile $Q_{max,p}$ of the annual maximum discharge distribution, selected from among best fitted functions in specific types of distributions.

III-05

Bedload Retention Basin Vorderbergerbach Austria – Physical Scale Model Study

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ABSTRACT

The torrent 'Vorderbergerbach' is the right tributary to the Gail River in the Carnian Alps which represent the border to Italy in the Southern part of Carinthia, Austria. It drains an area of 26.1 km². Lithologically, the basin consists mainly of limestone of local type (Eder chalk) and Ordovician shale. The upper parts of the catchment are characterised by glacial deposits like ground moraines where as the lower areas are stamped by quaternary deposition of unconsolidated sediment.

On August 29, 2003, a heavy rainstorm hit the village Vorderberg/St. Stefan, Austria and caused a severe flood. The peak discharge of 120 m³/s corresponded to a discharge of a 105-year return period. In the course of the event, some 250 000 m³ of sediment have been transported to the fan area and partially deposited outside of the channel, due to blocking of critical channel cross sections by sediment and woody debris. Around 2/3 of the buildings in Vorderberg were affected by water and sediment masses.

In order to protect the village from future inundation by water and sediment, a retention basin has been planned on the alluvial fan upstream of the village. The objective of this study was to analyse the bedload deposition process and to optimise the sedimentation capacity of the retention basin by means of a scale model investigation.

At the Institute of Mountain Risk Engineering of the University of Natural Resources and Applied Life Sciences (BOKU), Vienna, a physical scale model of the retention basin on a scale of 1:30 has been developed. Three variants of structures installed in the retention basin in order to support the deposition process have been evaluated. The hydrograph of the 150-years event ('design discharge') has been generated from rainfall – runoff analysis using the 'time – lag' model ZEMOKOST. Since no continuous discharge measurements have been carried out during the flood event in 2003, another hydrograph has been derived from a rainfall – runoff simulation, by using the precipitation data from rain gauges, located in the vicinity of the watershed.

Thus, the model roughness basing on the Froude similarity criterion has been calibrated to fit to the numerical simulations of the flow pattern.

After each flood wave simulation, the elevation of the deposited bedload has been surveyed by a 2-D laser scan. In this way, several variants of retention basin geometries and input hydrographs with corresponding bedload transport have been analysed in order to optimise the functioning and the retention basin capacity.

Keywords: *bedload transport, retention basin, scale models*

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III-06

The Lower Drava River Course Wetlands Revitalization and Sustainable Flood Control Measures Concept

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ABSTRACT

The lower course of the Drava River, between its mouth into the Danube and river kilometer (rkm) 176, belongs to the environmentally best preserved European riverine ecosystems, despite changes in hydrological regime caused by numerous hydraulic engineering projects carried out along the riverbed. The area is characterized by presence of numerous biological species, particularly species that are rare and threatened on the national, European and global level. According to general and globally adopted scientific and professional principles applied to the riverine ecosystem ecology, the river reaches on which no hydraulic engineering projects have been constructed are no more referred to as undeveloped and unstable river course sections but rather as highly dynamic and stable ecosystems. So far, 122.11 km of dikes have been built in the Croatian part of the lower Drava course. However, despite all the available structures, the Drava River valley remains the most flood-threatened area within the Danube catchment. Most of threatened areas and dikes are situated on the right riverbank. Construction of planned hydraulic facilities, the Osijek and Donji Miholjac Hydro Power Systems, is planned to protect the Drava River area under consideration against floods with occurrence probability of 0.1% (1000-year recurrence period). Therefore, preservation of the current state of the Drava River and its inundation area asks for implementation of specific protection measures, and the ecologically valuable areas that had been degraded need to be revitalized. The present paper describes a revitalization concept for the Drava wetlands and possible implementation of the flood control measures proposed in study The Drava River Inundation Area Development between rkm 0+000 and 176+450 for Flood Control and Revitalization of Floodplains, prepared by Elektroprojekt Zagreb for the Croatian Wasters in 2007. The study focused on defining hydraulic engineering, ecological and other measures for sustainable flood control and improvement in ecological state of the wetlands. Approach to revitalization of the Drava wetlands and flood control aimed at improvement in general ecological condition of the river channel and inundation pursuant to the provisions of international conventions and directives, national strategy and action plans, laws and regulations

Keywords: *The Drava River, wetland, ponds, river branches, projects, flood control, dikes*

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III-07

Avoided Drought Damage Evaluation Procedure

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ABSTRACT

An irrigation system is generally analysed using comparison of costs of system construction and benefits of increased yield and income.

However, agricultural production safety improvement, primarily avoiding of drought damage that is achieved by the irrigation system construction, is neglected. The paper uses an example to describe use of the drought damage avoided valuation method that might be used in future irrigation system feasibility studies. In the example, usual methods were used for determination of precipitation deficit probability and earlier used procedures for calculation of yield decrease caused by precipitation deficit during the plant-growing period, along with the input data and information from references. Although the obtained results are not applicable to all Croatian regions, they might help understanding what studies need to be carried out in case the proposed procedure is implemented.

Key words: *irrigation, drought, damage avoided, and construction feasibility*

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III-08

Long-term Monthly Discharge Prognosis
for the Danube River in Bratislava

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ABSTRACT

For a long-term analysis of hydrological series the longest possible observed series are desired. In Slovakia only one gauging station is capable of providing efficiently long time series of river discharge extending 130 years of observation – i.e. the Bratislava gauging station. This study aims to employ statistical tools for identifying changes in average monthly discharge characteristics of the Danube River. By means of autocorrelation and spectral analysis of the monthly discharge data, multi-year cycles within dry and wet periods were sought. The second part of this paper is devoted to the long-term prediction of monthly discharge of the Danube by applying stochastic methods. In forecasting the following two types of models were used:

1. Harmonic model derived from Fourier series;
2. Stochastic seasonal auto-regression model of moving averages - SARIMA.

The results of this study suggest that the water year 2008 is likely to be dry, while in 2009–2010 elevated discharge is likely to be observed.

Keywords: *Danube River, long-term discharge prediction*

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III-09

Organisational variants of Coordination and Information Centres for Flood Prevention

Wojciech Indyk[1], Andrzej Potocki[2]

ABSTRACT

In the paper, possible alternatives of different structures of institutional support for flood prevention system are discussed. In 1997 the catastrophical flood in Oder and Vistula Rivers catchments appeared. Just after the flood Polish government took actions for creation new, more efficient structure of flood prevention, protection and flood control systems. Additionally, from the legal point of view, in Polish law the new structure of flood prevention and protection were introduced.

The organisational structure had to provide the framework for efficient management of Coordination and Information Centres for Flood Prevention (Polish abbreviation – OKI). The existed during 1997 structure required a change with regard to effectiveness and efficiency of the operational management.

Determining a new organisational structure was generally a reacting to existing problems within an existing organisation.

During the works concerning the localisation of OKI within the crisis management structures, several institutional alternatives were discussed. These included:

- establishment of one single OKI, common for area of Upper Oder and Vistula Rivers cachments,
- establishment of one single, centralised OKI for the entire Polish territory,
- establishment of one or more OKI's outside the structures of Water Authorities, submitted directly to the Ministry of Environment,
- establishment of one or more OKI's as private institutions.

In the paper the detailed discussed structures are presented.

An analysis of possible main goals of establishing OKI was preceded by specification of crucial flood protection stakeholders. From the analysis it follows that OKI should co-operate with:

- Water Authorities – according to the catchments division (Polish abbreviation – RZGW),
- National Institute of Meteorology and Water Management – (IMGW) – that is main data supplier,
- crisis management centres,
- governmental and self-governmental administration in the water region,
- other NGO's and local communities (e.g. ecological associations) interested in flood protection,
- the society.

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Finally, the best proposed structure, main goal and tasks of Coordination and Information Centres for Flood Prevention are presented.

Key words: *flood prevention, water management, crisis management*

III-10

Program of the Restoration of Small Retention in Wda River Catchment Area

dr Elżbieta Wołoszyn[1]

ABSTRACT

The paper describes a program of the hydrological conditions improvement in the upper part of the river Wda catchment. The Wda river basin is situated in the north part of Poland, in the region of the lake district Pojezierze Kaszubskie. During the 1980-1994 period in this part of Poland the sever hydrological drought took place. The deficiency of the precipitation caused the lack of the soil moisture. As a result small lakes and swamps in the forest areas as well as the trees cover dried up. It was the reason for initiation of the moisture conditions improvement program in the catchment. During the winter period water from the Wda Channel was used to fill up the small lakes and swamps. For the moment the first 5 stages of the program are completed and significant ameliorations are already observed. The water reappeared in the dry lakes and swamps and the level of the ground water started also to rise.

Key words: *hydrology, swamp, lake, surface retention, forest, soil moisture, ground water.*

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III-11

Analysis of Flood Dykes Safety Using Numerical Methods

Grambličková Danka[1], Bednárová Emília[1], Minárik Marian[3]

ABSTRACT

Frequent occurrence of floods at present time invoked many discussions of experts on evaluation of flood dykes safety by extreme hydrodynamic load during floods. The problematic is very exacting due to many factors effecting changes of filtration flow in flood embankment, its subsoil and surroundings. Endangering of flood embankment safety is often accompanying by associate features during flood. Reliable forecast of development of flow velocities, uplifts, and seepages is also important information by decision making about the necessity and effectiveness of planned treatment. Finite element method is mathematical apparatus, which by sufficient input data allow analysing parameters of steady-state and transient flow and answer a number of queries of practice. Proposed paper analyse risk factors endangering safety of flood dykes by extreme hydrodynamic load. It points out some knowledge and experiences gained from application of finite elements method in practice and analyse effect of transient flow parameters on change of flow mode.

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III-12

Water Balance of Basin the River Plitvica

Vladimir Patrčević[1], Siniša Maričić[1], Kristijan Jozanović[1]

ABSTRACT

Stream Plitvica have been placed between the river Bednja from south and the river Drava northwards in alluvial valley at the town Varaždin. The total surface of basin to hydrological station Kneginjec Donji is 520 km2.

On the basis of extensive hydrological measurements, hydrological and meteorologic parameters in the basin of the stream Plitvica, has been made the hydrological processing of basin of water current.

On the hydrological station Kneginec Donji exists regular measurements of water levels and flow waters. On the special infiltrometric station -Varkom, inside the the water pumping station of water-supply town of Varaždin, many years exists measurements of meteorologic parameters with measurements infiltrations and evaporations.

For chosen 10 yearly periods (1995-2004) the monitoring and researching, has been spent analyses and evaluations water balance of basin, to hydrological station Kneginec Donji.

By this is especially the separated vertical water balance of basin as predominant in the total annual balance value.

Paper represents the result of water balance as well as bases of monitorings hydrological and climatologic parameters which have been spent on the basin.

This work are the segment of the hydrological research from 1988. years which spend for the purpose of getting to know vertical water balance on the quoted alluvium of the river Plitvica and river Drava.

Keywords: *precipitation, infiltration, outflow, monitoring, evaporation*

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III-13

Contribution to Dam Break Flood Forecasting Regulations in Croatia

Goran Gjetvaj[1], Mladen Petričec[2],Goran Lončar [1]

ABSTRACT

History of dam accidents and failures shows that dam failure caused floods are relatively rare, but can result in significant losses of human lives and material damages. Numerous countries have regulations aimed at decreasing the risks of downstream flooding should a dam break occur. In the Republic of Croatia, the regulation entitled "Guidelines for definition of consequences following a sudden dam failure", enacted in 1974, is still in force. The guidelines are very restrictive, based on the assumed total, instantaneous dam failure. Under such assumption, the flooded area is relatively large, restricting the use of the area downstream of dams and thus preventing development.

The new guidelines, based on a more realistic assumption relative to dam break, are in preparation.   These guidelines shall define a new approach to positive wave front simulation and risk analyses methods. The paper presents both the experiences with the regulation in force and the proposed new guidelines.

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III-14

Water Flow Regime and Vessel Routing Simulation in the Area of the Water Structures

Ľudovít Možiešik[1], Peter Šulek[1], Petr Valenta[2], Vladimíra Slabá[1]

ABSTRACT

A navigation stage consists of several objects such as lock chamber, weir, hydro-power plant. The operation of these objects affects the water flow regime in the vicinity of waterworks. Due to the force influence of the flowing water the vessel routing is affected, as well. Numerical models are presently used for the calculation of the flow water regime parameters. One of these models that solve 2-D steady flow in open channel is the SHALLOW numerical model. This model is using the Finite Element Method for solving partial differential equations. The solution results are water level regime and flow velocity vectors. SHALLOW model consists except of own computation program with the system of pre- and post-processing procedures as well, what makes available an interactive cooperation between numerical modelling and AutoCAD graphical system. Therefore, lots of alternative solutions and several applications in real practise can be performed.

Based on the results of mathematical modelling, the goal of the optimization process is to find such disposition arrangements of navigation stage that energetic demands and navigation safety will be fulfilled at the same time. In the paper is this optimization process described in sequential steps that result in a disposition arrangement, which fulfils required optimization criteria.

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III-15

Numerical Investigation of Flood Inundation on Urban Area after River Embankment Break

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ABSTRACT

The paper concerns numerical simulations of flood wave propagation resulting from river embankment failure. The aim of the work is to present the numerical calculations which can be useful for inundation zones identification. The simulations of inundations seems to be the main tool for assessment and reduction of risks from flooding. The numerical calculations are performed to predict and analyse the parameters of catastrophic flow in embanked build-up area.

In Poland the creation of flood hazard maps is required by Article 82 of the Water Act from 18 July, 2001. It calls for the creation of flood hazard maps for the areas unprotected and protected by the dikes down the major rivers. Flood maps (referred to as flood risk maps) are elaborated for planning purposes or for the needs of insurance companies. The information about potential flood must contain data like: time of the flood wave arrival to some characteristic points of the inundated area, extreme water depth, velocity in the flooded area and duration and range of the flooding. Polish legislation does not specify the mathematical models or numerical tools needed to simulate the flood wave propagation for flood hazard mapping.

Used in practice software shows that the complexity of mathematical models vary from one dimensional Bernoulli steady flow equation and Saint-Venant unsteady flow equations (for example in HEC-RAS and MIKE 11 computation systems) to two dimensional depth averaged Navier-Stokes unsteady shallow water flow equations (MIKE 21, NCCHE2D, WOLF). As the mathematical model of free surface unsteady water flow the shallow water equations are assumed in this paper. In order to solve the model equations numerical scheme of finite volume method is applied. For approximation of mass and momentum fluxes the Roe method is used.

Two embankment break test cases are investigated in the paper. The aim of the first experiment is to simulate the rapidly varied flow in the model city area where a building group representing a simplified town configuration was introduced. In order to verify the calculations, numerical results are examined against the experimental data available due to depth measurements. The experiment of model city flooding event was carried out at the hydraulic laboratory of Gdansk University of Technology. The second test (case study) concerns flood propagation on the embanked build-up area of Saska Kepa district of Warsaw (Poland). In Warsaw the areas of direct danger of flooding are currently limited to

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the belts between the flood protection dikes, although the reach of the potential flood hazard is much wider. Flood risk, and its magnitude, ought to be taken into account when planning location of construction projects in the valley of the river and in the adjacent zone.

Keywords: *mathematical modeling, numerical simulation, river embankment failure, inundation*

III-16

Influence of Pooling Scheme on Undirect Estimation of Rainfall - Runof Model Parameters

S. Kohnová[1], K. Hlavčová[1], J. Szolgay[1], M. Zvolenský[2]

ABSTRACT

In this paper an alternative method of estimation a rainfall –runoff model parameters for ungauged basins is presented. In the study the Hron River basin located in Central Slovakia was selected as a pilot region. The applicability of the concept was tested in selected 23 subcatchments of the basin. The presented concept is based on the subdivision of the region of interest to pooling groups, based in the first step on catchment boundaries and secondly on similar physiographic characteristic by using a clustering method. Subsequently parameters of a lumped rainfall – runoff model were estimated by calibration using a daily time step in subcatchments. Regional regression formulae for the estimation of rainfall-runoff parameters from catchment characteristics were derived separately for each pooling group. The performance of both approaches was compared. Finally the assumption was tested that in catchments selected according to a similarity measure, such relationships may perform better than in arbitrarily chosen catchments.

Keywords: *model parameter regionalisation, pooling scheme, multiple regression*

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III-17

Assessing Land Use Change Impact on the Runoff Regime in Selected Basins in Slovakia

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ABSTRACT

Distributed hydrological rainfall-runoff modelling was applied for estimating changes in the runoff regime using several land use change scenarios. The effect of the change in forest, grassland, agricultural and urban areas, including the historical potential natural land use was simulated using climate data from 1981-2000. Selected basins in Slovakia located in central and southern parts of Slovakia were selected as pilot basins. A physically-based rainfall-runoff model with distributed parameters was used for modelling runoff from rainfall and melting snow. Parameters of the model were estimated from three digital map layers: land-use map, soil map and digital elevation model. Changes in the long-term mean annual runoff, mean monthly discharges and maximal mean daily discharges were compared for the present and potential land use.

Keywords: *Hydrological rainfall-runoff model, distributed parameters, land use change scenario, runoff formation, partial runoff components*

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III-18

Evolution of the River Cut-off

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ABSTRACT

In the river engineering aspect, cut-offs pertain in river regulation actions that have significant effect on morphodynamical changes of the river channel. Shortening of the river course increases energy slope, which imply increase of shear stress on the river bed and disturbance of the river channel stability. To enable timely reaction in case of adverse effects, it is necessary to monitor the new situation. Due to diversity of geological, hydrological, hydraulical and morphological conditions, each river reach is a unique section. This paper gives theoretical aspects of the river channel evolution in the cut-off after creating the weir on the main channel of the river. Also, a meander cut-off results of morfologic changes observations are presented.

Development of the river geometry has been observed for the period of one year, as well as the changes of the hydrodynamical parameters. Methodology of data evaluation is demonstrated where focus is been on distinction beetwen total eroded material and material which was caved in cut off from river banks. Also, analyzes of the influence of the river discharge and water surface level slope on erosion progress in the cut-off within a year.

Volume of the total eroded material is approximated by the exponential curve. Prediction of cut-off evolution time is based on assumption that cut-off would be hydro-morfological stable when average cross section areas became equal for cut-off and for adjacent river bed. Predicted cutt-off evolution time is from min. 3,5 to max. 8 years.

Keywords: *river cut-off, morphodynamics, evolution time, drift erosion, river bank erosion.*

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III-19

Optimization of Water Detention Structures
to Control Flood Peaks in Urban Areas

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ABSTRACT

Continuous impermeabilization in urban areas requires constant attention to peak discharge and flood risks. Traditional engineering approaches mainly focused on drainage and stormwater conveyance infrastructure tend to become increasingly expensive, and are still limited in addressing environmental impacts downstream with release of high volumes of water. Recent stormwater management approaches are based on sustainable design and practices, developing solutions with a broader impact at the watershed context. These solutions are focused on rethinking the project and organization of urban spaces, and may be applied in different watershed scales and drainage components, including either structural or non structural approaches. The design of detention tanks is one measure to contribute to reduction of peak flows in urban watersheds, however some approaches to calculate the tank size based on precipitation and impervious area only may result on oversized structures. This study presents a mathematical model to optimize the size of a group of detention tanks in an urban watershed, taking into account not only precipitation and impervious surface area data, but also existing stormwater conveyance capacity, tank storage and translation hydrologic effects. The model calculates the minimal cost combined detention storage in the watershed subject to a constraint of peak discharge capacity of existing or projected conveyance infrastructure. The model was applied to a hypothetical watershed and simulation resulted in optimized detention tanks being significantly smaller than detention tanks calculated based only on precipitation and impervious area, while still able to prevent overflowing of local stormwater conveyance infrastructure.

Keywords: *stormwater, flood control, detention tanks, optimization*

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III-20

Two Examples of the Failures of the Inundation Levees

Jaromir Riha[1]

ABSTRACT

During the extreme floods in the years 2002 and 2006, the peak flood discharges in exposed streams exceeded the 100-year return period. A great number of flood protection levees was overtopped and the area behind them was inundated, in some cases with much more disastrous consequences due to concentrated flow from the breach. At the same time more than 20 small dams were breached. The very curious situation occurred at the Luznice river in 2002, where levee protecting sand pit Cep was overtopped. The sand pit was filled by floodwater and finally the levees were overtopped again and breached by the water from the sand pit and seriously damaged part of Majdalena village. During the spring flood in the year 2006, the levee close to the city of Olomouc was breached due to internal erosion. The villages of Horka and Sedlisko were flooded with extensive material losses.
In the paper the August 2002 and March 2006 flood events are described, the conditions during the breaching are analysed and some measures for future operation of the levees are proposed in concept.

Keywords: *levee failure, dam break flood, flood protection*

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III-21

Assessment of the Flood Risk Associated
with a Linear Defense System

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ABSTRACT

In the paperwork are defined the flood linear defence systems. There are also described the flood waves and studied the floods generated by the failure of hydro technical works from the linear systems.

The evaluation probability of the system failure is based on the relation between it charge and the hydro technical works resistance.

For a system which may contain at least two flood protection works it can occur the possibility of several breaching scenarios that can lead to floods. The total probability of flooding is calculated by taking into account all possible scenarios resulted from the failure of the flood protection works combinations.

On this base a theoretical computation model is elaborated, which can determinate the risk, respectively the protection degree. Simultaneously with the slogan "ignoring the risk is the greatest risk", the study is taking into account that the flooding risk cannot be completely eliminated.

The flooding risk computation schemes associated with the linear systems presented in the paperwork aim the real and possible situations from Romanian – Serbian cross border zone of the Timis – Bega hydrographical area. It's presented the collapse axle and the appropriate flood protection management.

The analysis of a flood wave caused by the flood defense system failure in different scenarios permitted the verification of the theoretical model and the quantification of the flooding risks and the protection degree implicitly.

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III-22

Analysis of Discharge Variability of the Danube River in Bratislava for 1876–1940 and 1941–2005

Pavla Pekárová[1], Peter Škoda[2], Milan Onderka[1], Juraj Pacl[1], Ján Pekár[3]

ABSTRACT

Applying the historical stage-discharge rating curve, the average daily stages of the Danube River measured at the Bratislava gauging station over the historical period 1876–1890 were used to obtain average daily flows. The calculated 130-year series of average daily flows was subject to an analysis in order to reveal changes in the characteristics of the series. A comparison of two 65-year data sets of average daily flows (1876–1940 and 1941–2005) did not show any significant change in the basic statistical characteristics of the river discharge. However, the time shift in the average daily flows was analysed by means of cross-correlation techniques. Highest correlation coefficient between long-term average daily flows for the periods 1876-1940 and 1941-2005 was achieved with a time lag of +13 days. At the end of March between 1941–2005 the average daily flow was 492 m^3s^{-1} higher that that of the period 1876–1941. In contrast, in mid-September the flow was found 541 m^3s^{-1} lower than that of the previous period of 65 years.

Key words: *Danube River, Bratislava, historical river stages, analysis of daily discharge*

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III-23

Bed Load Retention Sidearm – Hydraulic Scale Model

Cedomil J. Jugovic [1], Georg Schuster[1], Hans-Peter Nachtnebel[1]

ABSTRACT

Located at the confluence of the Steyr River into the Enns River, the city of Steyr was in the past often exposed to floods. Numerous flood marks in the Old Town attest the chronicle of the inundations. As the result of floods, the ongoing bed load deposition process in the city reach of the Enns River progresses and the risk of future flooding is growing permanently. These unfavourable bed load deposition, supplied primarily from the Steyr River, could only be removed by repeated, ecologically disputed, dredging of river channel. The project "Bed Load Retention Sidearm" is based on a detailed evaluation of the August 2002 flood. The analyses suggest several options for an improved flood protection of the city. The initial step is to centralize bed load retention and dredging zone upstream of the exposed area. The sidearm for bed load extraction and deposition should be located in the Himmlitzer Au, a green, partly agricultural area upstream of the city.

By the intended bed load extraction the proposed measures in the Enns River (widening of the flow course, lowering of the bottom level) can be realized without running the risk that they could become reversed and made inoperative already by the next flood. The proposed solution should also be economically and ecologically reasonable. Thus, the size of the construction should be as small as possible to minimize the costs and environmental impacts. Ultimately, human interference within the river ecosystem should be possibly reduced, satisfying the following criteria:

- Depositions in Enns River should be reduced.
- The flow continuum by low discharges should be preserved.
- Total bed load transported in Steyr River should be partially extracted.
- Ecological, urban and regional planning has to be taken into account.

In support of the ongoing project, a hydraulic model was constructed in keeping with the available space in the hydraulic laboratory on the scale 1:80/26.7. At such a scale the results of the morphological analysis had basically to be assessed qualitatively. Modelled river section with the length of around 1500 m in nature was performed with a "quasi-movable" river bed. The tests for the optimisation of the structure design were done by steady and unsteady flow with discharges of return period up to 100-years. The model has been calibrated to the current situation. Afterwards, the draft design of the inflow structure and sidearm itself has been modelled and developed throughout the experimental procedure. It took more than 15 basic design alternatives to finally obtain an optimal solution. The hydraulic scale model of the whole sidearm system, driven under different flow conditions, has been an essential instrument for obtaining reliable estimation of the system's optimal operation.

III-24

The Flood Risk Analysis of Areas Defended by Retention System

Kristina Novak[1], Neven Kuspilić[1], Duška Kunštek[1]

ABSTRACT

Retentions are often used as technical measures for protection from flash floods. They are either used as independent structures or a multi structured system. The more complex the system, the more complicated is the identification of relevant precipitations providing a critical discharge on the downstream area, mostly directed towards determination of flood risks. One of the key elements is the correctly developed simulation model giving precise forecast of oncoming water wave. The paper reports on the risk determination method associated with rainfall probability. For an analysis the example of the complex Medvešćak brook catchment was taken, as a part of Medvednica hill's water drainage system for protection of the city of Zagreb from floods. The simulation of oncoming water wave was conducted with hydraulic and hydrologic model, using HEC ("Hydrologic Engineering Centre") of the programme package, developed by the US Army Corps of Engineers hydraulic engineering centre. The model examines directly the output results' sensitivity (transformation of water waves of different return periods) to the set of hydraulic catchment parameters (various precipitation cases with corresponding return periods and intensities - ITP curves). The maximal discharge, return period and rain period dependence diagrams were created to estimate flood risks: $Q_{maks} - PP - T_k$ for characteristic catchment points. For these points, with regard to the bed capacity a water wave return period that does not overflow the bed was determined. The obtained results of the simulation model indicate that a satisfyingly constructed retention system provides a high-quality flood protection for the observed area of Medvešćak.

Keywords: *HEC - HMS, retention, runoff, water wave, risk*

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Topic IV

Geotechnical aspects
of hydraulic engineering

IV 01

Numerical Simulation of the Underground Dam Function in the Riparian Alluvial Aquifer

František Burger[1]

ABSTRACT

Artificial groundwater body feeding, which results from integrated surface and groundwater utilization and long lasting sub-surface accumulation, is preferred where it is possible. Artificial feeding has important role by repeated water utilization, because it gives also quality advantages (water clarifying in soil and in groundwater bodies). In order to utilize the underground reservoir for the storage of significant water amount with the intention to utilize it in later period, it is necessary to discover potential accumulation capacity of the groundwater reservoir as well as its convenience for feeding from surface water and easy pumping in the case of necessity. Groundwater reservoir should show sufficient free space between surface terrain and groundwater level for the water storage and water reservation from feeding during the period when the water is not necessary. This condition involves precise hydrogeological and geophysical survey including geological mapping and hydrogeological boreholes in order to state the configuration and accumulation capacity of underground reservoir. It is possible to estimate the suitability of hydrogeological groundwater body for feeding from the surface by the means of following parameters:

- surface covering layer has to be considerably permeable so that it enables water infiltration;
- unsaturated zone of porous environment should have high vertical permeability and vertical water flow should not be bounded by the appearance of low permeable clay layers;
- depth of the groundwater level should not be smaller than 5 to 10 meters.

Underground dam belongs to the management types of artificial hydrogeological groundwater body feeding. It is built in shallow alluvial sediments in order to restrain the immediate underground outflow from the groundwater body. It consists of impermeable wall situated along surface flow – the river. In the study results from numerical solution of the underground dam function simulated in the Čenkov valley study area during deficit water regime on 29.Sept.1954 are presented. Underground impermeable wall situated along the river through 2nd and 3rd geological layer should be without openings (windows) and dropped into the neogene. Obtained results are compared with numerical solution results without the existence of a wall during so-called "natural" deficit water status of the area at the low water level in the Danube river. From the comparison of results issues that:

- by the means of underground dam creation the river doesn't have feeding and drainage function except the area strip between the river and the wall. Open flows and canals in the area have increased draining function;

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- ➤ groundwater level under the terrain is by the underground dam higher than 2 m approximately on the half of area. Exceptional maximum values are up to 5,5 m and minimum values are around 0,1 m;
- ➤ not even in the case of underground dam it doesn't come to the confined groundwater flow;
- ➤ minimum velocity values approximately refer to natural status; maximum velocities in the case of underground dam are in the second layer higher for one dimension only in the strip of area between the river and the wall and in the third layer correspond to the natural state;
- ➤ underground dam will create static volume under the same initial and boundary conditions such as in the case of natural deficit steady water regime status, which represents the 20% increase of groundwater body aquifer volume opposite to the natural status.

IV-02

Jet Grouting Method Application For Excavation Pit Bottom Sealing

Damir Čorko[1], Davorin Lovrenčić[1], Meho-Saša Kovačević[2],

ABSTRACT

At planning and executing the construction pit excavations in alluvial soil layers, we are very often confronted with undergorund water problem, which level could be considerably higher than planned excavation depth. Consequently there is a problem of pit walls stability, sealing of pit lateral sides as well as pit bottoms sealing.

At solving first two problems, tehre is a number of technical procedures, more or less of standard use.

At pit botttom sealing, we are facing problems which can be extremely complex, but range of possible sollutions is very poor.

Cases with impermeable soil layers of suffficiant thickness at relatively reachable depth under pit bottom, are more and more seldom - it can almost be considered that such locations are alreay used up.

One of possible solutions for pit bottom sealing is application of jet grouting method. This sollution is very flexible and works are mostly under controll, which is wiht other methods very often not the case.

Some of the solutions used for numerous excavation pit sealings in various hydro-technical constructions executed during past several years would be shown in the Paper.

Also, the problem of the controll investigaton of executed works quality will be worked out in the Paper.

Keywords: *construction pit, pit bottom sealing, jet grouting, controll investigations*

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IV-03

Grouting Curtains in the Subsoil of Dams

Bednárová Emília[1], <u>Minárik Marian</u>[2],

ABSTRACT

In Slovakia there are 50 dams, which are recorded in the World register of dams ICOLD. Geological composition of their subsoil many times required realization of grouting curtain. In some cases during operation of water structure it was necessary to initiate their treatment. Causes which were decisive for starting of remedial works were different. This paper deals with the results and the necessity of remedial works.

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IV-04

The Utilization of the Geothermal Energy Resources in Slovakia

Jozef Kriš, [1], Ivona Škultétyová[2]

ABSTRACT

Geothermal resources represent that part of geothermal energy of solid, liquid and gaseous phases of the Earth's crust, which can be economically exploited from the Earth's surface and used by available technologies for purposes of power engineering, industry, agriculture, recreation and rehabilitation. The source of this energy is a residual heat of the Earth as well as heat releasing in radioactive decay of rocks and during the movement of lithospheric plates accompanied by volcanic activity and earthquakes. From this point of view, the geothermal energy is considered as renewable resource of energy. It mostly occurs in a form of hydro-geothermal resources such as geothermal water and steam. In addition, the heat of dry rocks is also included in to the geothermal energy resources. All of these energy resources are classified among the non-traditional alternative sources of energy.

It is generally known that Slovakia lacks primary energy resources. From the total consumption of fuel-energy resources the domestic resources of fossil fuels shared only 9.4 percent covering 17.1 percent of brown coal, 5.5 percent of natural gas and 1.68 percent of crude oil. The use of renewable energy resources covers 3 percent of the total consumption of primary energy resources. This fact ranks Slovakia among the countries such as Italy or Ireland.

Approach to the use of renewable energy resources, approved by the Government of the Slovak Republic, defines a basic framework for development of the use of renewable energy resources in Slovakia. Following this approach geothermal energy is ranked as the second among all seven renewable energy resources. Biomass has the best potential (46.7 percent) followed by geothermal energy (17.5 percent), solar energy (14.5 percent), waste heat (9.8 percent), bio-fuels (6.9 percent), small-scale hydropower plants (2.9 percent) and wind energy (1.7 percent).

There are 180 public swimming pools with the total number of 456 pools in Slovakia, including 156 pools with thermal water and 300 without thermal water. In 2006 157 swimming pools with 411 pools were in operation. Other swimming pools (23) or pools (45) were out operation due to technical or organizational problems. According to valid hygienic criteria, thermal swimming pool is defined as swimming pool comprising at least one pool filled by geothermal mineral water of portion higher than 50 %, regardless of whether there is successive circulation of water or not. Eventually the portion of geothermal water might be lower than 50 % in a case of exceeding the mineralization limit, i.e. 5000 mg.l^{-1}.

Key words: *Energy resources, geothermal water, swimming pool*

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IV-05

Sustainable Ground Improvement by Stone Columns

Meho-Saša Kovačević[1], Ivan Arapov and Ani Ivanković

ABSTRACT

Ground improvement presents a technological procedure that increases the bearing capacity of ground, reduces. i.e. controls total and differential settlements, reduces the time needed for deformations to take place, reduces ground permeability, removes water from ground completely by creating inner drainage systems, increases the erosive ground stability, and reduces the liquefaction risks.

Ground improvement can be brought about by means of various technologies. Due to the increased need for the heavy infrastructure objects' foundation works in extremely difficult conditions, the technologies, ground improvement techniques have been hurriedly developed.

Generally speaking, natural ground is turning into a new material through the processes of ground compaction and mixing. According to this the object safety depends on the quality of the new material. The ground improvement methods, selection of an adequate foundation structure, and improvement efficiency control method can make it possible to quantify the efficiency of the operations and to manage the risks.

The paper presents the Croatian experience in designing, executing and quality control of ground improvement by means of stone columns using the method of deep vibration compaction. The gravel or broken stone columns are installed into the coherent, i.e. poorly permeable ground types by pressing and vibrating, and then these columns take over additional loads. Along with the neighbouring ground, such granular material built in with vibrators has got higher stiffness and yields better resistance to shear. Whereas the foundation soil's bearing capacity increases its settlement decreases. Due to the high permeability of stone columns, the consolidation time is significantly shorter.

The ground improvement technology by means of stone columns is from the economic standpoint remarkably more convenient than conventional foundation works. The realization time is relatively short, and the procedure adjustable to field conditions. The foundations works on the future construction object can start immediately after the ground improvement has been completed. Only natural materials are built-in into the ground, which makes this procedure ecologically very acceptable, as well.

Keywords: ground improvement, stone columns, settlement, bearing capacity, quality control

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IV-06

Results of the Monitoring the Dobrá – Bogárka Landslide on the Banks of Domaša Dam

Baliak František[1], Malgot Jozef[2], Solčiansky Roman[3]

ABSTRACT

Gravitational slope movements, mainly landslides affect stability of reservoirs banks and endanger all kinds of water structures. In the paper are discussed problems of the treatmenr works on the landslides which originated on the banks of water reservoirs Domaša (locality Dobrá - Bogárka). In the paper we are introducing as an example the landslide on the locality Dobrá - Bogárka, monitored in years 2003 - 2006.

Keywords: *slope deformations, landslides, water reservoir, monitoring*

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IV-07

Measurements of Soil Erosion Production on the Investigation Plots "Abrami" on Flysch in Central Istria /Croatia/

Josip Petraš[1], Danko Holjević[2], Duška Kunštek[1]

ABSTRACT

The region of central Istria has all the physiogenetic predispositions necessary for the development of water erosion, which is excessive in many places. The water erosion is manifested there in various forms of pluvial erosion (surface wash), particularly in denuded areas so-called badlands, by torrential outflow regime and accordingly by discharge and delivery ratio of the sediment which is mostly deposited in watercourses. Soil erosion investigation in the area of central Istria in Croatia began in the fifties of the last century with a goal of testing the then modern protection methods of hilly surfaces from erosion, i.e. of acquiring necessary experiences on applicability of those methods on Istrian flysch and collecting data on construction costs as well as economic effect of such works. From series of locations under consideration, Abrami near town of Buzet was chosen, lying between $45^{0}24^{'}$ and $45^{0}21'$ degrees of geographic latitude and $13^{0}31'$ and $13^{0}25'$ degrees of geographic longitude, in the upper reach of the Mirna River. It covers an area of 23.46 hectares, on east-north-east exposition. In terms of specific phenomena of soil erosion and torrent occurrences in Istria, that part is very illustrative, and according to expert opinions, in given circumstances also sufficiently representative enough central (flysch) Istria. In 1969 an investigation of quantitative indicators for erosion intensity on this location was organized. Six observation plots were set up to that purpose in order to measure erosion sediment production. Those plots encompass various erosion factors on surfaces with different vegetation cover. Selection of erosion factors investigated was directed towards planted woods and meliorative regulation methods of surfaces affected by erosion, used on a larger scale in wider area of central Istria for restoration of torrential areas. According to adopted program, the emphasis was put on hydrological-biological aspects of soil erosion, in order to acquire insights into effects of various antierosion undertakings on soil wash-outs. During the research, run-off and soil wash-out (sediment production) quantity were measured in dependence on changes of meteorological parameters, and also vegetation cover development was monitored to record more significant changes. Investigation of quantitative indicators for erosion intensity, i.e. quantity measurement of erosion sediment in Abrami was conducted from 1970 to 1977. On an initiative from Faculty for Civil Engineering Studies from Zagreb, measuring equipment on observation plots was resumed during 1999 and 2000, so the measurements continued and they are still going on.

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The paper briefly describes methodology, purpose and results of sediment production measurements on investigation plots Abrami in central part of Istria, and point out the possibilities of application this results. Precisely, sediment production measurement results in central Istria create a bank of measured data, on whose basis the evaluation of particular parameters within parametric methods for estimation the soil erosion effects may be conducted, and thereby an additional reliability of such methods can be achieved.

Keywords: *Soil erosion, erosion sediment, flysch, resumption of investigation, measurement, erosion parameters, parametric methods, evaluation of parameters***,**

IV-08

Site Selection for Non Hazardous Regional Landfill in the Polog Region

Katerina Donevska[1], Milorad Jovanovski[2], Jovan Papic[3]

ABSTRACT

The aim of the paper is to present the site selection procedure for non hazardous regional landfill for the Polog Valley in the Republic Macedonia. The paper takes into consideration the selection of the location for a non hazardous landfill for the settlements that gravitate towards the Polog Valley situated in the North Eastern part of the Republic of Macedonia. Natural characteristics of the region including geographical position and geological, relief and seismic characteristics of the terrain have been presented. Climate, hydrological and hydrogeological characteristics of the region and also of the potential locations have been presented. Hydrogeological condition of the region is very specific due to the nearby spring Rasce that supplies with drinking water the city of Skopje. Because of its significance, the spring Rasce is under protection with national regulation, and zones of protection of the spring are established. These protection zones occupy significant part of the territory of the Polog Valley. Anthropogenic activities of the population living in the region including population, settlements and infrastructure have been described. According to the demographic condition and appropriate increase of number of population, projection of total number of population and of the generated waste for these settlements until 2032 is done. Also, estimation of the required landfill capacity for the exploitation period of 25 years is done.

The selection of suitable landfill sites is one of the most important and complex activity during the preparation of a modern solid waste management system. In Macedonia there are no legal requirements for landfill site selection procedure. There are general guidelines on the most important criteria for landfill site selection. The authors of the paper have chosen the practice of site selection conducted on a systematic exclusion and ranking approach based on assessment of selected criteria. The method of weighted matrix has been used for ranking of alternatives and final proposal of the most appropriate site. The applied method should be considered as approach that makes the decision making process clearer and results in the selection of the best possible location. Conclusions about the most appropriate location for non hazardous landfill location for the Polog Valley region are presented. According to

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the final score two sites have the best ranking scores. These two sites should be the best possible landfill sites according to the implemented methodology. It means that all the requirements which have to be fulfilled by the national regulation are met. Besides one location has the best ranking scores it should be noted that it is located in the second protection zone of the spring Rasce. It has been concluded that there is a need for further analyses to help to the decision making process for site selection.

Keywords: *non hazardous landfill, site selection, weighted matrix*

IV-09

An Application of Numerical Modeling of Soil Liquefaction to the Assessment of Condition and Revitalization Measures for Small Hydroelectric Power Plants

A. Bolt[1], T. Sukowski[2], W. Szudek[3]

ABSTRACT

The examples of simulation the liquefaction processes with standard
numerical procedures used for evaluation of the structure and soil beds state for small water plant
are presented. The aim it was choosing the optimal protecting solution for of the
structure. The main conditions depend to the well-documented state diagnosis,
monitoring systems of parameters, checking able models system.
The examples of the methodology of treatment together with the results of
calculations and conclusions connecting with predicted dangerousness and rejecting the
cause of there arise are presented.

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IV-10

Comparison of Evaluation of Soil Water Content by Global and DSSAT 4 Simulation Models

D. Igaz [1], - I. Tóthová[1] – P. Samuhel[1]

ABSTRACT

The submitted report compares simulated and measured values of soil water content. Soil water moisture was measured on research basis of SUA (Slovak University of Agriculture) in locality Kolinany (48° 22' 0" latitude, 18° 12' 0" longitude, 200 m above sea-level). The soil type is classified as sandy-loam Haplic Luvisols with humus content 2 – 2,99 % on experimental area.

There was used VIRRIB instrument for measurement of soil moisture working on TDT (Time Domain Transmissometry) method. There were used two kinds of models the first one Global model – simulation model of soil water movement in soil with crop cover (Slovak Academy of Sciences Institute of Hydrology, Bratislava developed by Majerčak, Novak) and the second DSSAT 4 model - Decision Support System for Agro technology Transfer (University of Hawaii, USA developed by Tsuji, Uehara, Balas) for simulation of soil water content.

Time series of simulated and measured values of soil moisture were prepared and evaluated during years 2002-2004. Measured and simulated courses of water content were consequently tested by correlation analysis in MS Excel and by analysis of percentage differences between simulated and measured values according to 15% differential.

Keywords: *soil water content, TDT, GLOBAL, DSSAT 4*

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Topic V

Integrated water resources management and EU Water Framework Directive

V-01

Some Chalanges for Future Engineering in Macedonia related to Sustainable Development of Water Resources

Zvonimir Vukelic [1], Ordan Cukaliev [2], Milan Ilieski [3], Zekirija Idrizi [4], Valentina Zileska-Pancovska [5], Marija Vukelic-Sutoska [6]

ABSTRACT

Related to sustainable development of water resources it is of interest to say that it is necessary to analyze physics, mathematics and informatics, chemistry, biology, geology, hydrology, social sciences, hydraulic structure, hydraulic machinery, fluvial hydraulics, groundwater hydraulics, hydraulic modelling, sanitary engineering, industrial hydraulics, and management of water resources (development of water resources, sources, supply, demands, operation and maintenance).

Regarding innovative technologies applied to integrated energy, water and environmental development and management one can say that the following topics may be of interest: global perspective of water and energy, sea water, fundamentals of design/operations, control and automation,, information technology, systems engineering, management fundamentals, filtration processes, water treatment and supply systems,, water resources and environmental management, water resources and environmental management in shifting technological paradigm,, innovative technologies applied to integrated energy, water and environmental development and management, food and agriculture, industrial safety and fire protection, reliability, maintainability, retrofitting and rehabilitation, diffusion of know how and technology, education and training, sources of global research, facilities and processes, management, professional societies and organizations, and suppliers, contractors, consultants, and research and development centers.

Speaking about groundwater then minimum set of data elements for groundwater quality should be general, geographic, well and sample descriptor. It is shown an example of unconventional technology of underground dams. It may be an excellent long-term source of water in semi-arid countries.

From energetic aspects, the construction of the hydro-electrical power plants, for example along the Vardar river valley, within the period 2010 to 2015 represents a basis for long-term development of the electric power system of the Republic of Macedonia. To that effect, 12 hydro-electric power plants are planned to be constructed along the Vardar river course, from Skopje up to the border on Greece, 200 km in length. There is a possibility for

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irrigation of 370.000 ha out of the total of 670.000 ha arable land. So far, irrigation systems have been constructed for 173.000 ha, out of which 40.000 ha in thr Vardar valley. The construction of multi-purpose hydro-system in this area shall enable irrigation of another 70.000 ha. From ecological aspects, the main emphasis is put on protection of the waters of the Vardar river and its tributaries. Protection is planned to be realized by construction of 135 stations for treatment of industrial waters and 9 complexes for treatment of waste waters from urban settlements.

Key words: *Water resources, sustainable development, innovative technologies, groundwater quality, structure related to uncertainty*

V-02

Simulation Model for Management of a Complex Diversion Hydro Power Plant

Ljupcho Petkovski[1]

ABSTRACT

The presented simulation model for water management of a complex diversion run-of-river hydro power plant (HPP) is composed of three parts: hydrological, hydraulic and energetic The hydrological model simulates the discharges of the potential intake structures, on the basis of measured flows from the observation points in the catchment's area. This simulation, in the hydraulic engineering practise, is performed by applying methods of Parametric Hydrology, using correlation functions, so it is not a subject of this report. The hydraulic model has to determine the discharge through HPP, in relation to capacities of intake structures and inlet conduits. Therefore, the hydraulic model has quantitative character, and it is not used to determine the hydrodynamic parameters of the flow in the simulation model. Taking into consideration the uniqueness of the water resource systems (WRS), particularly the different compositions of the complex diversion run-of-river HPP, it should be underlined that the hydraulic model has to be adapted to the specific configuration of the system. The energetic model is used to determine the energetic effectiveness of HPP, in relation to the installed discharge and the number of turbines.

In this paper are presented the description of simulation model and the results and conclusions from its application on the study of response of HPP Lera (Bitola, Republic of Macedonia). This HPP is part of the multiuser water resource engineering system, or hydro-engineering system (HS) Strezhevo. The production of electric energy from HS Strezhevo is assumed around 40 GWh per year. Four hydro electric power plants have already been completed (HPP Strezhevo, HPP Biological Minimum, HPP Filter-station and HPP Dovledzik) and they are currently in operation. Two new plants (HPP Lera and HPP Kazhani) are planned for construction. The algorithm of the quantitative hydraulic model, adopted for the configuration of the run-of-river diversion HPP Lera - Bitola, which will be applied to the management model for determination of the energetic efficiency of the HPP (for different variants according to the installed discharge of the HPP and sub-variants of the capacity of the water conveyances), is mathematically formalised by the set of conditional equations.

The final selection of the installed power of HPP will be done on the basis of a detailed economical analysis, using the criterion of maximisation of the net benefits, which are actualised in present worth. In this economic analysis, the average annual benefits for the different variants of HPP according to the installed discharges will be obtained in relation to the annual generation of electric energy, which will be estimated by applying the simulation model presented in this paper.

Keywords: *simulation model, diversion run-of-river hydro power plant*

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V-03

Sustainable Growing up of Water Supply and Waste Water Sewerage in SR

Tothova Katarina[1], Stanko Stefan [1]

ABSTRACT

The article talks about price development of drinking water and consecutive disposed sewage water, which got through many changes. Through Slovakia entry into EU, the state obliged to fulfill conditions out coming for each member country. On one hand it is finalizing of public ducts for drinking water supply as well as increase share of population with sewage. The goals are projected until the year 2015, where the difference among member states should be balanced. This goal has as a consequence price increase of drinking water. State eliminated cross grants for water economy area, adjusted water prices for households and businesses, what again has a consequence in form of water price increase. Therefore is water price question frequently discusses and is important to think about individual components, which create final water price. For final consumer protection and for water price regulation is established Regulation Bureau of SR. This one takes care about water price creation. Water price is therefore controlled as well as legitimate. Drinking water as well as sewage water is not only goods; it is service, which ensures distribution and delivery of drinking water as well as disposal and scavenger of sewage water. Last but not least water is of course part of our everyday life, therefore we should think about it real value.

Keywords: *sustainable development; water price; water supply; water companies*

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V-04

Basic Criteria for the Management of Pump Water Supply Systems

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Assoc. Prof. Petko Pelivanoski [1], Prof. Zivko Veljanoski [2],

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ABSTRACT

The water supply systems (WSS) nowadays become more complex systems, and the dependence of the population and industry on the safe water supplying is bigger every day. The task to provide safe water supplying is severely placed before the organizations dealing with management of water supply systems. And this task is very difficult to fulfil if modernization of the way of observing, planning and management of the work of water supply systems is not obtained. Among other things, it means involving computer technology in various branches of water supply systems, new methods of management, education of personnel etc.

This paper presents the criteria for management of pump's work in depend of the dual criteria in the same time, apropos of water's level in reservoirs and the consumption of water in water supply systems,.

The optimal management of the System can be analyzed in correlation to the criteria for supplying maximum water reserves in the water supply systems, minimum electric power consumption, minimal cost of electric power spent and etc.

Keywords: *water supply systems, mathematical modelling, simulation, technical and economical analyses, criteria for optimal management, optimal management*

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V-05

Optimal Exploitation of Gravitational Potential of Extremely Springs´ Yield Versus Long Distribution Water Systems

Katarína Tóthová [1], Ivan Mrnčo [1]

ABSTRACT

The conception of drinking water supply reflects relation between location of water resources availability and water consumption areas. This determines attributes of hydro-geological region, and water networks arrangement in area. The location of water resources is often imbalanced and this is the one of the reasons why for safety water supply there are build long water distribution systems. The long distribution water pipes connect deficit areas with areas of water resources shortage. For example: large capacity wells in Danube region near Bratislava have got a multiple greater yield than real demand in this region. In this case water is distributed from wells by multiple pumping for a long distances (tens or hundreds of kilometres) to insufficiency sources location. The region like this represents the foothill of the Little Carpathians, where local water sources – springs don't give ample yield for the whole year. Most of this springs offer high - quality water but yield variability of sources don't guarantees continuously water supply. Except for sources quality and yield the elevation placement of sources are important. The elevation potential designates gravitational water supply without pumping energy. In fact for a period of supply neither average yield of this springs aren't exploiting for water systems. Their balance capacity is technically designed for minimal yield of springs. And that's reason to set reasonable questions: Is it efficient to pump and distribute water for long distances also in maximum yield of gravitational springs? How can we determine rate of efficiency of extremely yields´ use. The answers are in analysis of necessary technical actions, investments and in the calculation of operating costs of pumping and system services dependent on variable yield of gravitational springs.

Keywords: *Water resources, spring, gravitational, yield, water system, long distribution system, pump, rate of efficiency*

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V-06

Terrain Measurements and Calibration of Hydro Dynamical Model of Groups of Channel Hydro Power Plants on the Váh Cascade

Radomil Kveton [1], Peter Dusicka [1], Jan Rumann [1]

ABSTRACT

The Váh cascade of hydroelectric power plants was constructed over 70 years. Individual power plants and entire groups of power plants were designed and built with different hydraulic parameters such as sizes of channels, discharges through power plants, etc. Therefore, the hydraulic structures of the Váh cascade are complicated. The water works Dolné Kočkovce - Ladce - Ilava - Dubnica - Trenčín and Trenčianske Biskupice - Kostolná - Nové Mesto - Horná Streda are the groups of channel hydro power plants on the Váh Cascade. Last year was made by our department terrain measurements and research on this water work system. The results of measurements were used for the better calibration of hydro dynamical model of these water works. The presented paper describes this process.
This work was supported by Science and Technology Assistance Agency under the contract No. APVT-20-046302.

Keywords: *Water Power Plant, Water Work, Hydraulic Parameters, Terrain*

Measurements

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V-07

European Water Directive and River Basin Management Plans for Trans-boundary Small Rivers of the Ferghana Valley (Central Asia)

Yusup Khai. Rysbekov[1]

ABSTRACT

Last 5 years in Fergana Valley (FV) the Project Integrated Water Resources Management ("IWRM-Ferghana") is realized (at financial support of the Swiss Agency for Development and Cooperation). One of main objectives of the «IWRM-Fergana» Project is to achieve sustainable and stable water supply and ensure equitable water allocation between all parties involved in water resources management (WRM) and use processes. The Project included four Components: 1. Group of coordination and support (national level); 2. Pilot channels (irrigation system level); 3. Water users' associations; 4. Pilot demonstration fields (level of farms). Taking into account that efforts on implementation of IWRM principles in the project area would be mocked if trans-boundary aspects of IWRM are not studied in FV, since 2007 the new Component "Trans-boundary small rivers" (TSR) was included on in the Project "IWRM-Ferghana" as FV is located in territory of Kyrgyzstan, Tajikistan and Uzbekistan, and irrigation infrastructure of project zone is closely connected to some TSRs (Akbura, Isfairam, Kholjabakirgan, Shakhimardan, Sokh, etc.). Interstate water allocation volumes for TSRs of FV were agreed by Parties and set in 1980 by appropriate Protocols of the Main water Agency of USSR (in centralized order). WRM in TSR was greatly complicated in recent decade due to population growth and new land development in river upstream areas (mainly in Kyrgyzstan and Tajikistan). Breach of the established water allocation results in intensification of social tension in border areas located in TSR basins that can be easily transform into international conflicts.

In a developing situation use of the European approaches to WRM is represented rather useful at realization of the Component "TSR". As is known, European Union Water Framework Directive (EU WFD) considers a river basin (RB) as the fundamental and natural unit for the protection of the aquatic environment and recommends, in particular, drawing up of Water Resources Management Plans (WRMP) for each RB, including Trans-boundary River Basins (TRBs). Depending on conditions, it can be WRMP for one or more RB. Sustainable WRM in the FV depends on coordinated actions of the project countries (Kyrgyzstan, Tajikistan, and Uzbekistan). In this context, it is advisable to take provisions of the EU WFD in part of RB management (Article 13) as a basis for strategic water development planning (SWDP). The EU WFD provides the framework for the protection of inland surface, transitional, coastal and groundwater, that is very important for IWRM. The EU WFD requires the identification of RB Districts (RBDs) and

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preparation RBMP for each RBD. According to the Article 3 of the EU WFD, States (in our case - Kyrgyzstan, Tajikistan, Uzbekistan) shall: a) identify the individual RBs lying within their national territories and assign them to individual RBDs (Item 1); b) ensure that RB covering the territory of more than one State is assigned to an international RBD (It. 3); c) ensure the appropriate administrative arrangements, including the identification of the competent authority, for the application of the rules of the WFD within each RBD lying within their territory (It.2); ensure that the requirements of this WFD for the achievement of the environmental objectives (It.4), and States may identify an existing national or international body as competent authority for the purpose of WFD (It.6), etc. Since independence, lawmaking in Central Asian countries has got a centrifugal force that complicated development of regional regulatory documents. Legislation needs to be unified. In particular, relevant WRM authorities in EU act within the framework of common EU legislation (Article 24 WFD). The project countries have not such legislation. National Water Agencies of Project countries could conclude Agreements on sustainable development in area of TSR basin management in the FV.

V-08

Some Practical Considerations Related to the Application of the Environmental Isotopes in Groundwater Resources Management *Bucharest Area Case - Study*

Gabriela Stănescu[1], Cătălin Stănescu[2],

ABSTRACT

Groundwater represent an important link in the world balance water consumption and has a number of advantages as to the surface one (higher quality, better protection against pollution).

This paper emphasizes the significance of the groundwater resources management in Bucharest area and reviews the environmental isotope techniques for investigations of the origin, dynamics and vulnerability to pollution of groundwater. The use of environmental isotopes reduces the time taken to determine and evaluate water resources.

Some general and concrete aspects of the theory of geological and hydrogeological of the Bucharest area based on classical methods are presented.

The isotopic study it was made, on one hand from the necessity of confirming or amend the already elaborated hydrogeological model, and on the other hand to elucidate the aspects concerning the movement of groundwater in the three layers system (named "Fratesti Aquifer") and also to see if there is a mixing of these waters with infiltrated superficial waters or surface waters.

The isotopic results interpreted in the zonal geological and hydrogeological context, confirmed the hydrogeological model already elaborated.

The novelty consists in some remarks about mixing with surface waters and demonstrates the vulnerability to pollution of groundwater.

Keywords: *groundwater resources, hydrogeological model, environmental isotopes, vulnerability to pollution.*

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V-09

Simulation Model of Global Yield Calculation of Water Supply System

Dr. Wojciech Indyk[1]

ABSTRACT

In the paper, a water supply system with many water intakes (at least two intakes with reservoirs) working for one water consumer is discussed. The key question for such a system is how much water can be taken from water resources with a desired level of time guarantee. It is suggested a simulation model which enables to calculate the maximum water yield for a consumer. In the proposed model calculation is done on the basis of historical gauge flows with a given time discretisation (decade discretisation is suggested from view point of hydrology).

Taking into account development of water consumer it is necessary to check from time to time if existing water resources will be able to fulfil future consumer's water demand. This demand is usually calculated on the basis of demographic forecasts, programmes of industry development, etc. Finally the one number represents the future water demand in an assumed time horizon (for instance 20 or 25 years). Now this number should be compared with global yield of water intakes working in the system. It means that only one number should characterize whole system in order to be able to compare this number with forecasted water demand.

As an example, the paper presents the computer simulation model of surface water supply system for Upper Silesia Region in Poland. The system, in its structure (water reservoirs, water transfers, water intakes, etc.), is one of the biggest and complicated in Poland. The structure of the system, the model assumptions, calculation method of the maximum yield of the system taking into account its time guaranty and computer application is presented.

Calculation of possibilities of water supply from many sources is needed in case of water shortage or when future water demand should be verified. In both cases the global approach to the system should be used instead of simple summarizing individual yields. Such a kind of calculation can additionally give the answer on the question: which water intake should increase existing capacity in order to fulfil future demand. It is obvious that after this kind of calculation the future on-line control of the system should be changed too. During on-line control the same algorithm as in simulation scheme should give the similar results if the future hydrology is similar to used during simulation.

Keywords: *water management, water supply system, simulation methods.*

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V-10

Water Reserves and Consumption in the Danube Lowlands

Jarmila Božíková[1]

ABSTRACT

The problems with drinking water delivery require different way of water and its sources use. The extensive approach to the water provision with required quality will have to be changed for an effective source protection and its rational use.

The paper deals with comments to the tariff, consumption, and perspective demand of drinking water policy under the reduced utilization capacity of sources, and the possibilities of the large-capacity source delivery development. Žitný ostrov could be an example of present functional and effective integrated protection - Hydraulic protection of Slovnaft groundwater.

In addition to the investment possibilities the public piping development is affected by an existence of quality water resources with a sufficient capacity. It is estimated that the new water companies, which arose after a transformation of state companies Waterworks and Sewage, will have to invest in this field 100 up to 130 bil. Sk within the next 15 years. Groundwater resources capacity used for the public piping reaches about 28 000 $l.s^{-1}$. With respect to saving and an economic recession actual exploitation is cca 14 000 $l.s^{-1}$.

From the sources of Žitný ostrov is exploited at present 2 415 $l.s^{-1}$, of that 1 234 $l.s^{-1}$ for water piping. Number of inhabitants supplied from this system is 425 000.

Bearing in mind a development of the water quality it is necessary to protect the sources of Žitný ostrov more effectively.

A conception of the groundwater protection in the upper part of Žitný ostrov against oil pollutions (OP) from a refinery complex Slovnaft by a hydraulic method was designed in 1972 in a connection with the oil pollution in the area of the II. Water source at Podunajské Biskupice. The system of SHGP vas selected from multiple alternatives of the groundwater protection namely because of its dynamic protection method.

Data from a measuring oh the pumping and monitoring drill holes serve for a documentation of functions and for an operative management of the SHGP system. A substantial part of the system control is a long term monitoring of the groundwater quality. An operation and a 100% protective efficiency of the SHGP system are controlled regularly by Slovak environmental inspection.

SHGP is an example of functional and effective integrated water prevention against OP from Slovnaft inc. at the upper Žitný ostrov.

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V-11

Water Management in the Medzibodrožie (Bodrogköz) Cross-Border River Basin Region - Case Study

Andrej Šoltész et al[1]

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ABSTRACT

Presented project was elaborated in frame of the INTERREG IIIA Initiative between the Hungarian and Slovak Republic. It was concentrated on the region among the Latorica River from the North, the Tisa River from the South, Bodrog River from the West and the Slovak-Ukraine border from the East (Fig.1). The confluence point of the Tisa and Bodrog rivers is the famous town Tokaj. The initiative came out from the Water Board enterprises in both countries – in Hungary as well as in Slovakia. The main reason for the project proposal was that in this region five flowing rivers were "alive" in this region fifty years ago. Except of the above mentioned Latorica, Bodrog and Tisa rivers there were another two rivers – Tice and Krčava - which were due to water management measures in the years 1946-64 more or less dried out. The reason for that is very simple – it was the construction of protection dykes on the Latorica and Tisa rivers and the consequent groundwater level decrease in the region between these two rivers due to decreased recharge of groundwater from surface flows. The goal of the project is the feasibility study of possibilities and design of possible technical measures for revitalisation of Tice and Krčava rivers [4].

Due to research work the Slovak University of Technology in Bratislava, Water Research Institute as well as Institute of Hydrology of Academy of Sciences has been involved into the project. After several discussions and consultations Ekövizig (North-Eastern Direction on Water and Environmental Issues in the River Basin in Miskolc) as the principal project proposer has been established – on the Hungarian side and the Slovak University of Technology in Bratislava on the other side.

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V-12

Technical and Economical Assessment of Small Hydro Power Plants in Market Conditions of Slovak Republic

Michaela Macková[1], Ján Rumann[1]

ABSTRACT

Slovak Republic, as a member of European Union, is bound to increase the amount of electricity production from renewable energy sources according to programme of increasing of utilization of renewable energy sources. Small hydropower plants (SHPP) are a renewable source of electrical energy. The construction of SHPP is mostly depends on investments from private sector. Thus not only the technical or ecological aspects of their operation are important, but also the economic effectivity of SHPP in form of fast return of investments. Methodology of technical and economical assessment of SHPP is based on the project of the particular SHPP (technical solution of SHPP, planned investments, hydropower computations with determination of amount of produced electrical energy, estimation of financial incomes of SHPP, estimation of other economic parameters). Appropriate attention to estimation of these input parameters for the technical and economical assessment must be paid, as well as to their actualizing according to the length of project preparation. This methodology of technical and economical assessment of SHPP in present market conditions contributes to development of SHPP in Slovak Republic.

Keywords: *Small hydropower plant, hydropower potential, economical effectivity*

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V-13

National Project of Irrigation and Management of Agricultural Land and Water in the Republic of Croatia

Davor Romić[1], Josip Marušić[2]

ABSTRACT

The National Project of Irrigation and Soil and Water Management (NAPNAV) accepted by the Government of the Republic of Croatia is a constituent part of a long term development programme of Croatian water management and agriculture. The National Project was created by Croatian scientists and experts applying other countries' experience with long tradition of irrigation system construction and use. On the basis of systematised and analysed natural water and soil potentials and defined relevant criteria implying current methods a chart of irrigation priority areas for Croatia was developed. An integral part of NAPNAV's elaboration was an illustration of existing condition in agriculture with a review of vegetal crops with and without irrigation system. The vital importance and the need for implementation of drainage systems were emphasised, along with their upgrading to design and performance level. The regular maintenance and growing, i.e. enlargement of agricultural lots is included here as well. This is a pre-requisite of rational functioning and irrigation system usage which can influence modifications in agricultural production's structure and for the production of high and stable vegetal crops. The nomination, evaluation and monitoring of *NAPNAV with description of activities, operations and obligations in the process of irrigation system development and usage were proposed as well.*

Keywords: *project, irrigation, management, soil, water, usage, crops, vegetal culture*

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V-17

Renewable Sources of Energy – Hydro Power in Croatia

Boris Beraković[1], Željko Pavlin[2], Jelena Dasović[1], Sandro Štefanac[1]

ABSTRACT

Due to obvious environmental pollution and limited non renewable sources more intensive usage of renewable sources of energy (RES) has become indispensable lately.
In this respect, the attitude toward the construction and usage of small hydro power plants (SHPP) has been changed, especially in the European Community (White Paper for the Community Strategy and Action Plan; Brussels, 1997). Since Croatia is preparing to join the European Union, the promotion of the use of renewable energy source of small hydro power plants, as stated in the Community paper, has been intensified as well.
This paper presents in short the situation and the possibilities for building hydro power plants in Croatia focusing on SHPP. The basic problems referring to the preparation of construction and use of the water power have been pointed out. The war and some rather significant changes (1990 – 1995) caused the stagnation in the development of water power management. However, in the last 16 years there have been no significant changes felt referring to water power management. The basic barriers in the construction and usage of water energy potentials are the absence of cost-effectiveness, environmental protection demands, and spatial plan documentation. The documents of the European Community referring to the usage of renewable energy sources are focused on removing these barriers in the construction of small hydro power plants (SHPP), and one of the basic incentives is the financial support in SHPP construction. These initiatives have been accepted in Croatia, and in this year certain laws and ordinances have been passed as the basis for the expected start of SHPP construction.
Proceeding from the need and decision to use renewable energy sources, the paper points out that the incentives must encompass all water energy potentials, regardless of the construction capacity, taking into consideration the possibilities and conditions of construction and usage, as in the case of SHPP.

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V-15

Problems of Inland Navigation in Poland in View of Integrated Water Resources Management (IWRM)

Teresa M. Jarzębińska[1]

ABSTRACT

The fundamental basis of Integrated Water Resources Management (IWRM) is that all water users are independent and their requirements have to be fulfilled. Therefore it is necessary to consider the needs of various water users together. The main water users are water supply and sanitation, industry, agriculture, electric energy production, navigation and recreation. It is also necessary to take also into account flood protection, although it is not water user. Water resources management has to be a systematic process for sustainable development, allocation and water resources use in view of social, economic and environmental objectives. It is different from the sectoral approach applied in many countries. Inland navigation is a very important user of water resources in most of EU countries. In Poland the situation is completely different. In EU countries the basic idea for the development of inland transport is its small negative impact on the environment. In Poland there are no ecological mechanisms in transport.

The total length of Polish inland waterways suitable for transport of goods amounts to 3600 km, but in reality inland navigation is carried out on 1500 km only. They form the part of international network of European inland waterways. In Poland at present actual technical state of inland waterways represents parameters from Class I to III according to the international classification. This waterways are utilized for local transport only.

The idea to adjust Polish inland waterways to international parameters of navigable routs (minimum IV Class) is unrealistic, because hydrological conditions do not allow to achieve appropriate navigation parameters, even with important investments.

Present situation of Polish inland waterways has numerous barriers for development. In this paper most important problems of inland waterways in Poland will be presented especially in view of IWRM.

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V-16

Water Management and Flood Control in Croatia

Danko Biondić[1] , Darko Barbalić[1] , Josip Petraš[2]

ABSTRACT

The paper describe the condition of water management and flood control in Croatia. The continental area of the Republic of Croatia covers 56.538 km^2, with 35.131 km^2 (62 %) belonging to the Danube River Basin, and 21.407 km^2 (38 %) to the Adriatic Sea Basins. The part of the Danube River Basin in Croatia comprises only about 4,3 % of the whole Danube River Basin area. It consists of parts of the Sava River Basin (25.769 km^2 or 74 %), the Drava River Basin (7.149 km^2 or 20 %) and the Danube River Basin without the Sava and Drava Basins (2.213 km^2 or 6 %). According to the 2001 data, a total of 3.045.829 inhabitants or about 69 % of whole Croatian population live on the Danube River Basin and the rest pertains to the Adriatic Sea Basins.

The major part of state borders either follow the courses of rivers, or are located in the middle of channels of the major rivers (the Sava, Drava, Danube, Kupa, Mura, Una, Neretva), and all the major rivers either have a spring, or flow away - or both - outside of the borders of Croatia, with the exception of the Kupa river.

For the water management's purpose the surface water resources fall into waters of state importance and local waters (waters of local importance) in Croatia. The system of state waters consists of 41 interstate (international) courses, 25 rivers running entirely across the Croatian territory, 15 open canals, 6 natural lakes, 34 accumulations and *detention basins*, 10 tunnels for karst fields' drainage, and 11 torrential watercourses of state importance.

The total length of state watercourses' network covers 3.935 km, and the total length of local watercourses 17.000 km. They comprise 945 registered torrential watercourses with total length of cca 7.500 km as well, with only 1037 km or around 14% trained ones.

The systems for flood protection and drainage on state watercourses have been completely constructed on 37% and partially on 42% areas, whereas such systems on local watercourses exist on only 20% of endangered areas.

2415 km of dikes have been constructed along state watercourses, and 1642 km along local watercourses. In addition to dikes, the flood protection system encompasses 58 multipurpose accumulations with total volume of 1057 million m3, 43 detention basins with the total volume of 23 million m3, and 5 large lowland retention basins with the volume of 1590 million m3 have been partially constructed within the complex flood control system in the area of Srednje Posavlje (*Middle Sava Basin*)**.**

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