XXIVth CONFERENCE
OF THE DANUBIAN COUNTRIES

ON THE HYDROLOGICAL FORECASTING
AND HYDROLOGICAL BASES OF WATER MANAGEMENT

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Mitja Brilly and Mojca Šraj

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ON THE HYDROLOGICAL FORECASTING AND HYDROLOGICAL BASES OF WATER MANAGEMENT

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CONFERENCE TOPICS

1. Hydrological forecasting

• Real-time informational forecasting systems
• Models for rainfall-runoff processes
• Other hydrological forecast models

2. Hydro-meteorological extremes, floods and droughts

• Meteorological data and hydrological modeling
• Long-term statistical methods
• Examples of extreme flood and drought events

3. Global climate change and hydrological processes

• Climate change impact on the hydrological cycle
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• Ecological aspects of hydrological changes
• Adaptation strategies in water management

4. Water management

• Consequences of the EU Water Framework Directive and the EU flood directive
• Water framework directive and integrated water quality processes
• Exchange of hydrological products, methods and models
• Legal and administrative challenges for integrated water management

5. Floods, morphological processes, erosion, sediment transport and sedimentation

• Monitoring of watershed and river bed/reservoir erosion and sedimentation
• Models of erosion and sediment transport
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FOREWORD

The IHP Conference of the Danube Countries has had a long history since its first meeting in 1961 in Budapest. The conference took place even before the International Hydrological Decade was proclaimed (1965–1975), a 10-year program that provided an important impetus to international collaboration in hydrology, and before the International Hydrological Programme of UNESCO was established. Later the Conferences sustainably supported the implementations of IHP programmes, as hopefully this conference will do, too. At the moment we are in a transitional period: the Sixth phase of IHP (2002–2007) entitled "Water interactions: Systems at Risk and Social Challenges" ended, and the Seventh Phase of IHP (2008–2013) "Water dependencies: Systems under stress and societal responses" has commenced.

The XXIV Conference of Danubian Countries is taking place between 2–4 June 2008, in Bled, Slovenia, under the auspices of the President of the Republic of Slovenia. It has been organised jointly by the IHP Committee of Slovenia, Slovene National Commission for UNESCO and the Environmental Agency of the Republic of Slovenia, under the support of UNESCO, WMO and IAHS. It brings together more than 250 participants from 22 countries from the Danube River Basin and outside Europe also.

The themes of the conference are:

1. Hydrological forecasting
2. Hydro-meteorological extremes, floods and droughts
3. Global climate change and hydrological processes
4. Water management
5. Floods, morphological processes, erosion, sediment transport and sedimentation
6. Developments in hydrology

The total number of contributions entered was 211, out of which 80 are presented orally. The highest number of presentations covered Topic 2: Hydrometeorological extremes. The extended abstracts are printed in this proceeding, while the full papers are published on the CD attached.

The results of the conference, achieved through the presentations and participation in plenary and parallel sessions, are partly summarized in the present proceedings. We hope that they will have stimulated further research and debate on the topics of hydrology.

We are proud to welcome you at the XXIV Conference of Danubian Countries on the hydrological forecasting and hydrological bases of water management!

Mitja Brilly, PhD
Chairman of
Slovenian National Committee IHP

Topic 1: HYDROLOGICAL FORECASTING

IMPLEMENTATION OF THE DISTRIBUTED RAINFALL-RUNOFF MODEL TOPKAPI-UCEWP INTO REAL-TIME FLOOD FORECASTING SYSTEM IN UKRAINIAN PART OF TISZA RIVER BASIN

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Paper introduces the overview of rainfall-runoff TOPKAPI-UCEWP model, results of modeling and forecasting issues and overview of developed real-time forecasting system.

Ukrainian part of Tisza river basin is located in the mountainous zones of the Ukrainian Carpathians. The intensity of rainfall can be extremely high, and the resulting high rates of runoff from the catchments (flash floods). This type of flooding frequently reaches disastrous proportions, resulting in ever-increasing property damage and social disruption.

Nowadays Ukrainian Center of Hydrometeorology mainly uses the conceptual box models with the lumped Rainfall-Runoff parameters of regional type for hydrological and floods forecasting. Also two years ago automatic flood forecasting system based on implementation of MIKE11 (DHI) hydrological system in couple with MM5 weather forecasting model was established for Transcarpathian region of Ukraine. But there are some difficulties for proper use of MIKE11 models, among them are lack of the observed data for proper rainfall-runoff models calibrations and as result some of subbasins of Tisza river were not covered by conceptual lumped NAM models (DHI).

Ukrainian Center of Environmental and Water Projects in cooperation with specialists of Ukrainian State Center of Hydrometeorology decided to implement modern distributed rainfall-runoff model approach for Transcarpathian region for hydrological forecasting and to develop the real-time hydrological forecasting system with coupling of numerical weather forecasting model MM5. As a basis for hydrological model was chosen the GIS-based fully distributed rainfall-runoff model TOPKAPI – UCEWP.

The TOPKAPI-UCEWP model was created based on the TOPKAPI model equations (E. Todini, Bologna University), which include description of soil infiltration, overland and channel flow processes. Also snowmelting and evaporation modules were developed. Previously the model was successfully applied to several catchments in Transcarpathian region of Ukraine. The model is derived upon the assumption that the horizontal flow at a point in the soil and over the surface can be approximated by means of a kinematic wave model. The point assumption is then integrated up to a finite pixel dimension, thus converting the original differential equation into a non-linear reservoir equation based upon physically meaningful parameters, which solution can be found numerically. The catchment behavior is finally obtained by aggregating the non-linear reservoirs into three cascades, representing the soil, the surface and the drainage network, following the topographic and geomorphologic elements of the catchment. The main advantage of this approach lies in the possibility of deriving the model structure and the parameters on the basis of digital elevation maps, soil maps, land use maps etc. and in its capability of being applied at increasing spatial scales without loosing model and parameters physical interpretation. These properties make the model suitable for real-time forecasting, for land-use and climatic change impact assessment; for extreme value analysis, given the possibility of its extension to ungauged catchments.

Real-time hydrological forecasting system was developed on Java platform using object oriented programming methodology not only for the graphical user interfaces but also for the numerical code, provides the user with high computational speed and robustness. For system setup all subbasins of Ukrainian part of Tisza river were covered by TOPKAPI-UCEWP model. System includes all necessary functionalities such as user interface, representation of modeling results and GIS data of region, connection with database of hydrological and meteorological data, etc. and covers Ukrainian Tisza river basin.

OPERATIVE HYDROLOGICAL FORECASTS FOR MAINTENANCE OF SUSTAINABLE FUNCTIONING OF CASCADES RESERVOIRS ON THE RIVERS OF UKRAINE

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There are two cascades of large reservoirs, which have complex function in Ukraine - on the rivers Dnipro and Dnister. Dnipro within the limits of Ukraine represents the cascade of 6 reservoirs with the total volume 43 cubic kilometers of water. Their water storage are used for generation of the hydroelectric power, are the main source of drinking and industrial water supply of the most part of Ukraine, an irrigation of the grounds in the center, in the south and the east of the country through system of special channels. On the middle flow of Dnister the cascade of two reservoirs intended first of all for regulation of floods is created.

Operating modes of cascades of reservoirs are developed by the special Interdepartmental commission taking into account a water-economic situation and possible development of water content of the basic rivers forming inflow of water to cascades. The Commission makes of the decision concerning the sizes and intensity of depletion and charging of reservoirs, establishes restrictions of discharge water and fluctuations of levels by ecological criteria; implements and supervises the order of the passing through the cascade of floods for prevention of undesirable floodings, etc. The Commission establishes the order of preparation and to realization artificial waters flow from Dnister's reservoir for maintenance of ecological equilibrium in Dnister's estuary and Dnipro's coastal lake.

To settle a functioning of water-economic complexes of Ukraine the Hydrological forecasts service in Ukraine provides the Commission and economical organization with operative hydrological forecasts of water inflow to reservoir on close and farther prospect - from 1 day till 90 days. These are forecasts of inflow for day, decade, month, quarter and the period of a spring flood. Long-term experience testifies to advantages of use of monthly and seasonal inflow forecasts by development of operating modes of reservoirs in comparison with the climatic long-term or provided sizes.

For forecasting of water inflow to reservoir the Ukrainian Hydrological forecasts service uses mainly conceptual box models with the concentrated Rainfall-Runoff parameters and models of transformation of water mass. Results of the forecast are one of components of the automated control system of water resources of Dnipro and Dnister which are used by water management organizations for calculations of an operating mode of reservoirs cascades.

Forecasts have special importance at floods formation or spring floods of rare frequency. The sufficient earliness and accuracy of hydrological forecasts of inflow during high and very floods on Dnipro in 1979, 1994, 2004 has allowed to pass them through all Dnipro's cascade with the minimal damages and in the most optimal mode. Formation of high (with frequency about 5-10%) rain floods in June 1998, September, 2007 on Dnister has been predicted not less than for 2 day. It has allowed to prepare in due time free capacity of the basic Dnister's reservoir, to reduce possible maximal charges on downflow of Dnister almost twice and to prevent floodings of territories in Moldova and Ukraine.

INPUT PREPARATION FOR DISTRIBUTIVE HYDROLOGICAL MODEL DATABASE APPLICATION SOMDATA

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Forecasting flood service of the Czech Hydrometeorological Institute has as its task to distribute the hydrological forecasts for the selected profiles with catchment area of several hundreds to thousands of km2. The distributive rainfall-runoff model HYDROG (Starý, 1991-2007) is used for this purpose for the Morava and Odra catchments. With the support of the feasibility study GAČR 205/06/1037 – Geoinformation technology utilization for the improvement of the rainfall-runoff relations the questions linked with the input data preparation for the above mentioned hydrological model were solved. The database application SOMDATA will be the result. The paper deals with its basics and functions.

The distributive rainfall-runoff models are able to involve both temporal and spatial distribution of the input data (i.e. precipitation, temperatures and snow cover). The exact input data are the fundamental term for the succesfull simulation and consequently the discharge forecast in the given catchment. There are always some errors of the measurements. These errors must be taken into account in the model calculation. The other requierement is to keep the input data transparency so that it would be possible to edit it where appropriate (e.g. at the underestimating of snow stores in the catchments based on measurement).

For the above mentioned reason the catchments of interests are devided into subareas (polygons) – in the mountain areas the maximum polygon area is dozens of km2, in lowlands it is possible to thing of larger ones. The input quantity is than considered as the mean value.. The time step of the input data is one hour.

The input data are automatically prepared by means of GIS. The measured precipitation are combined with radar data estimation in more variations (Šálek et al.,2004), temperatures and snow cover are area interpolated following the point measurements, whereas altitude dependence is taken into account. The forecasting values are considered according the outputs from various NWP models (e.g. ALADIN, ECMWF etc.), in some case the corrections are curried out based on the consultation with meteorologist. For the first three hours of the precipitation forecast nowcasting by the method COTREC (Novák, 2007) is used.

All the data are automatically louded to the Oracle database (CLIDATA). Moreover the system processes the point input data (waterstages of the gauging station and waterstages from the waterworks). By the help of the SOMDATA application the logic data check runs and the selected combinations of the input measured and forecasted data for the various basins are assembled so that the hydrologist gets on the basis of the model simulation the consistent information about the possible progress of the flood event. Because during the flood the hydrological forecasts must be updating most frequently, the input data files are compiled in the selected form automatically every hour.

Keywords: forecasting flood service, distributive rainfall-runoff model, precipitation, input data, basin.

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UPGRADING OF EXCHANGE AND PRESENTATION OF HYDROLOGICAL DATA AND INFORMATION ON SAVA RIVER BASIN

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Current system of hydrological data exchange in the real-time on Danube river basin is executing between competent hydrological services in accordance with “Recommendation from Danube Commission of providing navigation on Danube river with hydrometeorological information”, using Global Telecommunication System - GTS-a channels and HYDRA and HYFOR codes. In this system, data from hydrological station on the main Danube course and its direct tributaries are comprised. Existing way of data exchange is not transparent, which impose up –to-date monitoring of hydrological regime on bigger international rivers. Starting from that, in this paper, proposal of hydrological and meteorological data exchange and presentation are given based on web technologies for Sava river basin, which is one of the most important Danube tributaries. At the moment, national hydrometeorological services in Sava river basin, exchange their data for certain number of stations using GTS, while important part of their data is published on internet presentations. There is no existing internet presentation with available hydrometeorological data from Sava river basin.
The main purpose is to create public accessible internet presentation - portal (one – stop – shop), where all available hydrological and meteorological data, forecasts, products and information will be present as well as links to relevant institutions responsible for monitoring of changing of hydrological and meteorological regime in Sava river basin.
Hydrological data and information will be taking over from GTS and internet presentations. Then, data will be stored in the database as foundation for data presentation, selection and download. Presentation of data will be tabular and graphical. Data selection will be enable on different criteria. Data downloading will be enable in few formats: TXT files, XLS (Excel) files, XML (RSS 2.0 and Atom 1.0) and without payment. On the basis of customer and public reactions, expanding of the system is planed. System will be based on Open Source technologies (Apache – web server), MySQL database and PHP programming language. This internet presentation will be placed on existing web server in Republic Hydrometeorological Service of Serbia and existing information and communication infrastructure will be used.

Keywords: Sava basin, hydrological and meteorological data management, web technologies, internet portal.

MODELS OF RAPID RUNOFF GENERATION IN MOUNTAINOUS CATCHMENTS

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Field measurements of runoff generation in small mountainous catchments indicate more rapid water transport in the soil cover than the theory based on Richards' equation would suggest. The storm runoff generation in a small catchment is characterized by three effects: (1) The rising hydrograph limb grows very quickly and its duration is short – a few minutes or hours. (2) The falling hydrograph limb lasts for many days or weeks. (3) The greatest value of the soil water content is reached as a rule before the rain ends. It was found that the soil water flow instabilities significantly affect runoff formation in the catchment scale and transport of contaminants in the soil cover. In-situ observed flow instabilities in mountainous soils gave an impulse to the extensive investigation of runoff formation.

In order to elucidate this rapid transport of the soil water, computer simulations of gravity driven flow will be performed on three levels. The approach based on continuum mechanics can be characterized as a macroscopic level. The corresponding Richards' equation will be solved numerically. On the microscopic level, an approach via lattice-gas automata will be used. The lattice-gas model offers a simplified microscopic description of the flow. Hydrodynamic conductivity, retention curve and other macroscopic characteristics are then emergent properties of the model. An interesting insight into the inlet-outlet relation can be obtained through computer simulations on regular two- and three-dimensional graphs (networks). Various hypotheses concerning the stability/instability of the water distribution in a porous structure can be tested by numerical experiments having no a priori limitation. Moreover, for regular networks, exact mathematical results of the percolation theory can be used. This approach considers the porous structure of the medium but its basic object is the porous structure as a whole. That is why it can be characterized as an intermediate or mesoscopic one. The mesoscopic approach is able to retain the emergent properties of the microscopic one but in some cases it appears to work more efficiently.

Data measured in three mountainous and submontane catchments will be used for simulation modelling: (1) The Liz catchment in the Šumava Mts. (SW part of the Bohemia), (2) the Halenkovice catchment in Chřiby (central part of Moravia), (3) the Modrý Důl catchment in the Krkonoše Mts. (NE part of the Bohemia). The above-mentioned catchments are equipped with automatic monitoring stations for the continuous measurements of air and soil temperatures, suction pressures in the soil (water tensiometers), and precipitation amount and intensity. Discharge is measured in the closing profile of each catchment.

ESTIMATION SNOW RESERVES IN THE UKRAINIAN CARPATHIANS

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The estimation of snow reserves is the great importance at hydrological and avalanches calculations, at designing and construction of constructions (for definition of loadings on constructions), at a tentative estimation of conditions of a winter recreation, etc.
In connection with growth of water consumption and development of mountain territories there is a necessity of increase of accuracy of an estimation of water resources, including snow reserves which share makes up to 40 % of all deposits. And studying of its stocks becomes complicated significant variability of its characteristics as during the winter periods, and year by year.
Average values of the maximal stocks of water in a snow for the Ukrainian Carpathians have been received up to height of 1750 m. the area of territory with higher marks is insignificant, small and if necessary snow reserves on it is possible to define by extrapolation of the revealed dependence up to the uppermost high-altitude zones. Thus, by means of schedules of communication of averages long-term maximal snow reserves with absolute height in various pools there was possible a definition of these sizes for any high-altitude zone.
Obtained data allowed constructing detailed maps of average maximal snow reserves for territory of the Ukrainian Carpathians.
Data about date's maximal snow reserves are similarly processed and generalized. As dates maximal snow reserves a steady snow cover less able for changing on territory, than snow reserves, dependences of such dates on height of district were under construction but for separate pools, and as a whole for territory of the Ukrainian Carpathians.
On the basis of actual and settlement datas the map of dates maximal snow reserves (fig. 2) by means of which definition of optimum terms of carrying out snow shootings for the forecast of a spring drain for each concrete reservoir is possible has been constructed. Isolines on a map are lead with the step equal to 10 days.

Keywords: snow reserves, snow shootings, snow measurement.

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OPERATIONAL FLOOD FORECAST IN BAVARIA

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Structure and organisation of the Bavarian flood information service is introduced with focus on operational flood forecast. Five flood forecast centres corresponding to the main river basins (Main, Danube, Inn) and tributary basins where large reservoirs have to be operated (Iller-Lech, Isar) are responsible for operational flood forecast. They closely co-operate with the flood information centre and the state offices for water management. During the last eight years a meteorological and hydrological information system and database with an automated data communication system has been built up. Mainly numerical weather forecasts of the German weather service are used. Latest product is the short-term precipitation forecast using the results of online-adjusted radar. Development of snow cover and the total water release from snowmelt and rainfall is pre-processed by the results of the SNOW3-model. For large parts of Bavaria flood forecast models of modular structure have been developed, verified and adopted. The hydrodynamic models WAVOS (Danube and Main) and FLORIS 2000 (Lech, Inn and Danube) are in operation. For the tributaries rainfall–runoff models based on the program LARSIM are implemented. They are grid or sub-basin oriented. Future developments comprise the determination and illustration of the uncertainty related to the flood forecast.

Keywords: flood forecast Bavaria, flood information system, rainfall-runoff model, Danube river, Main river.

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OPERATIONAL EVENT BASED FLOOD FORECASTING WITH EMPHASIZE ON THE ESTIMATION OF THE INITIAL STATE CONDITIONS

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For the Austrian province of Lower Austria an operational flood forecasting system for small basins was developed (Holzmann & Lehmann, 2008). The basin areas vary between 50 and 300 km2 where some provide online data of discharge operationally. The main expectations from the forecast system are (a) a reliable forecast of peak discharge and peak occurrence time, (b) the provision of the shape of the hydrograph and (c) a simple approach to facilitate easy data handling and parameterisation. In a pre-feasibility study two methods based on statistical approach (multiple regression analysis) and on an advanced unit hydrograph concept were tested. The latter (UH concept) was installed for the operational system.
The unit hydrograph describes a transfer function between the unit rainfall and the responding runoff (see Holzmann & Nachtnebel, 2002). The shape of it is generally estimated from observed rainfall and discharge data and is generally considered constant for a basin. In our case we related the shape of the ascending limb of a triangular unit hydrograph to the time of concentration, which can be estimated by means of a digital elevation model (DEM). The length of the descending limb was dynamically defined and related to basin and event characteristics like area, rainfall intensities and depths, seasonal occurrence and antecedent rain index. It is sequently adapted to changing state conditions during an operational event.
For event based modelling also the estimation of the initial rainfall losses and the rainfall excess is of primary importance. A variable runoff coefficient concept was applied, where the runoff excess increases with the accumulated event rainfall. The parameters are the initial loss and the slope and threshold value of the variable runoff coefficient function. The operational estimation of the loss parameters are related to state parameters like the antecedent rain index at the beginning and at the end of the rainfall event, the rainfall intensity and the time of the year by means of a multiple regression relation.
For the operational use the input data are based on quantitative precipitation forecasts. These data consider forecasts of European weather models and radar patterns of the presence (see Haiden et al., 2007). The actual state conditions like antecedent rain index are estimated by means of the rainfall forecasts. The model performance rely very much on the reliability of the rainfall input. The quantitative data are provided as ensemble forecasts, which vary the quantities of the model input and the derived data like the state conditions.

Keywords: flood forecasting, precipitation forecasting, unit hydrograph, variable rainfall excess.

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ON THE REGIME OF EVAPORATION FOR THE BULGARIAN PART OF DANUBE RIVER

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The water resources planning, management for water supply and irrigation of agricultural areas required mathematical models for simulation the evaporation processes.
Many of the methods for estimation of evaporation need data for potential evapotranspiraion. For future sustainable development and water management of the Bulgarian area of Danube river the information for potential (PET) and actual (ET) evapotranspiration is of big importance. In the presented paper PET and ET are obtained using different methods for calculation such as Thornthwaite, Eagleman and Turc. Monthly data for temperature, humidity and wind speed, from 6 main Bulgarian meteorological stations situated along the Danube coast are used. The early course and seasonality of evaporation are analysed.

ONLINE UPDATING PROCEDURES FOR A REAL-TIME HYDROLOGICAL FORECASTING SYSTEM

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Rainfall-runoff-models can explain major parts of natural runoff pattern but never simulate the observed hydrograph exactly. Reasons are various sources of uncertainties embedded in the model forecasting system. Errors are due to measurement errors, the selected time period for calibration and validation, the parametric uncertainty and the model imprecision. In on-line forecasting systems forecasted input data is used which additionally generates a major uncertainty for the hydrological forecasting system. To compensate partially these uncertainties different techniques are investigated in a medium sized study basin. The catchment is located in the Austrian part of the Danube basin. The catchment area is about 1000 km². The forecasting system consists of a semi-distributed continuous rainfall-runoff model that uses quantitative precipitation and temperature forecasts. To provide adequate system states at the beginning of the forecasting period continuous simulation is required, especially in winter. It is of specific importance in alpine regions, where snow melt is a major source of flood events. System states are an important input for a continuous rainfall-runoff-model and contribute a lot to forecasted hydrographs. Although optimized system states give a better fitting it is not assured that the forecast connects directly to the observed hydrograph. For a proper visualisation, e.g. for publishing forecasts, still an output correction is needed.
Two different online updating methods are used and combined for enhancing the runoff forecast. The first method is used for updating the system states at the beginning of the forecasting period. This method changes the precipitation input observed in the last few days to improve the fitting of simulated and observed hydrographs. The target is not the corrected precipitation input but to modify the state of the system. The spatially distributed rainfall field is transformed by a spatially linearly varying correction factor. The parameters of this linear function are obtained by minimizing the differences between simulated and observed runoff at the different gauging stations in the catchment.
The second method is an output correction which is applied during the forecasting period. In case of a forecast run no direct comparison to measured runoff is possible. That for an autoregressive error model is used to correct the forecasted hydrograph by analysing the differences between simulated discharges and incoming observations at the gauging stations from the last few time steps. The AR(1)-Filter eliminates systematic errors and gives better forecasts. Especially in the first few hours of the forecast this method works well. The results can be substantially improved by varying the autoregressive parameter with the amplitude of discharge. In low and middle water situations the correlation is much higher than in cases of floods. Thus the discharges at the different gauging stations are divided into classes that have adapted correlation factors for different discharge situations.
Results from testing both methods show good results and improve the efficiency of the forecasts significant. In combination these two methods work together well as each method is more effective in different runoff situations. It also shows the need for multiple updating since one method cannot deal with all sources of errors.

Keywords: hydrological forecasting, updating, rainfall-runoff modelling.

USING NEURAL NETWORK MODELS TO FORECAST THE INFLOW OF DOROUDZAN DAM – IRAN

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One of the methods to have optimum exploitation of the water resources is forecasting the amount of available water in these resources. Doroudzan dam with 993 MCM reservoir capacity which is located in a dry area in south of Iran is a great water resource in region to use for irrigation, industry and generation hydroelectric power. Saving water in the reservoir to have the best use of it is a priority. In case of good forecast of inflow to the reservoir, discharging water through spillway could be minimized by an appropriate schematization of outflows and amount of excess water could be conducted to generate electricity. For this purpose 3 neural network models were created to forecast the amount of seasonal inflow, monthly inflow and weekly inflow to the reservoir. In seasonal model the data of last year rainfall, cumulative rainfall until last season, atmospheric forecast for specific duration and the amount of inflow in last season and last year were used. In monthly model neural network model the seasonal forecast, last year inflow amount and the cumulative inflow amount until last month were used. In weekly model, out puts of monthly model, the inflow in up stream branches, cumulative rainfall in the year till last week, last week rainfall and the inflow rate in last week were used. The models was used for simulation of the reservoir during 2000-2005 and during this years 500 MCM was saved in the reservoir and used to generate more electricity.

CALIBRATION TECHNIQUES USED FOR HBV HYDROLOGICAL MODEL IN SAVINJA CATCHMENT

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The catchment of Savinja river is mountainous and its discharge is characterized by frequent flash floods which are caused by intensive precipitation. For calibration purposes we used three different techniques: downhill simplex, scuffled complex algorithm and particle swarm optimization. Those techniques were used to calibrate the soil routine of the conceptual HBV rainfall-runoff model, which was developed by Swedish Meteorological and Hydrological Institute. The HBV model was calibrated on hourly time step in the upper catchment of Savinja river, with the basin area of about 460 km2.The optimization techniques were used to find such sets of model parameters that the simulated discharge is as close as possible to the measured one. The Nash-Sutcliff criterion was used to estimate how close the time series of the measured and simulated discharge are. The optimization techniques were compared as if they are able to find the best parameters as well as the number of model runs they require before they converge.

The calibration of the hydrological model is expensive problem in the scope of computer time needed. Since the parameters are related to each other, the problem cannot be split by finding each of the parameter independently. If the N is the number of parameters that need to be calibrated (usually in the order of 20), the calibration procedure has to find the minimum of the cost function in N dimensional space spanned by the parameters. Above all, the cost function can be non-continuous and can have local minima. Therefore, the optimal calibration must be robust, effective and have a global overview of the problem not to be fooled by the local minima.

Three different calibration techniques were used to calibrate soil routine of the HBV model on a relatively small Savinja river catchment. The simplest technique, SIMPLEX was the fastest in finding the parameters which produce the highest NASH score, however it was not able to distinguish between the local and global maxima of the NASH score. This method could be useful, is the starting parameters are close enough to the real best parameters. The other two methods, SCA and PSO, are able to find the global maxima, and are thus more appropriate for calibration. However, these two methods are more time consuming in the means of iterations before the equilibrium is reached.

Keywords: rainfall runoff model, optimization, downhill simplex, scuffled complex algorithm, particle swarm optimization.

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THE ASSESSMENT OF EVAPOTRANSPIRATION AND SOIL WATER CONTENT IN THE KYSUCA RIVER BASIN (SLOVAKIA) USING RAINFALL-RUNOFF MODEL

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Rainfall-runoff modelling is a commonly used tool for analysis of various aspects in hydrological research. An application of the distributed hydrological model brings the benefits of assessment of the spatial distributed results. However, a huge amount of data is required in this modelling approach. Primarily description of the spatial distribution of soil and vegetation types is an essential task and substantially influences a resulting accuracy. The Kysuca river basin has been chosen for an evaluation of soil water content and evapotranspiration by a distributed hydrological model SWIM (Soil and Water Integrated Model). The basin is located in north-western Slovakia and covers area of 1016 km2. The primary interest in this analysis was motivated by assessment of relations between selected factors and forest health conditions in the area and finding possible causes of forest deterioration.
Evapotranspiration and soil water content in two selected soil layers in each hydrotop have been evaluated in simulation period 1995 – 1999. The set of the maps each representing an individual day of simulation period has been obtained as a result of the simulation for each variable mentioned above. The results were statistically processed and compared to the available observed data. The evapotranspiration generally correspond to Tomlain (2003), who states that the annual average evapotranspiration in the region of north-western Slovakia varies from less than 400 mm up to more than 450 mm.
The plausibility of the model SWIM was proved by the simulation of discharge at the outlet. It could be assumed that other simulated variables, soil water content and evapotranspiration in this study, are satisfactory computed, too. This assumption is supported by establishing of expected relations between evapotranspiration and land cover. Nevertheless, exact accuracy of the model will be tested after getting data of the year 2007. The comparison the soil water data which have being measured in eight selected localities recently to the data obtained by simulations in the matching hydrotops will be carried out. This task is one of the main aims of the further research.

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Keywords: hydrologic modelling, soil water content, evapotranspiration, SWIM model.

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DEALING WITH UNCERTAINTY OF HYDROLOGICAL FORECASTS IN THE BAVARIAN DANUBE CATCHMENT

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Hydrological forecasts have become an important part of the flood warning scheme, since they are calculated for all river basins in the Bavarian Danube Catchment. Experiences with published forecasts during former flood events have shown the need for communicating the uncertainties associated with these forecasts to the civil protection and the public. Therefore methods for quantifying and representing these uncertainties have been developed and incorporated in the flood warning routine. The total uncertainty is represented by the 10% and 90% exceedance probabilities published together with the normal deterministic forecast via internet.
In operational flood forecasting a broad variety of different sources of uncertainty has to be considered. Errors are mostly due to the uncertainty and errors in input data, the simplification of the natural rainfall-runoff processes within the hydrological model and suboptimally calibrated model parameters.
Up-to-now the total uncertainty is estimated for each gauge by a statistical analysis of observed errors in archived runoff forecasts of the past. The resulting relative deviation is then offset against the ongoing runoff forecast. A newly developed approach varies the dominant factors of uncertainty like the meteorological forecast in headwaters by including forecast ensemble. The rest of the factors are represented by a static uncertainty measure derived from offline analysis und combined with the former.
For communicating the uncertainty of hydrological forecasts a simple and intuitive graph design has to be chosen for the public internet presence. More detailed information on different exceedance probabilities is published for e.g. the decision makers within the water management authority.

Keywords: flood forecast, uncertainty, rainfall-runoff simulation, ensemble, flood warning, Bavarian Danube Catchment.

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LOCAL WARNING SYSTEMS IN SLOVAKIA

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Two pilot local warning systems, based on the information from terrestrial stations, have been established within the POVAPSYS project in Slovakia. Upon the continuous monitoring of changes in precipitation activity development and state of the respective water flow level, the local warning system will transmit warning messages in case of exceeding the advanced setting limits. These messages are intended to a special group of authorized people. The early sending of the warning messages to competent authorities forms condition for initiation of securing and rescue works in terms of the Municipal Flood Plan and other related directives, which result from the Flood-Protection Act No. 666/2004 Coll. of Laws of the Slovak Republic.

The terrestrial stations are established after exhaustive terrain research, analysis of previous flood situations, and information from local inhabitants. Localized terrestrial monitoring stations constantly record data from raingauge sensor and water level sensor into a local memory of a monitoring unit and these data are continuously evaluated. In case the previously set limits are exceeded, the local station sends warning message to a central station (CS) and to a personal communication terminal (a cell phone or a pager). Responsible people can analyse the situation through the CS or by direct queries for current values on the monitoring raingauge and water level sensors through the Communication terminal KTO.

The first piloting of LWS Vrbovce was carried out in Western Slovakia in the Upper Myjava River Basin and its confluent, focusing on the GSM data transmission. The second piloting of LWS Čierny Balog, was carried out in the Upper Hron River Basin and its confluent focusing on the radio data communication. Both LWSs are run by municipalities and the SHMU has only a supervisory and advisory function. After testing and expiration of the warranty terms, the LWS will be transposed to the municipalities without payment.

In the LWS Vrbovce, which is a very good working system, we also developed public relations and prepared a flash flood practical exercise with participation of local authorities, the fire department, the river authority, the SMHU, the District and Regional Environmental Offices, i. e. all active flood units, and the non-profit organization of the Global Water Partnership.

The subject of this paper is to present our experience with the operating of the LWS, as well as other activities, like public relations, practical exercises, etc. The aim of piloting the LWS is to meet the needs of those who are interested in carrying out local warning systems (not only municipalities) and the SMHU is ready to offer expert advice and help select localities for monitoring stations, set limit values and solve other problematic situations.

Keywords: flood warning system, local authoritie.

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FORECASTING ANALYSIS OF RUNOFF FOR RESERVOIR REGULATION OF DAMS AND WEIRS IN TERMS OF HYDRO POWER PLANT OPERATION

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The present and past projects are usually based on past hydrological data. Real time forecasting involves the estimation of the magnitude of a variable at a prescribed or anticipated instant of time. For example what will be the level of flood discharge or stage in a river or reservoir after 10 hours from now or what will be the energy output of a hydro power station in a particular day or month.
This study is constructed in two parts. The first one contains an investigation of different factors affecting the runoff and in this way the useful volume of dams or weirs. The second part includes the time forecasting systems.
In the beginning the hydrometric stations are selected at the available analogy with the building project and then the correlative connection is found assessed by general and true correlative coefficients. The transferring to the project of the observations for the average annual and average monthly water discharges is made with the coefficient of analogy. The theoretical curves of probability are chosen using a minimum dispersion. By the last curves the average monthly distributions are settled with a probability from 2% to 90% by a statistical method. The control of reservoir regulation is carried out for a monitoring period of 20 to 50 years. During the investigated period of regulation the volume of discharges, overflow and shortage are calculated as well as the determination of the accepted volume of the reservoir and if the normative probability is executed. The hydro power output and its participation in the coverage of the charge diagram on the peak load, under peak load, daily and nightly part are determined in separate or forecasting years. Test examples are computed for the density and distribution functions as well as for the reservoir regulation.
Three approaches are used for efficient planning of water forecasting resources: Time Series Analysis (TSA), linear regression or auto regressive models and Artificial Neural Network (ANN). In this work two of the above mentioned methods are applied for a quantitative forecasting. The quantitative approach is useful when the information about the past is available. The following three steps are used: 3.1 Preliminary Analysis; 3.2 Choice and fit the model; 3.3 Evaluation of the forecasting. The first step can be carried out by a trend, seasonality, cycle, and random variation by means of exploratory analysis and fitting load data. Several methods are available for the realization of the second step as moving average, exponential smoothing, Holt-Winter linear algorithm, regression, autoregressive moving average (ARMA), etc. Since a quantitative forecasting varies widely and could fall easy under extreme conditions the third step is obligatory. In this connection there are various mathematical approaches that include genetic algorithm, non-linear regression, etc.

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SNOW COVER MAPPING USING MODIS IMAGES AND ITS POTENTIAL IN HYDROLOGICAL MODELING

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Satellite MODIS snow cover images are appealing for hydrological applications because of their good spatial and temporal resolution and acceptable mapping accuracy. Their main limitation, however, is cloud obscuration. The main objective of this study is to evaluate a snow cover mapping approach that enables cloud reduction by combining MODIS data from two platforms, the Terra and Aqua satellites. The potential of the combined snow cover product for hydrological modeling is illustrated by two case studies. The first study focuses on the integration of snow cover data into the calibration of a conceptual hydrologic model. In this case, snow cover images are used jointly with runoff data in model calibration over 148 Austrian catchments. The second case study demonstrates the usefulness of combined MODIS images in constraining and validating a distributed energy-balance based snow model in the context of a detailed operational simulation of snow water equivalent in one of Vienna's water supply regions. Both case studies demonstrate the value of MODIS snow cover images in hydrological modeling. Especially in alpine regions with sparse observations, the remotely sensed images provide a very valuable source of information which has strong potential for operational applications.

Keywords: MODIS snow cover, hydrological modelling.

THE IMPLEMENTATION OF THE HBV MODEL ON THE SAVA RIVER BASIN

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Following the good results using the Swedish HBV model for the simulation of runoff for the Savinja river basin, the model was used for modelling the Sava River discharge and modeling of snow cover over the Sava river watershed in Slovenia. The Sava River is a tributary of the Danube River, contributing to its largest runoff. The head part of the Sava River basin is located in Slovenia. It covers more than half of the territory of Slovenia, namely 10700 km2. The upper part of the basin is mountainous with altitudes up to 2800 meters. The altitudes of the plain area, in the middle reach are between 100 and 400 meters. The floods, usually flash floods, are caused by heavy rainfall in headwater mountain areas, especially in autumn. Some tributary flows can rise more than a hundred times in such events.

The HBV approach has proved flexible and robust in solving water resource problems and applications. The model consists of several fundamental hydrological routines, including a snow routine based on a degree-day relation, and a soil moisture routine that accounts for soil field capacity and changes in soil moisture storage due to rainfall/snow melt and evapotranspiration. The runoff generation routine transforms water from the soil moisture zone to runoff. The flexible structure of the IHMS/HBV system allows the model to make necessary sub-divisions with respect to different climate zones, land-use, density of the hydrometeorological network etc. The HBV can be applied to catchments of virtually any size, from less than 1 km2 to several hundred thousand km2. Larger river catchment is divided into subbasins, the HBV model is set up separately for each subbasin. The subbasins are then linked together and the outflow from the upstream ones is routed through the downstream ones. The HBV can handle time steps from 24 hours (day) down to 1 (one) hour.

Model input data is precipitation, values of potential evapotranspiration, e.g. standard monthly values and in case of climates with temperatures below zero, temperature data. Measured stream-flow or reservoir inflow is needed to calibrate, verify and up-date the model. Standard model outputs are discharge/streamflow/reservoir inflow, additionally the basin average temperature, precipitation, evapotranspitation, soil-moisture content and snow-pack are calculated. Most of those values can also, optional, be presented for all land-use types in all elevation zones. As is the case in all conceptual hydrological models, the HBV model can be sensitive to calibration of parameters, and more or less the same result can be obtained using different parameter-sets. The number of parameters normally used in the model is in the order of 20-25. While 5 of them are in most cases set to standard values, some 10 are very important to calibrate. The importance of a long enough period of historical data to allow calibration, and then verification on an independent period must be taken into account when using this kind of models.

The division of Sava river basin was made to 26 watersheds with area ranging from 0.26 km2 to 1019.85 km2 and further to elevation and vegetation zones. Data are collected for the period from 1990 to 2006 used for from 1990-1999 for calibration to determine the values of a number of free parameters and from 2000-2006 for validation. In spite there were some difficulties with incomplete data sets, calibration was successful.

Keywords: HBV, modelling, runoff, Sava, precipitation, evaporation, watershed.

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CONTINUOUS FLOOD FORECASTING COMBINED WITH AUTOMATIC FORECAST CORRECTION – APPLICATION ON THE MUR RIVER

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The trans-boundary Mur FFS provides a good example of an open and modern modelling system. It includes actually only the Austrian and Slovenian part of the watershed whereas the Hungarian and Croatian parts are not integrated. A very important element is that the largest national fraction that is also the upstream fraction of the watershed is located in Austria. Due to these geographical conditions it is clear that flood forecasting in Austria is independent to data and simulations from Slovenia. On the other hand, it is also logic that Slovenia needs to include the upstream part of the watershed, i.e., the Austrian part, to make sense full flood forecasts.
Thus, the challenge of this project was to build a common structure that simultaneously enables Slovenia 1) to optimise flood forecasting performances especially in that case and 2) both countries to keep their own responsibility for flood forecasting on the national territory. Further challenges that had to be addressed were the structure flexibility making possible 1) to include Hungary and Croatia in future and 2) to enlarge the system to other water resources management modelling studies like for low flow or water temperature.
Due to the long and good cooperation of both countries in the field of water resources management, it was possible to set a new standard in the frame of trans- boundary flood forecasting systems. A unique structure was set up that fulfil these requirements through the setup of one international and two national Flood Forecasting Centres. All three Centres share a complete identical setup whereas continuous simulations are made at the international centre and automatic transfer to the national centres is completed after each model run. Simulations results are published in German, Slovenian and English language, on a password protected homepage, and are refreshed after each simulation. This structure can easily be extended to Hungary and Croatia according to the setup of a national Flood Forecasting Centre in both countries.
Furthermore, the Mur FFS is built up off modern components that are integrated in the system to optimize the Flood Forecasting quality for the Mur River. These elements are: a) Incorporation of online data and meteorological forecasts, b) hydrological and hydrodynamic modelling including effects of hydropower plants, c) continuous simulation starting each hour, d) automatic simulation correction during hindcast and forecasts periods, e) transfer of each simulation setup and results to the national Flood Forecasting Centres and f) internet publication of the most important results
Finally, the flexible software solution build up of the rainfall runoff model NAM, the hydrodynamic model MIKE11 and the Flood Forecasting shell MIKE FLOOD WATCH easily allows to extent the entire system to other tasks by adding specific MIKE11 modules. Thus, it can be argued that the Mur FFS establish new standards for international flood forecasting systems especially in the field of data management and communication.
Keywords: Trans-boundary flood forecasting, continuous simulation, automatic forecast correction.

CONTINUOUS HYDROLOGICAL MODELLING IN THE CONTEXT OF REAL TIME FLOOD FORECASTING IN ALPINE DANUBE TRIBUTARY CATCHMENTS

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Devastating effects of extreme flood events in the recent past showed that in addition to structural protection, the prediction of floods with early warning systems is needed to reduce damage. Rainfall-runoff models are at the core of predicting catchment response in the imminent future. For their application in operational flood forecasting systems specific requirements that correspond with specific demands in the basin need to be fulfilled.

Continuous simulation is required in order to provide adequate system states for all flood situations, which is of specific importance in alpine regions, where snow melt can contribute to floods. The heterogeneity of basin features and meteorological characteristics requires high spatial and temporal resolution of model structure and input data. Influences of hydropower production demand the incorporation of reservoir management modules. As alpine catchments have short response times, meteorological forecasts are needed as input in order to achieve forecast lead times of 48 to 72 hours. Including ensemble forecasts contributes to taking uncertainty associated with forecasts into account.

This contribution presents the application of the semi-distributed, continuous rainfall-runoff model COSERO within operational flood forecasting systems in three alpine Danube tributary catchments. The Traisen, Enns and Salzach catchments have areas of 900, 6000 and 7000 km², with altitudes ranging from 200 to 3800 m.a.s.l.

Spatial discretization relies on the division of the watersheds into subbasins and subsequently into hydrologic response units based on available spatial information on subcatchment boundaries, soil types, land cover and 200 m elevation bands. The resulting mean unit sizes range from 4 to 14 km². Represented processes include snow accumulation and melt, interception, evapotranspiration, infiltration, runoff generation and routing. The model allows redistribution of locally generated runoff in order to consider diversions in the context of hydropower use and influences of karst cross-catchment groundwater flow.

The hydrological models are pre-calibrated with meteorological ground measurements of precipitation and temperature of several years in daily time steps. Meteorological analyses in 1 hour or 15 minute time steps based on ground observations and radar information are available from 2003. They are derived with comparable algorithms as in operational forecasting and provide the final calibration input.

In operational forecasting two online correction methods are applied. Each forecasting sequence starts with the re-calculation of the last 24 to 48 hours, using meteorological analyses as input. Errors between simulated and observed runoff are minimized by optimizing a correction factor for the input to provide improved system states. For the hydrological forecast quantitative 48 or 72 hour forecast grids of temperature and precipitation – deterministic forecasts with a 1x1km resolution and probabilistic forecasts with a 10x10km resolution – are used as input. The forecasted hydrograph is corrected with a simple autoregressive model. The forecasting sequences are repeated each 15 minutes.

First evaluations of resulting hydrological forecasts are presented and reliability of forecasts with different lead times is discussed. The presented modelling frameworks show recent examples of matching complex hydrological modelling with the requirements of operational real time flood forecasting.

Keywords: rainfall-runoff modelling, flood forecasting, early warning systems, alpine hydrology.

ANALYSIS OF MONTHLY DISCHARGE TIME SERIES IN SELECTED WETLANDS OF SLOVAKIA

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In the last few years the ecological conditions in important wetlands have markedly changed. One of observed areas is the national natural reservation wetland Kláštorné Lúky, situated in the Strážovské mountains in the northwest of Slovak Republic. The size of the wetland is 859 915 m2.
In the region of wetland Kláštorné lúky following gauging-stations were selected for the analysis: Kláštor pod Znievom/ Vríca, Kláštor pod Znievom/ Znievsky potok, Slovany/ Vríca, Moskovec/ Vedžer. The lenght of the timeseries is following: Kláštor pod Znievom/ Vríca – 21 years, Kláštor pod Znievom/ Znievsky potok – 18 years and Slovany/ Vríca – 17 years. Form the rainfall stations the Kláštor pod Znievom and Príbovce were selected. Time series from both stations have the observation length of 104 years.
The aim of the study was to model and build a forecast model for monthly discharge and rainfall time series in the area of the wetland Kláštorné Lúky. In the first step the mean monthly data were statistically evaluated. The statistical characteristics were calculated. Analysis of the systematical component (trends, seasonality, periodicity and residual components) was performed. Finally prediction models of mean monthly discharge and rainfall series were derived. The tested models were nonlinear models TAR (Threshold AutoRegressive model): SETAR (Self-Exciting Threshold Autoregressive), STAR (Smooth Transition Autoregressive) and LSTAR (Logistic Smooth Transition Autoregressive), TAR with exogenous component and TAR combined with Long Memory Models. For discharge prediction the Monte Carlo method in one step prediction was applied.
The obtained results would help the ecologists in decision making and wetland management process; by improving the ecological conditions in the wetland, and by planning future eco-technical measures (e.g. increase of ground water level).

DETECTION OF CHANGES IN THE FLOOD CELERITY BY MULTILINEAR ROUTING ON THE MORAVA RIVER

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The attenuation of flood waves on lower reaches of rivers has often been influenced by the extensive river training carried out on rivers during the last century. It is therefore often required to estimate the change in design floods resulting from changes to river beds. Recent advances in hydraulic modelling enable the building of mathematical models for a wide variety of real life flood routing problems, however, the lack of sufficient and appropriate channel geometry and roughness data on long river reaches or entire channel networks may hinder their application especially in less developed regions. Accurate field investigations are often prohibited by time schedules and costs and it is likely that this situation may remain such even over the long-term. The application of complete distributed hydraulic models in such data-sparse situations may not be justifiable or advantageous. Therefore the application of approximate (hydrologic) flood routing methods, in which the river is described as a lumped system, will remain a feasible alternative under certain hydraulic conditions. The same applies to scenario-based simulations for water resource systems optimisation and the routing of flood waves for engineering design. One of the alternatives, how to account for nonlinearity of the flood routing process with linear hydrologic models based on the storage-discharge relationship, is the use of multilinear models. In the paper a multilinear version of the two-parameter discrete linear cascade model for flow routing in river reaches with lateral inflow is used to detect and quantify changes in the river bed.

The results presented here originated in a study which aimed on the evaluation of the effect of flood plain developments and river training on the Morava River on the Austro-Slovak border. The relationship between flood wave-speed and discharge was studied on a reach of the Morava River between Moravský Svätý Ján and Záhorská Ves for flow conditions before and after the completion of a major river training scheme. Flood wave speeds for pre- and post-river developments were compared using empirical data, and the flood travel-time discharge relationships which were obtained by optimising the multilinear version of the Kalinin Miljukov flood routing model's performance on two floods representing pre- and post–river training conditions, respectively. It was shown that changes in the wave speed detected by the genetic optimisation on just two floods exhibit the same behaviour as that of the empirical data. The accelerated flood wave movement of floods for the post-scheme completion period can be seen as the results of the river training and the changed hydraulic conditions. It was shown as on the Danube in Szolgay and Danáčová (2007) that the method of the genetic optimisation of the travel-time discharge relationship is applicable to detecting changes in flood attenuation based on a small number of sample floods. The detected changes are included in the parameterisation of the multilinear model, and the change in the attenuation of the flood peaks due river training can be assessed by a simulation of the transformation a series of floods for pre- and post-river training conditions. These results can also be considered as a further step toward an (indirect) proof of the possibility of using a time variable storage parameter in the Kalinin-Miljukov model.

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Keywords: celerity of flood waves, travel-time of flood peaks, multilinear flood routing, genetic algorithm

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LONG TERM VARIABILITY OF ACTUAL EVAPOTRANSPIRATION ON THE BULGARIAN PART OF DANUBE RIVER

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The increasing of temperatures and decreasing of precipitation observed during last decades submit the question about the climate change trends of the actual evapotranspiration. For the future management of water resources the knowledge for the trends of actual evapotranspiration (ET) is important. The annual values of ET for 5 meteorological stations along the Danube river coast are obtained. In the present work the data for temperature and precipitations for stations Lom, Vidin, Oriahovo, Rouse and Silistra for the period determined by their operation are used.
The actual annual evapotranspiration is determined by the Turc (1954) formula

$$ET_{TR} = \frac{P}{\left(c + x^2\right)^{0.5}}$$

x = P / EPI
EPI = 300 + 25*T + 0.05*T^3

Where: E - saturated water vapor pressure, F – relative humidity, T_M Monthly average temperature, VM - Monthly average speed, P – sum of annual precipitation, T – mean annual temperature, T_M - mean daily temperature

The annual values of ET for the period 1691-1990 are 431mm for Lom, 434mm, For Svishtov, 420mm for Oriahovo, 467mm for Ruse and 395mm for Silistra.

The comparison with the annual ET for the period 1990-2006 doesn't show any considerable differences. The application of

The Spearman test has been applied for detection of significant trend during the years. No significant values has been find out.

The absence of the significant trend in ET could be result of the opposite trends in temperatures and precipitation

Keywords: actual evapotranspiration, Turc, Danube River.

DEVELOPMENT AND VERIFICATION OF THE SAVA RIVER LOW FLOW FORECASTING SYSTEM

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In Slovenia the Sava River Basin comprises the central part of the country. There are five in-stream hydropower plants situated on the Slovenian part of the Sava River (hydropower plants Moste, Mavcice, Medvode, Vrhovo and Bostanj). Good and accurate long–term low flow forecasts are especially important in the fields of sustainable water management, water rights, water supply management, industrial use of freshwater, optimization of the reservoir operations for the production of electric energy and other water-related disciplines in the Sava River Basin.
Starflow ultrasonic Doppler instruments, which enable us to perform continuous measurements of flow depth, velocity and temperature, were set up at relevant gauging stations located on the tributaries of the Sava River. Additional telecommunications equipment for remote access of the instruments was bought and installed. Software for on-line access and automatic collection of contemporary flow data from the instruments was developed as well. On a daily basis the real-time flow data automatically enters the low flow forecasting model and 7-day lead time forecasts for flows in the rainless periods are issued.
The development of the low flow forecasting models was based on the equation that is usually used for modelling the dynamics of the flow rates on the recession part of the streamflow hydrograph:

$$Q_{t+n} = Q_t \cdot e^{(-k \cdot n)}$$

where Q_{t+n} is flow rate at n-days after the time of the forecast t, Q_t is the flow rate at the time of the forecast, e is the base of the natural logarithm function, k is the recession constant and n is the number of days in advance for which the forecast is made.
First phase of the development of the Sava River's low flow forecasting model was analysis of the 10-year long streamflow recession data for the Sava River's tributaries, which showed great variability in the behaviour of individual recession segments. This meant that usage of a single numerical value for the recession constant wouldn't result in good accuracy, when the models are operationally run and used on a daily basis. By using the M5 machine learning method and analysis of the recorded recession streamflow data we modelled the recession coefficient k as being a function of the flow rate at which the 7-day low flow forecast is made and the decrease of the flow rate from the previous day.
Low flow forecasting models for most of the Sava River's Slovenian tributaries were developed and integrated into the model for forecasting 7-day ahead daily flows at the hydropower plants located on the Sava River. Low flow forecasting models for hydropower plants were developed by using the M5 machine learning method connecting appropriate Sava River tributaries' and hydropower plant flow data.
The Sava River low flow forecasting system is now operationally run on a daily basis and verification of the forecasting results on the hydropower plant data showed good results.

Keywords: the Sava River, Starflow ultrasonic Doppler instrument, low flow forecasting model, M5 machine learning method.

INFLUENCE OF GRID VALUES ON RUNOFF ESTIMATION BY REGRESSIVE MODELS

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Application of models, realized by regressive analysis over greater number of independent physico-geographic factors, on the river basins without hydrological observations is a long-range practice. One of the ways is also the projection of the parameters to the unit fields originated by the discretization of the ungauged river basin. The values of the discretization vary from the very small fields (smaller than one km2) to those of several hundreds square kilometers. The paper compares the results of the mean water runoff estimation in the river basin of the Lukovska River (113 km2, the tributary of the Toplica River on Mt. Kopaonik), which originated by applying the existing models on the territory of Serbia, and for field size of 0.25 km2, 1 km2, 4 km2 and 16 km2. The aim is to show if there is sense to divide the river basins into very small unit fields for obtaining better results or the same effect can also realize over far larger surfaces. From the practical point of view, it is much easier to use fields of larger surfaces, if it shows that their choice is justified with best result. However, the confirmation of it has to come from those river basins which had not been used in the analysis (Živković, 2007), but they satisfy the set conditions (long period of continuous hydrological observation, natural conditions of the runoff and relatively small river basin). Only in the examples tested in that way, the size of the unit field showing the best results may count on the epithet of qualitative entry.

Keywords: runoff estimation, grid values, regressive models, Serbia.

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Topic 2: HYDRO-METEOROLOGICAL EXTREMES, FLOODS AND DROUGHT

THE NECESSITY OF FLOOD RISK MAPS ON TIMIŞ RIVER

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In this paper the necessity of risk reduction in flood prone areas along the Timis River is clarified. Different methods to reduce risk in flood prone areas are analyzed as well.
Banat Hydrographical Area is positioned in the South Western part of Romania; the Serbian border limits the South and West of the area. The Northwest is limited by Hungary. Banat occupies an area of 18.320 km2, which represents 7,7% of the Romanian territory.
Banat Hydrographical Area was affected by severe floods on Timis River in 2000, 2005 and 2006. The 2005 flood was the most devastating one with large economic damage. As a result of these catastrophes the need for generating flood risk maps along the Timiş River was clearly shown. The water management experts can use these maps to identify the "hot spots" in Timis catchment, give the people better understanding of flood risk and help to reduce the flood risk more effectively especially in vulnerable areas.
According to the EU Flood Directive it is mandatory for the European countries to develop flood maps and flood risk maps. The maps help to assess the vulnerable zones in the floodable (i.e. flood prone) areas. Many European countries have produced maps, which show areas prone to flooding events of known return periods. In Romania maps showing areas at risk are not yet produced but Romania is starting to implement the flood risk maps at the national and regional level.
In order to prevent or reduce floods all tools and means for fighting them are necessary. Of course, the classical method of reducing flood risk with structural measures like linear defence systems (dykes), water retention areas and drainage channels is still needed. But nowadays experience shows that non structural measures like developing flood maps, flood hazard maps, flood damage maps and flood risk maps are of great importance to reduce flood risk. These measures will not stop floods but will increase public awareness of the danger that can occur during a flood event and will help the water manager to increase flood protection and prevention more effectively and more efficiently.

Keywords: flood, flood prone zones, flood return period, flood maps, flood risk maps, Banat Hydrographical Area.

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CONTRIBUTION TO THE DEVELOPMENT OF EXTREMES IN SLOVAKIA

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Within the framework of "The National Climate Program of the Slovak Republic" project (NCP) the "Water" programme handled. The first phase of the solution evaluated:
The verifications, reliability, homogeneity, and variability of a hydrological series,
Creating a new application of the recommended mechanism for the prediction of the possible development of a hydrological series (hydrological cycle and balance and available water resources),
assessment of the potential impacts of climate change on water resources and the hydrological balance,
proposed frame measurements.
The main recommendations resulting from the first phase of the solution of NKP SR are as follows:
pay attention to possible changes in climate variations,
follow up the development of hydrological extremes,
consider the creation of surface and subflow water resources during winter periods in terms of possible changes of minus temperatures to positive,
monitoring snow cover as one of the runoff change indicators in hydrological years,
monitoring the development of climate and hydrological cycles through changes in long- time characteristics.
In 1994 generalized map of Slovakia was constructed with respect to the sensitivity and vulnerability of water resources: the low degree of vulnerability, which affects approximately 38% of the territory, medium degree, which affects 34 % of the territory and the high degree, which affects 28 % of the territory.
The submitted poster deals with the monitoring development of extremes on Slovak territory by comparising extreme indicators within the 1931 – 1980 and 1961 – 2000 periods. The time sections mentioned represent two reference periods in Slovak hydrology, in which the period 1961 – 2000 is valid at the present time in hydrological routing work.
In the contribution we concentrated on an examination of and evaluation of the hydrological series outgoing from the results of the NCP and considered of development hydrological extremes in terms of an extended series of measurements.
The hydrological series of discharges (Qannual, Qmax, and Qmin) are evaluated hydrological from the point of the view sensitivity and extremes of the territory and compare the results with the vulnerable regions declared by the NCP.

Keywords: National Climate Programme, monitoring, vulnerability of territory, flood index, extremity of territory.

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COMPUTATION MODEL FOR THE IMPACT ASSESSMENT OF THE ACCIDENTAL FLOODS

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The paperwork is proposing to analyze and to assess the impact of the accidental floods occurred from the linear defence systems failure. The different structural and non structural measures are taken into account, aiming the existent defence systems or the new conceptual ones (The EU Flood Directive).
For the impact assessment are analyzed the existent computation models, with their adaptation for the aimed situations and it has to be proposed a new model by utilizing a matrix of the costs (including the damages) for different breaching scenarios. The model can be applied for the global impact assessment, but it can also be used differentiated for the economic, social, human impact or towards the environment.

Keywords: accidental floods, linear system, non- structural measures, new concepts.

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SYSTEM IDENTIFICATION OF RIVER MODAU WITH MARKOVIAN ESTIMATORS

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In this work we present a study directed at modifying the identification problem for nonlinear systems by deconvolution processes, and Markovian estimation functions We will implement the expectation maximization (EM) and the stochastic expectation maximization (SEM) methods to estimate the predictability of the Modau river regime.
The iterative EM algorithm computes the Maximum-Likelihood (ML) estimate in the presence of input discharge signal and system functions (Dempster et al, 1977). Each iteration of the EM algorithm consists of two processes: The E-step, and the M-step. In the expectation, or E-step, the system function is estimated given the Modau discharge signal and current estimate of the model parameters. In the maximization or M-step, the likelihood function is maximized under the assumption that the system function is known. Nevertheless, the EM algorithm requires at each iteration the computation of a conditional expectation and this step cannot always be done in a closed form. In such situations we implemented a stochastic version of EM: the SEM algorithm, proposed by (Diebolt and Ip, 1996).
We used Modau river discharge data set to test the performance of system identification algorithms. The signal predictability of the EM and SEM algorithms were tested with different initial conditions (triangles) and reasonable convergence was obtained. The algorithms produced comparable results, the maximum difference between the predicted discharge value and the observed discharge value after 126-210 iterations is $31.5 \pm 6.8\%$. by the EM algorithm. By the Kalman filter algorithm the fitting level is similar but lower ($34.7 \pm 2.9\%$ after 48 iterations) to the EM algorithm.
In Table 1 the algorithm results is conformed to the Modau river test signal in percent.

Keywords: system identification, Markovian estimator, discharge predictability.

Table 1.

	Initial Condition A	Initial Condition B
EM	28.2 ± 5.5 / 143	31.5 ± 6.8 / 126
SEM	27.4 ± 4.6 / 210	31.1 ± 6.5 / 163
Kalman filter (Gilks et al, 1996)	34.7 ± 2.9 / 48	

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DEVELOPMENT OF NEW APPROACHES TO MONITORING OF DANGEROUS PRECIPITATIONS AND PROCESSES WHICH CAUSE THEM

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This work is devoted to development, ground and realization of new approaches to monitoring of weather processes which stipulate origin of the most dangerous weather phenomena in Ukraine - strong and very strong rains, strong heavy showers and to the exposure of their features in the regions of country.
On the basis of systematization and generalization of the known criteria of baric topography (laplasian geopotentsiala, curvatures of isobars, changes of density of isobars in the direction of an axis of coordinates, advection of temperature and divergence of wind speed) are specified the quantitative criteria of the baric systems of a weather scale. For the first time is developed the method of their objective authentication (OIBS) which takes into account thermodynamics individuality of air mass.
On the basis of OIBS is specified the structure of the baric field of the lower troposphere in a warm period (April - September). There are received averages for each month, and the warm period as whole, sizes of repeatability of the baric formations, air masses and frontal zones in Ukraine. For each identified element of baric fields are received average values of steam and specific kinetic energy in the lower troposphere. There are investigated their periodicity and annual variability, features in regions of the country at different synoptic processes, and also influence on repeatability of dangerous and spontaneous precipitations. It is certain, that periodicity of repeatability of catastrophic precipitations is similar to periodicity of investigated characteristics. The received results testify to an opportunity of oscillatory character of these changes.
The lead analysis of annual variability of energy and specific humidity of cyclones which took place in Ukraine during when on its territory the increase in repeatability of cases of dangerous and spontaneous quantity of precipitations (1992-2003) has shown, that during this period their specific humidity increased, and kinetic energy decreased. There was observed the increase in repeatability of baric formations of the raised pressure and reduction of repeatability of baric formations of the lowered pressure.
The received results testify that the developed technique of objective identification of baric systems of synoptic scale really displays structure of an atmosphere, its energy and specific humidity, allows to understand the formation mechanism of precipitations and their variability, it can be used for their research and monitoring.

EXTREME HYDROLOGICAL SITUATIONS ON THE DANUBE RIVER

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From a flood defense perspective, river floods are usually defined as flows, which overtop the river banks and inundate the riverside area (if unprotected) or reach the defense line, potentially threatening a protected area. River engineering and water management structures are designed referring to high waters that, as a rule, are unlikely to be exceeded, or have relatively long return periods. Such stringent criteria with regard to the level of protection are governed by the extent of possible flood damages.
Flood defense structures along the Serbian reach of the Danube River have been built to ensure protection from 100-year flood. As such, the occurrence of a flood wave with a peak discharge equal to or higher than the design criteria is considered as an extreme situation.
The Danube, Tisa and Sava rivers, which meet within the territory of Serbia, have snowmelt/rainfall discharge regime. High waters generally occur during the spring, because of snowmelt in upland river basin portions. However, due to different sizes of the river basins, high waters on the Danube and its main tributaries do not occur simultaneously, although such events have a certain probability. An extreme flood wave along the stretches of the Danube River downstream from its large tributaries can emerge only in the case of a simultaneous occurrence of high waters on the Danube itself and one or more of its tributaries.
This paper presents some results of an analysis of conditions, which may lead to an extreme flood situation on the Danube River. The analysis included three main steps. Firstly, a computation of high-flow hydrographs for the Danube, the Tisa, the Sava, and the Velika Morava rivers was done, based on HMS Serbia data for the 1931-2006 period. Minor tributaries were not taken into consideration, assuming that their high waters cannot contribute to extreme flood wave on the Danube, due to a major difference in river basin sizes. In the second step, a selection of different combinations of flood waves at each confluence of the Danube and a large tributary (Danube/Tisa, Danube/Sava and Danube/Velika Morava) was prepared. In the last step, a modified Kalinjin-Miljukov method was used to calculate flood wave propagation along the Danube. Model inputs were computed high-flow hydrographs for the Danube and its tributaries, and model outputs were the Danube's discharges at profiles downstream from the mouths of the Tisa, Sava and Velika Morava rivers. Different combinations of flood waves on the Danube and its tributaries were investigated, which had various probabilities of simultaneous occurrence (5%, 2%, 1% and 0.1%). A statistical rank of calculated flood waves for the Veliko Gradiste profile (i.e. the lower course of the Danube in Serbia) was estimated at the end.

MAPPING OF EXCESS WATER HAZARD IN THE REGION OF SOUTH HUNGARIAN GREAT PLAIN

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Frequent occurrence of extreme anomalies in natural water distribution is a great problem for the agricultural production in Hungary. An important step towards an effective solution is the detailed and reasonably accurate mapping of the influential environmental factors of excess water inundation (Pálfai 1994; Bíró and Thyll 1999). The total area inundated by excess waters might be as high as 5,000-6,000 km2 in Hungary. In this paper GIS based mapping of excess water hazard and some related influential factors are presented in the South Region of Great Hungarian Plain. Limited numbers of affecting environmental factors were considered, and information on these factors was collected and arranged in a harmonized manner. One well-defined and quantified parameter represented the affects of influential factors. Each factor was spatially represented:
Effect of groundwater (GW): It was represented by the standard depth of groundwater; i.e. the average of its ten highest values within two periods (1960-1980, 1981-2005) because of continuous decrease of groundwater level of Danube-Tisza Interfluve (Duna-Tisza köze);
effect of soil (SOIL): Effect of soil was modelled and spatially represented according to Várallyay et al. (1980) by the water management characteristics of soil (infiltration capacity, mm/h);
effect of relief (RELI): It was represented by a normalized version of relief intensity; i.e. RELI = variation in elevation / 75 * relief energy;
effect of land use (LU): a numeric coefficient of land use based on CORINE Land Cover (CLC50) database and individually attributed to its categories;
effect of agro-geology (GEOL): It was represented by a complex index taking into consideration the depth and thickness of the uppermost aquitard;
humidity index (HI): It was represented by 10% possibility of occurrence of root square of sum of monthly weighted precipitation and sum of monthly weighted potential evapotranspiration ratio.
Multiple regression analysis was used for the determination of the role of various factors in the formulation of excess water thus providing weights for its stochastic linear estimation by the applied factors. For this reason the map of relative frequency of the past excess water events (1950-2006) was also compiled, which was provided an independent estimation of the spatial distribution of the most risky areas, as well as the dependent variable of a multiple statistical analysis. According to our experience, involving humidity index in multiple regressions rather worsened the fitness. As a consequence, it was finally used just as a multiplying correction coefficient. The values coming from the regression equation were multiplied by and added to a constant value, resulting in the Complex Excess Water Hazard Index (CEWHI).
CEWHI = (1.6 – 0.007 * GW – 0.15 * SOIL – 0.025 * RELI – 0.17 * LU – 0.04 * GEOL) * 5 * HI
The values provided by the equation were then used to compile the excess water hazard map based on more detailed original map layers.

Keywords: excess water, hazard mapping, GIS.

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EXTREME DROUGHT EVENTS AND AGRICULTURAL PRODUCTION IN SERBIA

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Meteorological droughts appear as a result of deficiency or complete absence of precipitation during longer period of time on certain area. Primarny reason why this aspect of drought deserves full consideration is a fact that precipitation represents the element of hydrological cycle that most effects the water balance.
Considering the fact that the definition of the meteorogical drought points out in the foreground the time period and spatial distribution of the rainfall, as well as the numerous researches have shown that drought represents part of climate conditions of broad proportions, it was necessary to gather and process data for large enough number of meteorological stations during long enough time period, that will give clear overview of the climate factors on the territory of Serbia. Analysis for 24 main meteorological stations that belong to the National network of meteorogical stations was conducted, for the period that included 45 years - from 1961 to 2005. Also, the data gathered from certain number of meteorological stations from neighbouring countries (Croatia, Hungary, Romania and Macedonia) was analyzed.
In this paper trends in changes of temperature and precipitation during the choosen period will be defined. Distribution of the temperatures and rainfall inside the year will be discussed because the agricultural production is especially influenced by the values of these parameters during the growth season (april-september). Also, the water deficit will be calculated - difference between potential evapotranspiration ETp, that was calculated using Thornthwaite method, and the effective rainfall. For a detailed analysis of the rainfall SPI index will be used. In the end results of the above analyses will be compared with yield of wheat, corn, sugar beet and soybeen during the examined period.
Yield in 2000 and 2003 will be independantly analyzed. For this reason meteorological conditions that were observed during these two years were separately examined. April 2000 temperatures were on the average arround 3 degrees, and in june 2003 5 degrees Celsius above average values. Lack of precipitation that accompanied this increase in temepratures on some stations was dropped to such an extent that the absolutely minimum ammount of rain was registered since the beggining of measuring on those stations. Combination of these two climate elements during the key growth stages of the plants considerably affected reduction of the yield.
Estimation of possible irrigation, as one of the measures to combat drought, will be given in this paper. Necessity of the revitalization of the existing and construction of the new systems for irrigation on the territory of the Republic of Serbia will be considered. Influence of the irrigation systems on the preservation of the yield during the years with extreme climatological conditions, as well as on the stability and protection of production in rest of the years will also be discussed.

CALCULATION OF PMP AND PMF

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The PMF is by definition the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the drainage basin under study. A PMF is generated by the probable maximum precipitation (PMP), which is defined as theoretically, the greatest depth of precipitation for a given duration that is physically possible for a given size storm area at a particular geographic location at a certain time of year.
The purpose of the study was to calculate PMF for Sava River that flows near Krško Nuclear Power Plant (NEK). To assure flood safety of NEK it is important to know possible maximum flow of Sava River. We used 24-hours data of PMP that we got from Environmental Agency (ARSO) and divided them to hours data. We calculated eight different scenarios: scenario for spring rainfall, autumn rainfall, maximum rainfall through all year, one scenario was made on basis of equation of PMF (Dingman) dependant only on event duration, two scenarios were made after FEMA guidelines and two after data received on basis of October flood event in Slovenia. The PMP scenarios data were inputted in calibrated HBV model for Sava basin and flow results were calculated.

FLOODS AND LOW FLOWS – HYDROMETEOROLOGICAL SERVICES OF THE DWD

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Hydrological models are based on meteorological input – predicted data, e.g. quantitative precipitation forecasts and observed data in real-time. Flood risk studies are based on long time-series of observations, e.g. climatic data. The evaluation of low flow events require the analysis of development of the hydrometeorological conditions for episodes up to one year. Generally hydrological applications request area-related information of high quality.

The department of Hydrometeorology of DWD is the focal point for all inland water aspects, and serves the hydrological customers with all required DWD products complemented by interpretation and individual advice (customers support). The user requirements are followed by the close cooperation of DWD and the responsible agencies and flood forecast centres of the Federal Countries and the Federal Institute for Hydrology. .

The hydrometeorological services of the DWD comprise:

Provision of numerical forecasts of precipitation and complementary variables of the models COSMO-DE and COSMO-EU for the specific regions.

Hourly gridded precipitation data sets based on combined radar and in situ observations for Germany and neighbouring regions in real-time (RADOLAN) and radar-based now-casting for two hours after observation (spatial resolution 1km).

Gridded analysis and forecast products for the snow cover and run-off resulting from snow melt and rainfall (Model SNOW, spatial resolution 7km for total Germany, 1km for southern Germany).

Statistics of extreme rainfall for various duration periods (5min to 72hours) and re-occurrence times (2/yr up to 1/100yr) for individual stations as well as gridded data for Germany (spatial resolution 8.5 km).

Gridded daily precipitation data sets for the period 1951-present based on up to 4000 rain gauge stations for Germany (spatial resolution 1km).

Gridded monthly precipitation data sets for the period 1951-present based on up to 50.000 rain gauge stations for global land surface (GPCC products, spatial resolution 0.5° lat./long.).

Case studies about meteorological causes, the forecast skill and climatological aspects for selected flood, drought and low flow events.

The presentation at the International Danube Conference will summarize the scientific/technical aspects of the services and demonstrate application examples.

THE INTEGRATED WATERS MANAGEMENT IN THE TIMIS-BEGA AREA USING THE AUTOMATIC SYSTEM OF MONITORING RIVERS "RIVER LIFE"

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The population from the entire globe is vulnerable in front of natural disasters which are increasing due to the consequences of the social-economical development, funcial improvements and climate changes. In the last years the impact of floods has become more important. Also in Romania as a result of the bigger number of people who suffer because of these negative effects. In this way it is necessary to elaborate and introduce some integrated, realistic and clear strategies in order to reduce the frequency and intensity of the damage caused by high floods.
Besides the monitoring realized by the people which is made of the visual readings of level, the water and the air temperature, the amount of rainfalls, in our system there is also a monitoring realized through some automatic stations. The purpose of these stations is to monitories the river from its springs to its way out of the country.
In the paper it is presented the functioning-way of the"River Life"' automatic system to prevent and combat the floods in the Timis-Bega area.
The hydrographic basin of Timis-Bega rivers is monitored in the superior side by the Hydrological Station Lugoj and in the inferior side by the Hydrological Station Timisoara.Every hydrological station is divided in many hydrometric stations, each of these having the purpose of monitoring the river stream adequate to each of them.
The sensor of automated stations has the role of recording the water level each hour, the corresponding flows, the water temperature and the amount of rainfalls and also some chemical parameters like the water pH, the amount of oxygen and ammonia in the water etc.
The data base obtained through this monitoring allows the increasing of the anticipation time for the prognosis of high floods and in the same time taking some optimal decisions for operates in the complex system of the water administration.

Keywords: water management, monitoring, flood.

HYDROLOGICAL EXTREMES EVENTS IN BULGARIA –CURRENT AND COMING

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At the beginning of the XXI century, the sustainable use of water is not only a priority question for water scarce regions but for almost all sectors and regions. Imbalances between availability and demand, degradation of water quality, regional and internal conflicts, all bring water issues to foreground. In parallel climate is changing gradually as a result of the increase greenhouse effect. The objective of this study is to present the response of the Bulgarian rivers to the changing of the main flow-generating factors and also to detect changes in the frequency of hydrological extremes. Long series with 105 yearly observations of precipitation and 70 yearly series with discharge values have been utilized in process of assessing. Analyzing 104 years precipitation series, nine annual maximum sums over 800 mm (mean is 650 mm) were select. Five of them occurred during the last fifteen years, i.e. their frequency has increased drastically to 34 %. After a long drought period of about twenty years (since 1982) a few very heavy floods occurred between February and August 2005 and during the spring of 2006, which caused massive losses of livestock and immense damages to the infrastructure and economic activities. The 24-hour precipitation fallen with exceptional depth have a probability of occurrence once in 1000 years. Summer and winter low flow in 2006 and 2007 were contiguous which suppose a new drought period. There is no compelling evidence change in frequency of drought. The changes in droughts events are pronounced in their duration and severe.

The assessment of the coming hydrological extreme has been achieved using observed data for the period 1961-1990 and also results from regional climate change scenarios for the Balkan Peninsula developed by the MGICC/ SCENGEN package in A2 and B2 storylines, especially HadCM2 and ECHAM4 models as the most suitable for Europe. Multi-regression models, a water balance model, and the HBV model have been used to simulate low flow and maximum monthly flow in climate changed conditions. The reduction in precipitation and increase in temperature results in a decrease of runoff according to both the Water Balance and the HBV models. The size of decrease of low flow will be greater according to the HadCM4 scenario. The decrease magnitude of flow tower 2025 is alike to this during the previous long drought period (1982-2000).The degree of stream flow decrease varies with the assumed time horizons and exhibits an acceleration of the decrease towards 2100. Second order tributaries will be dry towards 2050, 2100.

COMPLEX APPROACH IN WATER BALANCE COMPONENTS EVALUATION (ON THE EXAMPLE OF ARDA RIVER BASIN)

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The evaluation of water balance components like precipitation evapotranspiration losses, surface flow, its part going to groundwater recharge and others is important for water resources management and environmental planning. The elaborated complex approach is using monthly precipitation totals of precipitation and monthly averages of air temperature and river flows for one particular Bulgarian river basin. An optimisation procedure is used to evaluate the monthly evapotranspiration totals, while the elevation gradients of air temperature and precipitation are taken into account.
Analysis of river hydrograph based on daily discharge averages is made and separation of groundwater recharge via automatised procedure within MS Excel is applied. Thus evaluation of the main components of surface water balance is implemented.
Important for the analysis of surface flow dynamics is the use of hydrotechnical facilities and their influence on the flow. A cascade of three reservoirs exists in Arda river basin. The characteristics of the inflow, outflow and accumulated water volumes are evaluated using monthly averages. Conclusions on the average residence time of the water in those reservoirs are drawn as a basis for further environmental planning.

THE TEMPORAL AND SPATIAL CHANGEABILITY OF THE RUNOFF OF RAIN FLOODS IN THE BASIN OF TISZA RIVER (ON THE TERRITORY OF UKRAINE)

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In this work was investigated condition of long-term changeability and features of spatial distribution of depths in the rain flowing floods in the basin of Tisza on the territory of Ukraine. For this reason data with the period of observations more than 50 years from the 26 hydrological water stations were used. Thus statistical row (or sequence) depths of runoff of rain floods amounts to 120-180 values.
As is well known in Tisza's basin (on the territory of Ukraine) floods are formed in a warm period of year (by rain) and also in cold period (by snow and rain). The climatic and orographic features further to this. Tisza's basin differs in the condition of moistening – 1000-1400 mm of precipitation falls on average during the year in Carpathians and 1800-2200 mm in some years with abundance of water. Rain floods arises here as a result of intensive rainstorms fallen on mountain slopes with the tilts more than 200-400‰ (Lukyanets, Sosyedko, 2000).
Accordingly to the study (Lukyanets, Sosedko, 1998) a period of time of high water content is 16-17 years and low is 9-13 years. In this year's group the certain character of variation of runoff is saved. Within the year's group cyclic with periods 3-4 or 6-8 years of high water content floods was kept. In 20-th century periods of high water content were observed in the Tisza's basin and adjacent catchment area in 1912-1927, 1940-1955, 1965-1981, 1993-2006 years. Using the selected periods it is possible to see that passage of large for volumes rain floods corresponded with general regularity of many year fluctuations of annual runoff. This fluctuation appears in the alternation of groups of years of high and low water content.
The largest for water content floods (1-10 % by frequency) were formed in periods of high water content 4-6 times within the limits of one period.
The rain runoff part of the annual runoff of water in the rivers of Tisza's basin averages 20-30%. At some rich of rain years on the east of catchment area (basins of rivers Teresva, Tereblja, Rika, riverhead of Tisza) the depth runoff of water during rain floods could be 45-50% from its annual value. On the west (basins of rivers Borshava, Latorica, Ush) the part of rain runoff could be even more and to reach 60-65% from annual value.
The analysis of the spatial distribution of depths of rain flood runoff of 1% probability of exceeding (as a map) showed that the highest values of depths of runoff in the basin of Tisza were observed in mountain part. Here they reach values 300 mm and more, and envelop 8-10 % of territory and with maximums more than 200 mm - 40-45 % of the Tisza's basin within the territory of Ukraine.

Keywords: catchment, runoff, flood, water content, temporal changeability, spatial changeability, variation.

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THE SIMULATION GEOLOGICAL & ENVIRONMENTAL FOR WATER SHORTAGE FROM JIFARA PLAIN BASIN NORTHWEST OF LIBYA

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Libya is among the countries suffering surface water supply shortage Due to scarcity of rain and snow era, and the formation mature, the vast Libyan lands (1.700.000km) of which 95% arid lands, in this study our focus will mainly be on Jifara blain basin with such a complicated geological formation higher to the south and lower to the north with extreme slop towards the sea, this area was exposed to cleave movement resulted in two fractures, the first fractures heading north-east toward Tunisia borders as for as Jabal Abu-kirsh , 100 to 200 meters , the second fracture is heading west and called, the greater Azizia elevate, such movement led to fold and slop towards the sea forming three rock units :

1 -Mountain front sequence extending from homes to missiles to the west where it includes gargarish formation constituting sand lime sediments, such sediments formed water reservoirs of great subterranean water reserves.

2 - Mountain front sequence extending east and west to Tunisian borders, this line of sequence includes Abu-gailan and Abu-shaiba being covered by sand and limestone soil sedimentary containing underneath lime sediments it is around 700 meters over sea level, this formation also contains deep and wide gulfs including Mjineen and Essirt valleys being the main feeder to most north west area.

3 -Hadba surface sequences include the 4th era formations scattered in most edges and centre of the area with rock masses in which much low water exists. It is believed that such rock units moved back to its present place by reason of different erosion factors, the basin is believed to be covered by lime and sand rock that led to the birth of lime water accumulations reaching 2.4x1610cubic km. Also the occurrence of low level water reservoirs scattered in the centre of the basin which was exposed to up and down and fracture movement contributed to the lowering of the north part of the basin most parts of this basin have been flooded by sea water during the Miocene and Oligocene resulted in the formation of rock Hollows consisting large quantities of water most of which are accumulated in the sea it is also believed that there is a large water basin branching from Jifara plain, it is also believed that the low level in the underground reservoirs is

Attributed to the low level of the north part of the basin where water flows from the south part towards the lower north part to flow into the sea water forming fresh water reservoirs inside the sea if we examine the way taken by water during the water cycle we find the movement indicates that it originates from sea to land , then land to sea again , once again it is believed that most countries will produce fresh water from sea in future as a result of water cycle of water returning to its original source.

The 4th era sediments are considered to have contributed to the basin surface and underground features formation during Holocene containing water carrying sediments such as Quaser El-haj formation consisting of lime and grain rocks where reservoirs of Al-Azizia Abushaibs and Abu-Ghailan are located where water is being pumped from Miocene layer as well as gargarish

Formation which contains Ber El-Ghanam and kikla reservoirs that are covered by lime sediments, water is being pumped towards south of the basin, the south area of the Jifara plain. there are also saline sediments being spread south and west of the basin such salineâ€™s were as result of dropping of Oligocene the matter which led to the salinity of the soil by effect of infiltration of salts contained in the rain water by this study we expect to find a trace of water flow from Jifara plain, towards sea, through a hollow in its north part, this matter resulted in creation of severe water shortage in the area.

In this study, it is proposed that 3D three dimension surveys be carries out in the basin to find out the geological structure which led to this natural phenomena resulting in deformation to the installation of water distillation units for the purpose of refilling of such underground water reservoirs for the increase of its pressure and water reserve and increase of pressure.

INFLUENCE OF THE PRECIPITATION AMOUNT IN LJUBLJANA ON THE SAVA RIVER DISCHARGE IN ZAGREB

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Speaking about climatic changes, one pays most attention to the air temperature changes, known as "global warming". Precipitation amount changes and their consequences are much rarely mentioned. This paper analyses the influence of precipitation amount on discharge on a part of the Sava River drainage basin. Ljubljana and Zagreb have been taken for referential stations. 1925-1995 period was analysed.
In the Sava upper flow there is much rain and snow because of the Alps' influence The quarternary aquifer volume is small because of the dynamic relief, so it fills up and empties quickly. Therefore, the correlation between the precipitation amount in Ljubljana and the Sava River discharge in Zagreb is very steady (0.81).
The whole analysed period in Ljubljana and Zagreb shows the trend of the annual precipitation amount decrease. In this connection, the inter-annual precipitation variations in Ljubljana are much greater than in Zagreb. In the annual discharge of the Sava River in Zagreb two periods can be singled out: 1926-1960 and 1960-1995. They are both characterised by the discharge decrease trend. The analysed data affirm the presumption about the key significance of precipitation in Ljubljana, i. e. in the Sava River drainage basin upstream from Zagreb. Precipitation amount decrease is the consequence of the (mezzo)circulation atmospheric condition changes in this part of the Northern Hemisphere. Therefore, the falling trend of the annual precipitation amount in the analysed part of the Sava River drainage basin corresponds to the same trend in the zone spreading from the Pyrenean Peninsula across the Alps to the south-eastern Europe. Natural (climatic) fall of the Sava River flow is so prominent that it enlarges the water pollution in the surface flow.

PERFORMANCE OF DIFFERENT REGIONAL FREQUENCY MODELS FOR SEASONAL MAXIMA OF 5-DAY PRECIPITATION TOTALS IN CENTRAL EUROPE

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Reliable estimation of design values of hydrometeorological extremes is essential in applied climatology and engineering practice. There is a consensus among researchers that regional approaches to the frequency analysis yield design value estimates superior to those based on the traditional at-site analysis. In principle, groups of sites supposed to have similar probability distribution of extremes may be defined in two different ways:
based on fixed regions – design values are estimated within fixed (but not necessarily spatially contiguous) homogeneous regions; the most frequently used technique is the L-moment-based regionalization approach developed by Hosking and Wallis (1997);
based on flexible regions, i.e. pooling groups – 'regions' are specifically tailored to the site of the interest, i.e. each station has its own group of sufficiently similar sites; one of the most popular pooling approaches is the region-of-influence (ROI) approach introduced by Burn (1990).
The advantage of the pooling techniques lies mainly in eliminating undesirable step-like changes in growth curves and design value estimates at a transition from one fixed region to another.
Gaál et al. (2008) examined the performance of different regionalization approaches by Monte Carlo simulation experiments. Analyzing the datasets of annual maxima of 1-day and 5-day precipitation totals in Slovakia they concluded that the pooling approaches outperform the traditional regionalization methods at most stations. The current study is an extension of the aforementioned analysis by focusing on the 5-day precipitation maxima (which are frequently considered measures of larger-scale flood risks) in warm and cold seasons, respectively. The area under study covers the Czech Republic and Slovakia. The performance of various frequency models confirmed the superiority of the ROI approach in warm season; however, in cold season, the regional approach by Hosking and Wallis appears to be preferable to ROI models. Such behaviour may be explained by important role of the topography of the countries both in the process of delineation of fixed regions, and in influencing the spatial patterns of cold season (mostly frontal) precipitation by leeward effects, respectively.
The study is supported by the Grant Agency of AS CR under project B300420601.

Keywords: regional frequency analysis, region-of-influence approach, pooling groups, extreme 5-day precipitation events, Slovakia, Czech Republic.

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DROUGHT AND ARIDITY PHENOMENON'S IN SOUTH-WESTERN ROMANIA

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The climatic records of the last century present a progressive heating of the atmosphere with a significant precipitations variation during short periods of time. Even drought is a normal, recurrent feature of nature, at the beginning of the 3rd millennium this phenomenon represents in many areas a meteorological pollution, result of the massive quantities of air pollutants released in nature. The climate responds at this situation in a very visible way and with increased impacts upon the society. Regarding Romania's case, if desertification is more common for southern and south-eastern part, the western and south-western parts are characterized by aridity (which is a long-term feature of climate) and periods with drought. In South-Western Romania became obvious the climatic tendency of passing from wet and half wet climate to half-wet and half-arid (even arid in some areas) climate. Corroborated with the missing or the degradation of hydroameliorative works, were created the necessary conditions for the appearance of water scarcity phenomenon in different forms and at different scales. In western and south western Romania, an important role in drought phenomenon appearance is played by vertisols which are spread on large surfaces. It deserves to be mentioned here and the problem of the surface drainage and drainage arrangements which worked intensive till few years ago and decrease dramatically the water table level in soils. The paper will present an image regarding the climatic situation in Romania's south-western part, consequence of the climatic changes in the last years. I will present some maps with different aridity indicators (De Martonne, Lang and Dantin Cereceda and Revenga Carbonell) for two counties, graphs with temperatures and precipitations evolution in the last years, problems regarding the Romanian legislation about water scarcity.

Keywords: drought, aridity, climate, climatic changes, indicators, maps.

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STATISTICAL EVALUATION OF RUNOFF VOLUME FREQUENCIES OF THE DANUBE IN BRATISLAVA

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Flood volume is another important flood characteristic apart from a peak runoff. For solution to some water management and hydrotechnical problems it is necessary to know not only values of maximum discharge Qmax, but also the shape of a flood wave or its volume. In applied hydrology it is difficult to assign values of flood wave volume with particular probability of exceedance to corresponding values of T-year discharges. Their dependence is irregular to a considerable extent, so it is essential to know a flood wave hydrograph with the given exceedance probability, also. The importance to know the flood wave volume, as an important hydrological characteristic, was evident during the flood in the Danube River in 1965, when the flood bank broke due to prolonged period of higher water levels not because of their extremely high water stage values.

In the presented study, statistical methods are used for evaluation of changes in the maximum volumes of runoff of the Danube River in Bratislava within two time periods: 1876–1940 and 1941–2005. In order to calculate these yearly peak runoff volumes of particular durations, a reconstructed 130-year series of the mean daily discharge of the Danube at the Bratislava gauging station was used. We calculated the 130-year series for the highest yearly 2-, 5-, 10-, 15-, 20-, 25-, 30- and 60-days wave volumes (V2–V60). Those series were subsequently divided into two 65-year series and changes in their cumulative probability distribution function were analyzed.

From the results it follows, that the both null-hypotheses, the both series have the same mean and have the same variance, were not rejected. These results are confirmed by values of the test H0 (test of mean values equality of all old and new runoff volume series V2–V60).

The conclusion is that the runoff volume regime during the floods (in term of mean values, variances and consequently of cumulative probability distribution function) has not changed substantially during the last 130 years, which is of importance to water management and water managers. This conclusion pertains not only the short-term flood runoff episodes (V2), but also the long-term ones (V60). With respect to the fact that hydrological regime of the Danube River at Bratislava has to a great extent a character of the Central-European mountain river, it is possible to extrapolate these results (particularly those claiming no climate change impact) also for other rivers in Slovakia originating in its Carpathian mountain region. In future, however, it will be desirable to confirm this hypothesis on other Slovak river(s) with long runoff data series, possibly on the base of reconstructed discharge values by indirect methods (analogy, mathematical runoff modeling etc.).

Keywords: Maximum runoff volume, Danube River, Climate change.

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STORM SURGES AT THE DANUBE RIVER MOUTH

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Storm surges are the special hydrological events at the Danube River mouth, depended on wind direction and speed in the nearshore zone. Positive storm surges and water level rise are caused by strong east winds, and negative storm surges and water level fall are produced by strong west winds.
Statistical analysis of observational data on annual maxima of positive and negative storm surges collected in the Danube nearshore zone (Primorskoe gauging station) in the recent 50 years showed that positive surges with a range of more than 1.0 m near the delta coastline have a probability of less than 5%, and negative surges of the same range have a probability of less than 0.3%. The maximum positive and negative surges of 50%-probability in the Danube nearshore zone are 45 and 32 cm, respectively. Extreme positive and negative storm surges in the Danube nearshore zone were observed in 1979 (+114 cm) and 1968 (–68 cm) respectively.
Surge-induced level variations in the Danube mouth area were examined by a method based on the analysis of surge attenuation along the delta branches and the river proper. The obtained results were used to calculate the propagation distance and the ranges of positive and negative storm surges at different gauging stations along the delta branches and the Danube River.
It was found that surge attenuation follows the exponential law and a decrement depends on river water discharge. Calculations shows that positive surges of 0.5, 1.0, and 1.5 m in the nearshore zone at a low river water discharge of the Danube of about 3000 m3/s can spread upstream over 209, 272, and 309 km from the sea. Negative surges of 0.5, 1.0, and 1.5 m in the nearshore zone at river water discharge of about 3000 m3/s can spread over 157, 204, and 231 km.
Surge phenomena, especially extreme ones, have a significant effect on the natural resources of river mouth and water management.

Keywords: positive and negative storm surges, wind, water level

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MODELLING THE EFFECT OF SMALL RESERVOIRS ON FLOOD REGIME IN THE CHOMUTOVKA RIVER BASIN

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The aim of this article is to present partial results of more extensive research which is focused on the impact of integrated flood protection on extreme hydrological events. One of several aims is to design a system of flood protection measures in a small mountain catchment. This system could cause the decrease of flood flows. With help of deterministic lumped model HEC-HMS (Hydrologic Engineering Center - Hydrologic Modeling System) several simulations of the impact of potential uncontrolled small reservoirs system on flood flows reduction were carried out. As an experimental catchment a headwater part of the Chomutovka River basin in the Ore Mountains was chosen (northwest of the Czech Republic, area 14,5 km2). In this catchment 3 locations which could be potentially used for establishment of small water reservoirs were proposed. First a hydrological model of the real basin (without reservoirs) was build up and with the help of measured data calibrated and verified. Then the reservoirs system was implemented. For assessment the impact on hydrological regime of the basin four scenarios were carried out – 10, 20, 50 and 100-year recurrence interval of 1-day precipitation.
In the first scenario the decrease of flood peak about 42 % in the outfall Tišina was simulated (present stage compared with hypothetical stage). In the fourth scenario (100-year precipitation) it was 21,18 % by "A" variant and 44,4 % in case of grater "B" variant. The sufficient function of small uncontrolled water reservoirs was approved.
Model HEC-HMS and its water control facilities model appears for this kind of hydrological problem suitable. However, it requires a precision by parameters derivation, mainly parameters of the dam body (number and location of culverts). A concept of the location of culverts in different levels (elevation) seems to be applicable. Through this concept a non-linearity of the outflow from the reservoir is ensured. In the following research it is necessary to better specify some parameters, such as the volume of reservoirs and also to propose sufficient total capacity which prevent extreme floods like in August 2002.

Keywords: Rainfall-runoff models, HEC-HMS, Floods, Flood protection, uncontrolled small reservoirs, Chomutovka River, Czech Republic.

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HYDROLOGICAL ANALYSIS OF HIGH WATERS AND FLASH FLOODS OCCURRED IN SEPTEMBER 2007 IN SLOVENIA

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Almost every year local heavy rain showers and flash floods appear in different parts of Slovenia. Heavy and abundant precipitation which captured the western, north-western and northern parts of Slovenia on 18 September 2007, caused quick rise of river discharges especially in the region of Baška grapa, Davča, the Cerkljansko and Škofja Loka hills. In that area the streams Selška Sora, Davča and Kroparica caused real destruction of infrastructure, homes and business. The torrential streams and rivers flooded also in the region of Karavanke and foothills of the Kamnik-Savinja Alps, Kranj and Domžale fields, the Tuhinj valley and extensive Celje region. The Savinja and Dravinja were high in the middle and lower stream. The peak discharges on the most flooded and affected areas exceeded the periodical maximum discharges measured at the water measurement stations. The return period of floods was there more than 100 years. The Sava was high mostly because of the high tributaries of the Sora, Bohinjska Bistrica, Lipnica, Tržiška Bistrica, Kamniška Bistrica and Savinja. The return period of the flood wave on the Sava was around 20 years. Besides flooding many landslides were triggered, what is usual for Slovenia at such hydrological situations. The result of this catastrophe was enormous economic damage and loss of six people's lives.

Meteorological forecast predicted the precipitation for September 18, but not in such a great amount, short period of time and its extent as happened afterwards. The unusually and unexpectedly heavy rainfall with extreme intensities covered the area of western, north-western and northern Slovenia. The highest amount of precipitation between 200 and 300 mm was registered in the region of Bohinj and hills of Cerkljansko and Škofja Loka. More than 100 mm of rain fell in north part of Ljubljana valley, in the surroundings of Celje town and in some parts of the Savinja catchment. Most of precipitation fell within 6 to 12 hours. The return period of the highest precipitation was more than 100 years.

There was not a lot of precipitation in Slovenia from the beginning of September 2007 and discharges of the rivers were low early in the morning of 18 September. Regarding to the meteorological situation on 18 September, the hydrological situation was the worst in the catchments of the Selška Sora, Cerknica, Bistrica, Lipnica, Tržiška Bistrica, Pšata, Kamniška Bistrica, Dravinja and some tributaries of the Savinja. The measuring equipment on the Selška Sora in Železniki stopped to work and flood wave was not recorded. The hydrograph was simulated by the HEC-1 model using Watershed Modelling System. The peak of flood wave is estimated to 278 m3/s, while the highest discharge from the observation period 1991-2006 is 148 m3/s occurred in 1995. Analysis of runoff coefficients showed that the coefficients were very small in the Sora catchment. The coefficients of direct runoff were about 0.27 and the coefficients of total runoff about 0.31. Regarding to small antecedent soil moisture and consequently low flows before the flood event, the infiltration into the soil was very high and that was also a reason for numerous landslides. One of them destroyed the hospital Franja, a historical monument from the Second World War. The river transport of sediment load was also very high during that event and the measured values of sediment load on some measuring sites exceeded periodical values.

Keywords: flash flood, precipitation, HEC-1 model, return period, hydrograph, runoff coefficient, September 2007.

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POSSIBILITIES OF HEADWATERS RETENTION POTENTIAL ENHANCEMENT – CASE STUDY UPPER OTAVA RIVER BASIN

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In context of catastrophic floods and extreme droughts in recent years there is an urgent need of solving of flood protection and drought problem questions using also untraditional practices such as gradual increase of headstream areas retention capacity. Therefore thorough analysis of peatbogs hydrological function and qualified reference of former ameliorative channels dyking implemented in Otava River source area (southwestern Czechia) is carried out by detailed comparison of hydrological regimes in its subcatchments with different peatland proportion. Peatbog influence on hydrological process can be considered also with respect to its affecting of water quality, respectively to ionic content including carbon and oxygen isotopes balance of water in periods of high or low discharges.
This project currently bear on existence of several water measure profiles with long time data series, on using modern methods (automatic ultrasound and pressure water level gauges, shuttle precipitation gauges) and upon results of bog pools detailed research. Thorough analyses of extreme runoff phases show higher frequency of peak flows and their shorter reaction to causal rainfall in case of highly peaty areas, therefore more distinct runoff variability of streams draining peatland localities. As well, detailed analysis of snow conditions including snow cover height and snow water equivalent determinations is carried out. Acquired data in the form of graphical outcomes show very significant snow reserves variability in relation to the altitude.
The problem of peatbogs hydrological function depends on a number of factors considering its type, health state, rate of anthropogenic impact, etc. In addition to considering dyking of former drainage channels we should also evaluate possible former accumulation reservoirs (used for wood floating) restoration with potential function as dry polders. Using complex system of hydrological models we can simulate runoff process and assess the effectiveness of these reservoirs. Implementation of such unforceable measures could contribute to reduction of peak flows and to increase of water resources during extreme droughts in future.

Keywords: retention potential, headstream area, flood protection, peat bogs hydrological function, water level gauge, runoff variability, peak flow, drought.

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EXCESSIVE AND ABUNDANT RAINS IN THE DANUBE PLAIN

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Besides the abundant continued rainfalls, of practical interest are also the excessive (vigorous), but short (of short duration) rainfalls, which often last a few minutes only or a small part of the hour. As it is known abundant is the daily rainfall higher than 30 mm.
Generally, we mean by excessive (heavy or torrential) rain a relatively short, but plentiful rain. These rains are distinguished from the abundant ones, which are also characterized by huge amounts of rain, but achieved in a longer time interval and with relatively lower rainfall rate. The pouring rains are usually local; characteristic for them is their high, but varying in time and place, rainfall rate, as well as the relatively small area they affect.
In our country as excessive rains are considered the ones of rates higher than 0.18 mm/min or over 30 l/(s.ha), irrespective of rain duration. Excessive rains are measured from the pluviograph with the method of the maximum intensity. Basic parameters for characterizing the excessive rains are the rainfall amount, the time duration (continuation) of the rain, and its rainfall rate evaluated by the amount of rainfall in a unit of time.
Following basic statistical characteristics for the excessive and abundant rains have been considered: average and maximum amount, frequency and repeatability in the region of Danube plain. Values expected at least once in N years are estimated.

PRECIPITATION INTENSITY PROBABILITY DISTRIBUTION MODELLING FOR HYDROLOGICAL AND CONSTRUCTION DESIGN PURPOSES

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The characteristics of rainfall intensity are important for many purposes, including design of sewage and drainage systems, tuning flood warning procedures, etc. Those estimates are usually statistical estimates of the intensity of precipitation realized for certain period of time (e.g. 5, 10 min., etc) with different return period (e.g. 20, 100 years, etc).
The traditional approach in evaluating the mentioned precipitation intensities is to process the pluviometer's records and fit probability distribution to samples of intensities valid for certain locations ore regions. Those estimates further become part of the state regulations to be used for various economic activities. Two problems occur using the mentioned approach: 1. Due to various factors the climate conditions are changed and the precipitation intensity estimates need regular update; 2. As fare as the extremes of the probability distribution are of particular importance for the practice, the methodology of the distribution fitting needs specific attention to those parts of the distribution.
The aim of this paper is to make review of the existing methodologies for processing the intensive rainfalls and to refresh some of the statistical estimates for the studied areas.
The methodologies used in Bulgaria for analyzing the intensive rainfalls and produce relevant statistical estimates:
- The method of the maximum intensity, used in the National Institute of Meteorology and Hydrology to process and decode the pluviometer's records, followed by distribution fitting for each precipitation duration period;
- As the above, but with separate modeling of probability distribution for the middle and high probability quantiles.
- Method is similar to the first one, but with a threshold of 0,36 mm/min of intensity;
- Another method proposed by the Russian hydrologist G. A. Aleksiev for regionalization of estimates over some territory, improved and adapted by S. Gerasimov for Bulgaria;
- Next method is considering only the intensive rainfalls (if any) during the day with the maximal annual daily precipitation total for a given year;
Conclusions are drown on the relevance and adequacy of the applied methods.

HYDRAULIC MODELLING OF A FLOOD DEVELOPMENT USING THE DHI MIKE11 PLATFORM (ON THE EXAMPLE OF NOVI ISKAR AREA)

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Devastating floods become more frequent in the recent years inundating a lot of industrial and riparian lands. That is why it is important to know the zones along the river reaches which are vulnerable to inundation. For this reason it is of great importance to have hydraulic modeling of discharges and water levels along those river terraces. The DHI MIKE11 platform and its “Hydrodynamic module” were chosen as a modeling tool. Another very helpful tool for defining the inundated area as a first approximation is the use of a high resolution images received from satellites. Such an image covering a region of 10 sq. km of the Sofia valley along the Iskar river up to the town of Novi Iskar was used for the flooded area determination and further as optimisation target.

For building the hydraulic model, the following parameters were defined:

relevant river network of the studied area,

cross-sections on the main river and all the tributaries in the modeled river network,

boundary conditions for the system,

timeseries with discharges, water levels and precipitation,

hydraulic structures in the studied area,

hydraulic parameters of the modeled river and its tributaries, which were further optimized to fit the optimization target.

The achieved results show that this modeling platform gives flexible instruments to realize the particular concept while the achieved modeling results show very good coincidence of the calculated flooded area with the one outlined from the satellite image. Conclusion is drawn that despite of the good modeling results, further efforts are needed in using different instruments for flood plains modeling. More specific attention should be paid to the hydraulic processes there.

TRENDS IN HEAVY PRECIPITATION IN THE CZECH REPUBLIC: COMPARISON OF TREND DETECTION METHODS AND NON-STATIONARY EXTREME VALUE DISTRIBUTIONS

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Trends in multiple characteristics of heavy precipitation over the area of the Czech Republic are evaluated using a high-quality dataset from 175 rain-gauge stations covering the period 1961-2005. The examined variables include maximum seasonal k-day precipitation amounts, rain intensity index, and percentage of total precipitation falling on days above long-term seasonal 90th and 95th percentiles of daily amounts. Changes in extreme precipitation indices derived from trend detection methods are compared with non-stationary extreme value models.

Results show that the temporal changes have been generally more pronounced in the western than eastern part of the country. Spatially coherent increasing trends are identified for all indices of heavy precipitation in winter in the western region, the relative trend magnitudes being mostly between 20 and 30% over the 45 years. Increasing but insignificant and spatially less coherent trends in heavy precipitation prevail also in summer. Opposite trends occur in spring (when they are related to declines in seasonal precipitation totals), and the changes are spatially least coherent and insignificant in autumn (in spite of the increase in mean precipitation).

The analysis partly supports an emerging picture of prevailing positive trends in precipitation extremes over the mid-latitudinal land areas in winter. However, the cut-off between the western and eastern parts of the Czech Republic in many precipitation characteristics, including the trends in winter-time indices of precipitation extremes, may indicate that the pattern of changes is more complex and less coherent in eastern than western Europe.

The study is supported under project B300420601 of the Grant Agency of Academy of Sciences of the Czech Republic.

Keywords: heavy precipitation, extreme value analysis, climatic variability, trend detection.

EXTREME VALUE MODELS FOR HEAVY PRECIPITATION IN REGIONAL CLIMATE MODEL OUTPUTS IN CENTRAL EUROPE

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Several regional climate models (RCMs) driven by two different global climate models are examined as to their abilities to reproduce frequency distributions of heavy precipitation events in central Europe, and their applicability for construction of scenarios of possible future changes is evaluated. The model runs include RCMs with a horizontal resolution around 50 km (available within the PRUDENCE project, Christensen et al. 2007) as well as high-resolution experiments with the HIRHAM RCM with 25 km and 12 km grids. Both control climate outputs (corresponding to the 1961-1990 period) and climate change scenarios for the late 21st century (2071-2100) under the SRES-A2 and SRES-B2 greenhouse gas emission scenarios are analyzed.

In the first step, individual grid-box extreme value models are applied into RCM outputs for the control climate corresponding to recent conditions, and their results are validated against observed distributions of extreme daily precipitation. Two common approaches to the extreme value analysis, the 'block maxima' and 'peaks-over-threshold' methods, are employed and compared. The peaks-over-threshold analysis with increasing threshold censoring is found particularly useful for estimating multi-year return levels of daily rainfall amounts (Kysely and Beranova 2008), with confidence intervals obtained from parametric bootstrap.

As control climate outputs of the RCMs suffer from a number of drawbacks related to the simulation of precipitation, climate change scenarios of heavy precipitation (based on differences between RCM outputs for the future and control climates) need to be interpreted with caution. The results for the late 21st century climate show that heavy precipitation events are likely to increase in severity in winter and with less agreement among models also in summer. The inter-model and intra-model variability (and related uncertainties) in the pattern and magnitude of the change are large, but the scenarios tend to agree with precipitation trends recently observed in the area, which may strengthen their credibility.

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Keywords: regional climate models, extreme precipitation, climate change, peaks-over-threshold analysis.

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GROUNDWATER DROUGHT IN DIFFERENT GEOLOGICAL CONDITIONS

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Within the hydrological cycle, groundwater is normally the last to react to a drought situation, unless surface water is mainly fed by groundwater. In deep aquifers the slow reaction of groundwater implies that only major meteorological droughts will finally show up as groundwater droughts. The lag between a meteorological and groundwater drought may amount to months or even years. (Tallaksen and van Lanen Eds., 2004).

The influence of meteorological drought on the baseflow formation was investigated in the upper part of the Nitra River catchment (central part of Slovakia) Topla and Ondava River catchments (eastern part). Time series (1983-2003) of discharges in six discharge gauging stations were processed and analyzed. In the Nitra River catchment, its right-side tributaries Chvojnica and Tuzina represent natural conditions of streamflow formation, left-side tributary Handlovka is strongly influenced by mining activities.

The catchments differ in climatic, geological and hydrogeological conditions. Volcanic sedimentary rocks, sandstones and conglomerates occurred in Handlovka River catchment, gneisses and migmatites occur in Tuzina and Chvojnica River catchments. Gravels and sands occur in Nitra River catchment and claystones and sandstones in Topla and Ondava River catchments.

The Bilan model and BFI estimation procedure were used for baseflow calculation. The Bilan model (Kasparek and Novicky in Tallaksen and van Lanen Eds., 2004) has been developed for assessing water balance components of a catchment using a monthly step. The BFI model (Morawietz in Tallaksen and van Lanen Eds., 2004) performs separation of the base flow from the total stream flow and calculates the Base Flow Index (BFI).

The whole observed period was classified according to yearly precipitation amounts; very dry, dry and normal years were defined. Topla River catchment is characterized by occurrence of 33 % of very dry years, which is the maximum value among all evaluated catchments. Frequency of dry years reached 33 % in all gauging stations except of Chvojnica and Tuzina. In the case of normal year occurrence, there were established the highest values for Chvojnica, Tuzina and Ondava (47 %) and for gauging stations in the rest of catchments it was 33%. Our research was focused on changes in baseflow values mainly in very dry years.

Very similar base flow values were determined using Bilan and BFI models. Because of different catchments size it was necessary to re-calculate the baseflow values into specific groundwater runoff values. We started with comparison and analysis of baseflow courses in very dry years in general in the whole observed time series and then especially in winter and spring months.

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Keywords: hydrological drought, baseflow, groundwater storage, soil water storage, model Bilan, model BFI.

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FLOOD REGIME OF THE COLD PERIOD OF YEAR IN TRANSCARPATHIAN AND FEATURES OF ITS FORECASTING

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Floods in the Tisza river basin are formed during any season of year. For this river basin are characteristic floods of mixed origin (rainfall and snowmelt floods), which pass during the cold period of year. Such regime of water content is caused by climatic features of this territory protected by mountains from cold air masses and at the same time accessible during all year for receipt of warm damp air from Atlantic and the Mediterranean (table).

Frequency of the maximal discharges/water levels

Territory (river basins)	Frequency of floods (%) for the periods	
	The cold period	The warm period
Eastern Transcarpathian (Upper Tisza, Teresva, Tereblya, Rika, Borzhava)	55-65	35-45
Western Transcarpathian (Latoryzya, Uzh)	70-80	20-30

During floods of the cold period as a result of snowmelt from high-altitude zones (200-400 m abs.) inflow 20-30 % of a runoff. For spring season the water runoff is formed from all high-altitude zones, mainly during 30 days.
The network of hydrometeorological observation in Transcarpathian is limited. But there is an opportunity to estimate/predict the characteristic of the cold period floods (layers, the maximal water discharges) from not studied catchments depending on landscape parameters of district.

Keywords: flood, cold period, warm damp air, river basin.

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LOW STREAMFLOW ANALYSIS OF THE LOWER DRAVA RIVER

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History shows that lower Drava is an important factor of social progress. The birth and growth of human settlements are related to the river. The Drava River is a source of water for many purposes, but it is also a natural wastewater recipient. Knowing the regime and characteristics of low streamflows are very important to different water management systems and structures, in view of planning, designing, construction, maintenance, exploitation and overall management. The low streamflows are specially important when different aspects of the water quality are discussed. The characteristic of low streamflow is to have the quantities of water in a streamflow, i.e. recipient, at the minimum and therefore the possibilities for dilution of pollution brought in are also minimal. Analysis of low streamflow of the lower Drava River is necessary as a starting point for consideration of future development trends, particularly those relating to protection of natural values of Drava and Danube rivers and Kopački Rit; stream capacity for receiving wastewater, and water quality protection.
The paper presents results of analysis of the Drava River low streamflows from the gauging station at the Lower Drava River – Donji Miholjac [77+700/ Drava rkm] in the period from 1980 to 2007. Frequency curves of minimum annual flows are widely used in the classification of streams according to their capacity for waste substance discharage and planning the development of surface-water resources. A low streamflow frequency curve for gauging stations, which shows magnitude for the various numbers of consecutive days against recurrence interval, is presented in the article. Also, analysis of stochastic processes of stream low flows is presented by the paper. The calculating method takes into account all essential components of the aforementioned process like deficit, duration, time of low-flows appearance, in addition to number, maximum deficit and maximum duration of low streamflows in the determined time interval.
In analysed period, mean annual flow is Qsr = 500 m3/s, maximum observed flow is Qmax=1891 m3/s, and minimum is Qmin = 157 m3/s. Only the deficit less than accepted truncation discharge has been stochastically analysed so the attention has been concentrated only to the lower extreme zone, that is to the partial duration series. As to the truncation discharge, the flow of 95 % of low-flow has been accepted, from the flow duration curve of the mean daily flows, Qr =243 m3/s. Number of 38 low-flows were recoreded within 28 years. There was a period of 10 years without low-flows. Low-flows were not recoreded only in May and June, whereas there were 6 low-flow days in April, and 1 low-flow day in July. Days with maximum recorded low-flows were in January - a total of 112, in February – 95, and in December – 66. The highest probability is to have only one low-flow per year, i.e. P(k=1) = 0,349. Maximum deficit in analysed period was Dmax = 186.019.200 m3, with maximal observed duration 94 days, and average deficit was Davg = 19.828.800 m3. Ten-year recurrence interval of deficit is D10 = 82*106 m3, i.e. 100-year recurrence interval D100 = 158 *106 m3, during one year interval. The extreme low-flow duration of 10-year recurrence interval T10= 45 days, i.e. 100-year recurrence interval T100= 86 days, for one year interval.

Keywords: Lower Drava River, hydrology, discharge, low streamflow, truncation level.

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EXTREME HYDROLOGICAL EVENTS ON THE LOWER DANUBE AND IN THE MOUTH AREA DURING RECENT DECADES

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Late in the 20th century and early in the 21st century, a frequency of catastrophic hydrological events on the Danube River increased. Extreme hydrological events in the Danube River basin and also in the basins of the other European rivers (Elbe River in Germany, Kuban' and Terek rivers in Russia, etc), happened over the latest years, are evidence of new tendencies in the meteorological and hydrological processes. Global climate warming, intensification of synoptic processes, increment in the total amount of precipitation and its irregularity resulted in an increase in a frequency of extreme hydrological events.

In a frame of our investigations, we consider:

(i) Formation and transformation of the catastrophic rainfall flood along the Danube River in August, 2002, when at a number of gauges on the Middle and Lower Danube water levels exceeded historical maxima and caused inundation. The preceding synoptic situation and the basic features of the flood movement along the Danube River are revealed.

(ii) Formation of the extreme spring–summer flood in March–June 2006, when water levels on the Lower Danube also exceeded historical maxima. The rise of water levels in the mouth area was accompanied by strong storm surges and led to inundation.

(iii) Peculiarities of the extreme low water period (drought) in August–October 2003, when water levels in the Danube River mouth area were the lowest since 1950.

In our study, we use the results of join Russian and Ukrainian investigations of the regime of the Lower Danube and delta, and hydrological and meteorological observational data of Danube Hydrometeorological Observatory. Long-term trends in changes in many hydrometeorological characteristics are revealed. During recent decades, the air and water temperature, the amount of precipitation increased. The water runoff of the Lower Danube increased in spite of water withdrawal and evaporation losses from reservoirs. The impact of above-mentioned extreme events and other changes in regime of the Danube River on the hydrological and morphological processes in the mouth area including delta and nearshore zone of the Black Sea is shown.

Keywords: extreme hydrological events, rainfall flood, spring and summer flood, low water period, drought, inundation.

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THE EXTREME HYDROLOGICAL FENOMENOENS IN SUPERIOR HYDROLOGYCAL TANK OF THE IALOMITA, DURING 2000-2005

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The superior hydrographic tank of Ialomita is situated in the south of Romania,the south of the Mountains Bucegi and of the Ialomita Subcarpathyans, on a surface of about 686 km. The Ialomita river has its spring at 2450 m hight, underneath Bucura Peaks ad the Turkish Mecet, and after a distance of 71 km, the river is headed in the high plain area, near Doicesti. The river receives in this space, 13 effluents (7 on it's left and 6 on it's right –all with a length over 5 km).
In order to understand and analyze the climate conditions that influence the liquid leak regime numerous statistic and mathematic data have been used, from over 13 meteorological stations(Vf. Omu,Voinesti and Targoviste), and for the liquid leak, 13 hydromechanics stations.
The period above mentioned was taken into consideration because a series of deviations from the multianual average of the last 40 years. In order to explain this we can mention the alternation of the drought years (2000), when an etiaj leak has been registered which affected the sewage regime of the localities from this geographical space, but also of the socio-economical activities, with the raining years (2001,2005),when extreme hydrological phenomen on have occurred (floodings, storms). Some of these manifestations have been characterized through historical flows, fact that lead to changing the attention parts, danger and floods.

Keywords: climate conditions, liquid leak, flloods.

STATISTICAL LINKAGE OF DAILY PRECIPITATION IN BULGARIA TO ATMOSPHERIC CIRCULATION

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The non-homogeneous hidden Markov model (NHMM) introduced by Hughes and Guttorp (1994) links large-scale atmospheric patterns to daily precipitation data at a network of rain gauge stations via several hidden (unobserved, latent) states called the “weather states”. The evolution of these states is modeled as a first-order Markov process with state-to-state transition probabilities conditioned on some indices of the atmospheric variables. Due to these weather states the spatial precipitation dependence can be partially or completely captured. In this study an 8 state NHMM is developed to relate daily precipitation amounts at 32 stations covering broadly the territory of Bulgaria to synoptic atmospheric data. At each site a 40-year record 1960-2000 of daily October through March precipitation amounts is modeled. The paper is a continuation of Neytchev et al. (2006) who studied the cold half years period 1978-1988. The atmospheric data consists of daily sea-level pressure, geopotential height at 500 and 850 hPa, air temperature at 850 hPa and relative humidity at 700 and 850 hPa on a 2.5° x 2.5° grid based on NCEP-NCAR reanalysis dataset covering the Europe-Atlantic sector 30°W–60°E, 20°N–70°N for the same period (http://www.cru.uea.ac.uk/cru/data/ncep/). The first 30 years data are used for model fitting purposes while the remaining 10 years are used for model evaluation. Detailed model validation is carried out on various aspects. The proposed model reproduces well the rainfall statistics for the observed and reserved data whereas the identified states are found to be physically interpretable in terms of regional climatology.

Keywords: Hidden Markov Model, Precipitation Amounts Model, Statistical Downscaling.

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PRECIPITATION DEFICIT PERIODS IN THE DANUBIAN LOWLAND IN SLOVAKIA

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Geographic position of Slovakia creates preconditions for existence of the temporary precipitation deficit periods resulting in drought mainly during transition seasons (spring and autumn) as well as summer. Not only precipitation deficit but also precipitation surplus represents a trouble that cause increasingly more significant and widespread damages. In the term of precipitation deficit period occurrence in the Danubian lowland region in Slovakia represent potentially the most endangered areas by drought. However our experience from climatological practice indicates increasing risk of the precipitation deficit incidence even in other region of Slovakia. The ascending extent of regional of precipitation deficit period is also very significant. Selected meteorological stations from which the daily precipitation totals data sets are available within the above mentioned period are situated in different natural and climatological conditions in Slovakia.
The long-term time series of daily precipitation totals available from the end of 19th century, respectively from the beginning of the 20th century to present period have made us possible to analyze the incidence of the precipitation deficit period in Slovakia.
In our previous statistical and regional analyses of precipitation deficit periods within the 1901-2006 period we have revealed the noticeable changes not only in occurrence frequency but also in annual regime of drought periods occurrence in the most southernmost regions within the Danubian lowland in Slovakia. The Danubian lowland represents from the economic viewpoint the most eminent and interesting region in Slovakia.
In the paper we deal with the statistical trend and frequency analysis as well as with the annual regime and regional extent analysis of the precipitation deficit periods incidence at selected meteorological stations in Slovakia, mainly in the Danubian lowland region. Recently climate in the Danubian lowland begins to show some features typical for the Mediterranean region with its warmer spells and aridization trends.

Keywords: precipitation deficit periods, the Danubian lowland region, drought, aridization trends, Konček´s moisture index, climate scenarios.

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T-YEAR MAXIMUM DISCHARGES ON WATER COURSES IN SLOVAKIA

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T-year maximum discharges serve the purpose of background for design, building and operation of water management constructions and facilities, regulation of water courses, flood protection and environmental protection. The Slovak Hydrometeorological Institute (SHMI) processes and provides these data according technical standards.
When preparing design discharges in Slovakia, it is a tradition that the whole territory of state is processed and the system of river network is considered. This way was also applied for data updating (finished in 2006) with new methods and technologies (GIS). Contribution describes methodology and results of mentioned updating.
Background materials were time series of hydrological data obtained from surface water stream-gauging stations during the whole observation period (minimum 20 years). In every stream-gauging station there was made a very important and difficult analysis and adjustment of maximum annual discharges.
T-year maximum discharges in 340 stream-gauging stations were calculated using mathematical-statistic methods. 7 theoretical distributions were used for values calculations with moments method, maximum likelihood method and weighted moments probability method for parameter estimation.
In the profiles without observation pooling scheme of 100-year maximum specific discharge (qmax.100) was applied. Input data were time series from selected 197 stations with catchment area from 20 to 300 km2 and minimum impact of anthropogenic activities.
Homogeneous regional types were selected by cluster analysis (10 homogeneous regional types were selected) and according residual deviations of regression relation qmax.100 from physiographical and climatological catchment characteristics for the Slovak Republic (8 homogeneous regional types).
Applied methods for T-year maximum discharges estimation are influenced by several uncertainties, logical principles have to follow in the system of stream network (e.g. T-year maximum discharge under the confluence is less or equall of tributaries sum, generally discharge is higher with catchment area increasing...).
New interpolation top-kriging method utilizes topology of stream network and contribution of area size. This method was applied in the river Hron basin.
With methodology mentioned above T-year maximum discharges were determined in stream-gauging stations and significant profiles in Slovakia.
Estimated values and new methodology are using for data providing for design, building and operation of water management constructions and facilities, regulation of water courses, flood protection and environmental protection in Slovakia.

Keywords: T-year maximum discharges, pooling scheme of 100-year maximum specific discharge, topkriging, stream-gauging stations, flood protection

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MULTIPLE-COINCIDENCE OF FLOOD WAVES ON THE MAIN RIVER AND ITS TRIBUTARIES

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This paper addresses the definition of multiple coincidences of flood waves on the main river and its tributaries. Contrary to previous studies of partial coincidences of various flood parameters (Prohaska, 2000) for the main river and one of its tributaries, this procedure allows for the definition of complex (multiple) coincidences of a single parameter for the main river and several of its tributaries.
Due to pronounced complexity of flood origin on the considered rivers, there were analyzed the largest annual flood-volumes above discharge corresponding to 50% duration of the daily flow. It was assumed that flood wave of the Danube River at GS Pancevo with the exceeding probability, θ, is formed by corresponding floods at Bogojevo having the exceeding probability p (return period T) and arbitrarily chosen combinations two-dimensional coincidence of flood at the Tisza River near Senta and the Sava River near Sremska Mitrovica. Using the devised procedure there was formed a relationship of the probabilities of coincidence of flood events at the considered stations in the form:

$$p(Wiz,p=\theta)Pan = P((p(Wi,p=T)Bog \cap p(Wj,r)Sen \cap p(Wk,z)Sr.M) \quad (1)$$

where:

p(Wiz,p=θ)Pan	Exceeding probability of flood volume of the Danube River at exiting profile near Pancevo,
p(Wi,p=T)Bog	Exceedance probability of flood volume at the inflowing profile of the Danube River at GS Bogojevo,
p(Wj,r)Sen	Probability of flood wave of the Tisza River near Senta (inflow profile into the considered river section),
p(Wk,z)Sr.M	Probability of flood wave of the Sava River near Sremska Mitrovica (inflow profile into the considered river section).

The results of evaluation of the multiple coincidence of floods on the Danube, Tisza and Sava Rivers for a 1000-year flood of the Danube River near Pancevo are presented in Figure 1.

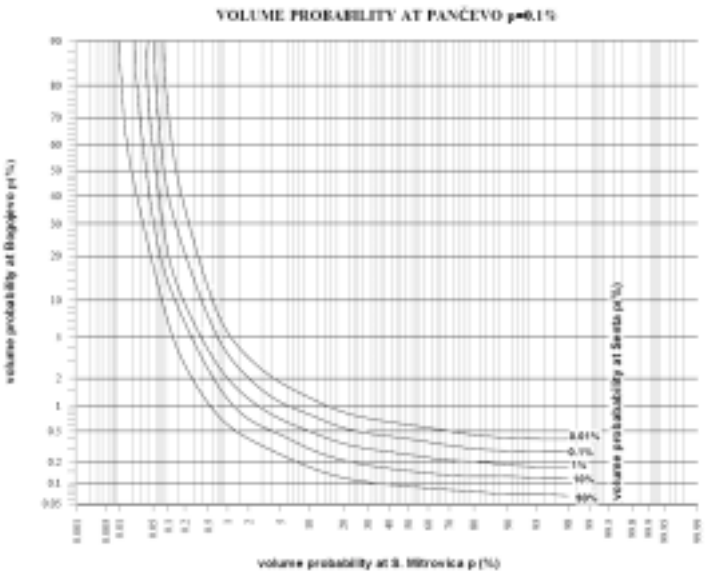

Figure 1. Multiple coincidence of 1000-year flood of the Danube River near Pancevo as a function of floods of the Danube River near Bogojevo and the Tisza and Sava Rivers near Senta and Sremska Mitrovica, respectively

Numerous list of practical uses of the developed methodology for analyses of flood coincidence at the Danube River and its tributary the Tisza and Sava Rivers suggest broad opportunities for application in water resources management. The most frequent applicability is tied to flood protection and river bed training. It can, also be used in real time forecasting and flood warning. This paper contributes to an improvement of practical – engineering hydrology, particularly with regard to assessment of flood events and comprehensive flood-risk analyses.

Keywords: Multiple-coincidence, flood wave, flood wave volume, two-dimensional distribution function, cumulative probability function, exceeding cumulative probability.

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SPATIAL-TEMPORAL EVALUATION OF MAXIMAL QUANTITY OF PRECIPITATIONS FOR HYDROLOGICAL CALCULATIONS AND FORECASTS

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At estimation of statistics of maximum quantities of precipitations for the certain time intervals (12, 24h.) often use data adhered to standard terms of observation. In such cases quantities of precipitations of one rain appear quite often dismembered between contiguous days. Therefore the maximal precipitations for a day appear reduced, compared with their values for 24 hours. So during a flood on November, 4-5, 1998 in the Tisza river basin the difference between the maximal precipitations for meteorological day and 24 hours which have been not limited by certain terms, represented in 22 items 20-50 % (10-60 mm). Therefore it is expedient to generalize the maximal precipitations for 12 or 24 hours.
The quantitative indexes of maximal precipitations for the definite period of time only then have a value, when their repetition is known within the limits of district, homogeneous in physiographic relation. Therefore accurate idea of temporal and spatial distributions of maximal precipitations it is possible to get through the district curve distributions of probabilities, built owing to the period's method on a single consistency which is created by uniting of a data from a few observation stations. It is thus, that there is the identical mode of precipitations in a certain district, only their maximal quantities are distributed by chance on territory.
The incorporated aggregate of maximal precipitations has a volume N, if the measure of every realization is equaled to n_i at their common amount m:

$$N = \sum_{1}^{i=m} n_i$$

For an example, in the mountain part of the Dnister river basin (square - 14 thousands of sq.km.) are selected 6 homogeneous districts on distributing of precipitations, caused the features of location of mountain ranges of the Carpathians. The quantity of observation stations after precipitations presents in every district 4-6. The estimations of maximal precipitations of 1% probability exceeding for 12 hours, calculated for these districts owing to the period's method, there are 70-110 mm within the limits. Maximal precipitations of 5 % probability hesitate on the selected districts from 50 to 75 mm for 12 hours.
Such generalization of maximal precipitations allows getting the reliable detailed information about their spatial-temporal regime.

Keywords: maximum quantities, precipitations, mountain part, homogeneous districts.

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QUALITY MANAGEMENT FOR DISCHARGE MEASUREMENTS IN BAVARIA

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The hydrology of surface waters is based on the knowledge of the two main hydrological parameters, water level and discharge. These data are not only needed for almost every hydrological planning, but are very important for the management of high and low water.
Our long term goal is a complete registration of every natural runoff – covering everything from low to high water – at our 600 measuring stations using limited resources but at the same time achieving high reliability and quality. To this point we are currently enforcing the use of modern data acquisition technology for water level and discharge measurements. The new techniques enable a continuous registration of water levels, actual velocity and consequently the discharge. Currently we are using gauging methods like the well known bubble gauge and radar, while the ultrasonic systems become more and more frequent. The moving boat techniques using the ultrasonic-doppler-systems (e.g. ADCP, Q-Liner) are gradually substituting traditional methods for discharge measurement. In addition to that hydraulic methods (e. g. SIMK) are being incorporated in the measuring systems as well.
Since the start in the year 2000 almost all gauges have been equipped with data loggers and automatic data transmission systems. One of the outcomes of these investments is the online availability of hydrological data on our website (www.hnd.bayern.de). Needless to mention that this step requires high quality data and a lot of effort has to be made in order to guarantee these high standards. A highly efficient quality management system is therefore obligatory.
To achieve this goal, a new project has been initiated to improve the present rating curve. By means of hydraulic calculation the curve will be verified and if necessary adjusted to minimise deviations in the near future, which is of high importance especially for the forecast of flooding.

Keywords: hydrology, quality management, flooding, gauges, technical improvements.

THE EVALUATION OF ECOLOGICALLY ACCEPTABLE FLOWS IN SLOVENIA

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Excessive water abstractions from watercourses constitute a negative impact on the structure and functioning of aquatic and riparian ecosystems. In order to preserve and improve the aquatic ecosystems it is therefore necessary to maintain adequate quantity and quality of water in watercourses, which can be ensured by providing ecologically acceptable flow (EAF).
In Slovenia, a large diversity of watercourses regarding their hydrologic, morphological and ecological characteristics dictates the determination of EAF separately for individual sections of watercourses. From 1994 until the end of 2006, EAF was determined at 187 watercourse sections in Slovenia, for the existing (163) and new water users (24). The EAF values were determined for water abstractions from watercourses and for outlets from storage basins. Of the total of 187 EAF value determinations, 61 were implemented in the sections of watercourses with the catchment area larger than 100 km2, while 126 EAF value determinations were on smaller watercourses.
According to the review of EAF determination studies, it may be concluded that the determination of EAF values for water abstractions intended for energy purposes prevailed, followed by the EAF determination for fish farms, drinking water and industrial purposes. On the basis of hydroecological method, the EAF was determined at 145 watercourse sections and 42 on the basis of modified ecohydrological method.
The results of the analyses have shown that the EAF values vary substantially both with regard to the sQn (mean minimum flow in the considered period) values and the sQs (mean flow in the considered period) values. This implies that it is not possible to generalize as to which proportion of the sQn value or the sQs value represents the EAF value. This is proven also by the findings of numerous experts throughout the world (Acreeman and Dunbar, 2004). The analysis results support the basis for EAF determination used in most countries of the European Union, namely, that an interdisciplinary approach is needed in the determination of EAF and for each watercourse section separately, whereas the hydrological data represent only a certain base value for the EAF determination. The determination of EAF moves in the direction of the determination of dynamic EAF values, e.g. the determination of acceptable water flow by individual months. The EAF value must ensure the water regime of watercourses preserving the aquatic and riparian ecosystems while, where ecologically and economically feasible, still enabling water abstraction.
Concerning the water abstraction, the determination and provision of EAF is one of the best protection measures for watercourses in Slovenia, as also a principal measure leading to the improvement within the framework of the river basin management plan.

Keywords: ecologically acceptable flow, rivers, Slovenia.

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DETAILED ESTIMATION OF WATER LEVELS IN THE TISZA BASIN FOR DETERMINATION OF STREAMSIDE FLOODING AREAS PROBABILITY

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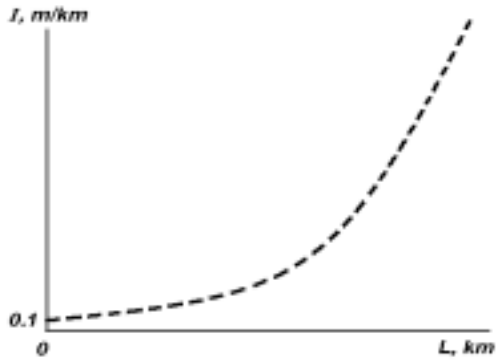
With the purpose of definition of the streamside flooding areas and flooding of settlements in the Tisza river basin is created an informational system Tisza-7. The calculation of water levels in absolute marks is carried out in two stages: (a) in the ranges of profiles certain through 5 km on the Tisza river and its basic inflows (12 rivers); (b) near 99 settlements, which are located along these 12 rivers and also can be flooded.
Total quantity of diameters - 224, including a stretch of the Tisza river in the territory of Hungary. At presence of the necessary information water levels are defined for all diameters and settlements.
The loading diagram of system Tisza-7 is constructed with use of forecasted or predicted data about water levels from 32 hydrological posts and inclination of water surface on river areas between posts and length of these areas. Such principle allows calculating water levels in absolute marks with their detailed representation on river areas near necessary posts. Water charges are used only for evaluation of predicted levels as the calculation method of water weights moving does impossible to receive water levels outside hydrological posts.
For definition of water surface river slope (I) are constructed their dependences on distance (L) up to a mouth or diameter № 1 for all 12 rivers of the Tisza river basin. Dependences I=f (L) have a typical aspect (Figure).



Inclinations change in significant limits, especially in a lower reaches of the rivers with an output on the Zakarpatya lowland - from 6-30 up to 0,09-0,14 m/km. At definition of inclinations are applied such approaches: interpolation between ranges of the posts, estimation during floods, comparison of the calculated levels with certain at flooding settlements, the spatially-resulting analysis with the attraction of morphometric characteristics, research of river slope variability at different height of floods, including owing to influence of receive rivers.

For the input information in the system Tisza-7 are used data about water levels for the certain term or their forecasting values. In the latter case results of calculation will have greater earliness, especially on the Tisza river and in the lower reaches of its inflows. There are the most expedient interaction of the system Tisza-7 with the basin forecasting system “Tisza” which includes 4 subsystems of a short-term forecasting of a runoff variation and one subsystem of a long-term forecasting of a spring flood characteristics (Sosedko, 1987; Susidko 2000; Luk’yanets et al., 2000).

Keywords: water levels, river basin, flooding area, condition, hydrological stations, river slope

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DETECTING AND MONITORING OF DROUGHT IN SERBIA AND SOME EXAMPLES OF EXTREME DROUGHT EVENTS

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A major stady of droughts was conducted to develop a basis for quantative assessment of drought conditions in territory of Serbia. Such information should aid decision making related to local and state actions to mitigate the effects of future droughts. Procedures are given for assessing the most important aspects of drought in terms of precipitation conditions. The classification system linking values of the Standardized Precipitation Index (SPI) with drought intensities was transformed in criteria of drought occurrence and severity, as percent of the mean values of precipitation for any given time period.

Routine monitoring of daily and monthly precipitations, including and some soil water balance components, serves to detect onset of drought and its duration. Because of the slow-onset nature of drought, there is a possibility for establishing an early warning system which will have capacity to detect early emergence of rainfall deficiencies, as the best indicator of an incipient drought period. This information should be supplemented by long range forecasts of precipitation and temperature out to a month or season, which are at this time widely disseminated all around the world.

MODELLING SNOW ACCUMULATION AND SNOW MELT IN A CONTINUOUS HYDROLOGICAL MODEL FOR REAL-TIME FLOOD FORECASTING

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The objective of this paper is to present results of snow modelling with a continuous hydrological model in the context of a real-time flood forecasting system in an alpine Danube tributary basin. In alpine basins snow melt can contribute severely to flood runoff and its accurate modelling is of central importance to flood forecasting. In order to provide adequate system states for all flood events the processes of snow accumulation and snow melt need to be simulated continuously.
Snow modelling generally faces problems of snow data scarcity. Snow depth is measured at many stations, but mostly in the valleys, and snow density and snow water equivalent are not measured regularly. Remote sensing data such as MODIS snow cover images can provide spatial information. Available snow data typically are not transmitted in real-time and therefore cannot be used as input for real-time flood forecasting. The same applies to measurements of radiation. Though precipitation measurements are known to have considerable errors especially in winter, they are, together with temperature measurements, commonly the only available input for the simulation of snow system states in the context of real-time flood forecasting.
In the presented continuous, semi-distributed rainfall-runoff model snow processes are calculated for hydrological response units derived from intersection of subbasin boundaries, soil types, land cover and 200 m elevation bands. Only precipitation and temperature are needed as input. Separation of precipitation into rainfall and snowfall is effected with two threshold temperatures. Snowfall is distributed to five internal snow classes with a log-normal distribution to consider variable snow-depths within a zone. Snowmelt is simulated with a temperature-index approach with spatially distributed, seasonally varying melt-factors. Higher reflection of fresh snow is considered by a reduction of the melt-factor after the snowfall event. The model also accounts for evaporation from snow, retention of liquid water in the snow pack, refreezing of retained liquid water, and settling of the snow layer.
The model was implemented in a flood forecasting application in the Salzach basin. The presented results were obtained in its most upstream part, where the influence of snow melt on runoff is highest. This upstream basin has an area of 600 km², with altitudes ranging from 800 to 3600m a.s.l. The model was calibrated manually against measured runoff with precipitation and temperature regionalized from daily ground measurements of five years and hourly precipitation and temperature analyses incorporating ground and radar measurements of two years.
Seasonal variations of runoff due to snow melt were reproduced accurately in the resulting runoff simulations. Simulated snow depth and snow covered area were evaluated with snow depth ground measurements and MODIS snow cover maps. Strengths and limitations of the model and the quality of the input data were assessed. Tests with multi-objective recalibration showed little effect on simulated runoff in the period of largest contribution of snow melt to floods. Evaluation results with MODIS information and with snow depth ground measurements lead to similar conclusions. This demonstrated the value of MODIS snow cover images as a source of information for hydrological modelling in alpine areas, where ground observations are scarce.

Keywords: snow modelling, rainfall-runoff modelling, flood forecasting, alpine hydrology, MODIS snow cover data.

EXTREME FLOODS IN THE KRKONOŠE MTS. (CZECH REPUBLIC) IN SUMMER 2002 AND 2006

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Hydrological and meteorological conditions preceding two extreme periods of rainfall in the Krkonoše Mts. in summer 2002 and 2006 are discussed in the article. We analyze the role of insufficient plant transpiration in the formation of the two events. Heavy rains in August 2002 and 2006 were caused by cyclones of Mediterranean origin, which moved from Hungary to Poland over the eastern part of the Czech Republic (Brázdil et al. 2006; Řezníčková et al. 2007).

The Modrý Důl catchment area is situated in the eastern part of the Krkonoše Mts. (crystalline complex of the Krkonoše Mts.). The drainage area of this catchment area covers 2.62 km2. The highest point is Studniční hora Mt. (1554 m a. s. l.), the minimum elevation of the closing profile is 1010 m a. s. l. The soil types are Humic Podzols and Lithic Leptosols with a very thin humic layer; deeper soil of about 60 cm depth can be found in the bottom of the valley. The lower part of the basin supports the original spruce forest, while arctic-alpine tundra with dwarf pine covers the upper part above the timberline. The climatic conditions correspond to the characteristics of the cold humid climatic zone. The mean annual precipitation ranges from 1200 to 1300 mm. The mean air temperature in July is 12.1ºC. The maximum total retention of water in the basin is about 70 mm.

Automatic monitoring stations were installed at four localities with different vegetation cover. Air temperature was measured at two levels (5 and 200 cm above the soil surface). Soil temperature was measured at three depths (15, 30, 60 cm). Soil water availability for plant transpiration was evaluated using tensiometric pressure measured in the soil at four depths (15, 30, 45, 60 cm). The discharge at the closing profile was continuously recorded. An automatic meteorological station was placed on Studniční hora Mt.

Meteorological data demonstrate that air temperatures were high for many days before the extreme rainfall. This means that overheating of the air was caused by insufficient precipitation, resulting in the lack of transpiration cooling of the landscape. In contrast, high tensiometric pressures before the extreme rainfall provide evidence that plant transpiration was not limited by water shortage in the area of Modrý Důl. This means that the source of overheating laid outside the Krkonoše Mts. The relation between potential transpiration and precipitation in the Czech Republic during 1961–1990 showed an appreciable decrease in the driest area and an apparent increase in the wettest area during 1981–1990 compared to 1971–1980. These results indicate that the cause of the air overheating is not an increase in incoming solar energy or a reduction in precipitation, but is probably due to (a) a reduction in the water retention capacity of the landscape, (b) increasingly extreme precipitation, and (c) a reduction in forest areas in the studied region.

Keywords: hydrology, extreme floods, land warming, plant transpiration.

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FLOOD RISK MAPS IN THE CZECH REPUBLIC

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According to the Flood Directive (Directive of the European Parliament and of the Council on the assessment and management of flood risks) the process of preliminary flood risk assessment started in the Czech Republic. Part of this process is development of a methodology for construction of Flood Risk Maps. The methodology defines the applicable data resources and contains procedures and methods for the assessment of flood risks. The methodology is based on Risk Matrix, which combine return period of floods, water depth, and velocity of stream in floodplains. There are two results: flood hazard and flood risk maps.
Possible use of results of the risk analysis in floodplains can be in many ways, constituting the groundwork for the decision-making about the alternatives of spatial development in endangered zones, for flood prevention, for the planning of the rescue work during floods, for the awareness of public about the existing risks, and so forth.

Keywords: flood hazard, flood risk, Risk Matrix, flood risk maps.

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ESTIMATION OF THE SHARES OF THE SLOVENIAN SAVA RIVER'S TRIBUTARIES IN THE SAVA RIVER'S MEAN DAILY FLOW AT THE TIME OF HYDROLOGICAL DROUGHTS

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The Sava River runs 945 km from northwest to southeast, rising in Slovenia, continuing across Croatia and Bosnia and ending in Serbia at its confluence with the Danube in Belgrade. It contributes approximately 25% of the Danube's total discharge and has a drainage area of approximately 96 400 km^2, which represents approximately 15% of the Danube River basin.
In Slovenia, the Sava River basin forms the central part of the country and has a drainage area of 11 761 km^2. There are five in-stream hydropower stations situated on the Slovenian part of the Sava River and more hydropower plants are planned to be built in the near future, so knowledge about streamflow behaviour of the Sava River's tributaries during rainless periods is of high importance in the decision-making processes regarding water-related issues. The main tributaries of the Sava River in Slovenia are the Sava Dolinka, Radovna, Sava Bohinjka, Trziska Bistrica, Kokra, Sora, Ljubljanica, Kamniska Bistrica, Savinja and Krka rivers.
Analysis of the low flow hydrological situation on the reach of the Sava River from its spring to the Vrhovo Hydropower Station was performed by using two different methods. Structural shares of the Sava River's tributaries in the Sava River's mean daily flow at the time of hydrological droughts were estimated. First method included identification of the longer low flow periods in the Sava River basin and estimation of the daily based structural shares of the Sava River's tributaries in the Sava River's mean daily flow. The other method was calculation of the characteristic low flow statistics Q_{95}, Q_{90} and Q_{50} for all of the final gauging stations on the Sava River's tributaries and calculation of the relationships between them.
Results were compared and useful information about the hydrological situation on the Slovenian part of the Sava River at the time of hydrological droughts was obtained. From the obtained results we can estimate that the Sava Dolinka and Sava Bohinjka rivers contribute approximately 30% of the Sava River's discharge, that the Radovna and Trziska Bistrica rivers contribute approximately 15% of the Sava River's discharge and that the Kokra River contributes approximately 5% of the Sava River's discharge during the time of hydrological droughts on the reach of the Sava River from its spring to the Mavcice and Medvode hydropower stations. On the reach of the Sava River from the Mavcice and Medvode hydropower stations to the Vrhovo Hydropower station the Sora River contributes approximately 25% of the Sava River's discharge, the Ljubljanica and Savinja rivers contribute between 35 and 40% of the Sava River's discharge and the Kamniska Bistrica River contributes approximately 5% of the Sava River's discharge during the time of hydrological droughts.

Keywords: low flow hydrological situation, the Sava River, structural shares of the Sava River's tributaries, characteristic low flow statistics, hydrological droughts.

THE MINIMUM FLOW IN THE UPSTREAM BASIN OF THE TIMIS RIVER

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The minimum flow represents a very important stage of the water flow, especially during the long periods lacking rainfall, in the cold season, but also in the dry seasons.
Due to this fact, we made an analysis of this stage of the water flow in the upper basin of the Timis River, upstream the Lugoj hydrometric station. This part of the hydrographical basin presents a major importance due to the fact that downstream this hydrometric station at about 7 km there is The Costei Hydro technical Knot, through which at low water levels, the entire quantity of water in the Timis river goes towards the Bega river.
The hot period of the year 2007 was characterized in Romania by the presence of some very long periods with high temperatures (the maximum values being of over 390 C in many regions) and lacking rainfalls. Under these circumstances very low values were recorded on rivers, drastic drops of underground water reserves – having as an effect the appearance of drought in certain hydrographical basins.
In the analysed hydrographical basin the values of the minimum water quantities during the summer were situated around the assurance values of 75%.
This allows us to conclude that this summer wasn't among the driest, lower values being recorded in 1950-1955, 1957, 1962, a.s.o.

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THE EXCEPTIONAL FLOOD REGISTERED ON THE RIVER CERNA IN JULY 1999

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The Cerna River is the first important tributary of the Danube River on Romanian territory; its river basin is formed of 2 main streams – Cerna (F=465 km2) and its tributary – Bela Reca (713 km2).
The year 1999 has been important because of the producing of some floods with a relative rare probability of appearance, which appeared in different river basins across Banat area.
In July 1999, large amounts of rainfall have been recorded in the hydrographic basin of the Cerna River, which were higher than the average monthly multiannual with about 200%. It is imperative that we notice the fact that out of a total monthly rainfall, more than half was produced in one single day (12th July).
In the analyzed hydrographic basin, there are 2 storage lakes. All these triggered not only the production of electric energy but also overtook volumes during the flood, thing that favored the considerable reduction of losses; considerable volumes of water were retained in these storage lakes. The analysis has also included reconstitution of the flow of water which observed the values that would have been recorded if this accumulation hadn't existed.
The analysis proves that certain elements (duration of the flood, growth time) are bigger than the average figures, while the others are more reduced.

Keywords: Cerna River Basin, exceptional flood, 1999, july.

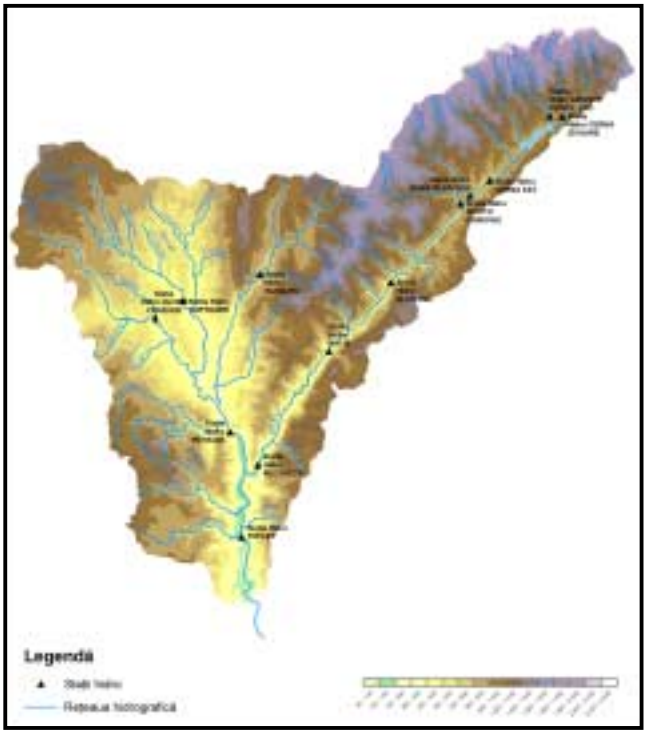

Figure 1. . *The Cerna River Basin*

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THE MAIN CHARACTERISTICS OF THE HIGH WATER REGISTERED IN BEGA RIVER BASIN DURING FEBRUARY 1999

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The year 1999 was characterized by high water events with a rare probability of appearance, produced in different months of the year, in different river basins from the Banat Region.
In Bega River Basin the most important high water appeared in the middle of February and was generated both by rain and snow layer melting.
The cold period of 1999 was characterized by relatively high quantities of precipitation (module coefficients from 1,17 to 2,15), the most part of those being liquid (rainfall). At altitudes higher than 1000 m, the snow layer was relatively continuous. Weather warming appeared in the middle of February, in the same year, generating the melting of an important layer of snow, overlaid on the water layer generated by rainfall.
The high water (flood) event, appeared between 20 - 27 February 1999 and we did some comparison between the main element of the event (specific discharge, high water duration, increasing time, shape coefficient) and the mean element of high waters.
After the analyze we observed that some elements - which is a characteristic of high waters generated both by rainfall and snow melting, while other elements are smaller (α, overrun layer) - this as a consequence of river basin response at the generating elements.

Keywords: Bega River Bassin, high water, February 1999.

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METHODS OF FACING WITH DROUGHT IN FARS PROVINCE - IRAN

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Fars province with 122661 km^2 area is one of the largest provinces in Iran. This province has variety of climate so the warm and dry in southern and eastern parts and cold in northern part. The temperature range from -10 ºC to 45 ºC and annual rainfall from 100mm to 800mm are specific characters of this province. Considering the huge amount of exploitation of underground water resources, the level of underground water tables in most planes of province has negative balance. The drought in recent years has limited the conditions of using the underground water resources. Considering the region climate conditions, process of climate changes and recent droughts, in this research the activities has been done to reduce the effects of droughts have been evaluated. Some programs as accomplishing artificial recharge projects, changing the cultivation methods, changing the irrigation systems, limiting exploitation of underground water resources, using surface water resources instead of underground water resources as well as executing water crisis symposiums in some parts of province to acquaint the people and learn water consumers to manage exploitation of water resources during the drought. Evaluating these activities, accomplishing artificial recharge projects were adverted as the best method and the operation of 69 executed artificial recharge projects, expectation of 23 under construction projects and 59 under study projects were considered.

COMPARISON ON RESULTS FOR YIELD OF WATER SPRINGS IN YEAR 1990 AND 2007

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From the aspect of the flora and fauna, including the existence of the human, the role of the water has very significant importance. This fact enforces the need of immediate attention accompanied with permanent research and monitoring of the water resources.
In the period of 1975 to 1977, the Water Development Institute of RM has developed cadastral database of the springs.
This database contains information, about 4414 springs on the territory of the whole republic.
Using immediate measures all of the important springs in the RM, with yield of 10/100 l/s, were surveyed with direct measurements of the spring capacity. With this study 125 springs were surveyed in the western part of the country which were situated in 17 municipalities.
The previous survey conducted in 1990 included 907 registered springs out of which 177 were dried up (144 were registered in the cadastre and 33 new registered).
This amount is 19.5% dried up springs from the whole.
According the parameters and available data in the Water Development Institute of RM and with consulting other experts on this issue, the year 1990 is considered the driest year in this period.

Keywords: yield, cadastral, spring, dried.

HYDROLOGICAL ANALYSIS FOR LOW STREAMFLOW THRESHOLD DETERMINATION

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Hydrological analysis has been conducted of low streamflows of the Sava River near Županja, using the data for the period 1945-2006 (N = 62 years).The following reference low streamflow discharges are used in the paper:

$\overline{Q}_{min}$ = 276 m^3s^{-1}, H = -42 cm average minimum annual discharge
$Q_{30,\ 80\ \%}$ = 250 m^3s^{-1}, H = -67 cm minimum average 30-day discharge of 80% probability
$Q_{30,\ 95\ \%}$ = 200 m^3s^{-1}, H = -128 cm minimum average 30-day discharge of 95% probability
Q_{min} = 158 m^3s^{-1}, H = -188 cm absolute minimum discharge in analyzed period
$Q_{RP\ =\ 100}$ = 145 m^3s^{-1}, H = -214 cm 100 – year low streamflow For information purposes the minimal navigation level has also been defined:
$Q_{94\ \%}$= 297 m^3s^{-1}, H = -23 cm (minimal navigation level).

The paper offers recommendations for warnings (I level) and hydrological drought alerts (II and III level). This is an attempt to highlight both warnings and danger alerts for hydrological droughts. In concrete case, three levels are proposed for the Sava near Županja:

I level – warning $Q_{65\%}$ = 663 m^3s^{-1} (H = 188 cm)
II level – alert $Q_{30,80\%}$ = 250 m^3s^{-1} (H = - 67 cm)
III level – alert $Q_{30,95\%}$ = 200 m^3s^{-1} (H = -128 cm)

The first level – warning would be announced when the water discharge drops below 663 m^3s^{-1}, which is the value corresponding with the 65 % of average discharge duration curve. After that, depending on meteorological forecasts (weekly, ten-day, monthly and seasonal) and hydrological forecasts, both II and III level of hydrological drought danger would be announced.

In conclusion, it must be underscored that the issues related to the low streamflows in the open watercourses are very complex and ask for expert and thorough multidisciplinary approach with more quality and reliable measurements.
Special attention needs to be paid to development of meteorological and hydrological methods and models for monitoring and quality and timely predictions of hydrological droughts.

Keywords: hydrological analysis, low streamflows, referenced discharge, hydrological drought, Sava River, low streamflow increase, climate.

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UNDERLYING PRINCIPLES AND CONSEQUENCES OF CAPACITY REDUCTION OF THE RIGHT BANK RIVERS OF PRYPYAT

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One of modern major problems of the Western Polisya including a biological variety, in our opinion, there is a problem of river functioning and connected with them water-marsh ecosystems in the Prypyat river basin, in particular the rivers: actually Prypyat, Stokhod, Styr, Turiya, Vyzhivka, Goryn, Sluch, Stvig. For the rivers of Polisya is characteristic significant overgrowing of river-beds and flood-lands of water vegetation and bushes and, accordingly small capacity - from several cubic meter up to tens for a second which is caused by their small depth, small inclination, excessive quantity in the river-bed of hygrophilous vegetation and other factors. Thereof it is created head of water levels in the rivers, decrease in stream speed, i.e. the certain water masses proceeds at higher levels, than it happens under condition of the free waterway.

In long-term aspect (1947-1999) on the right bank rivers of Prypyat is observed the increase tendency of levels and increase in terms of flood-lands flooding. For example, increase of an annual water level in the river-bed and flood-lands of Prypyat in Ljubashovskyy district of the Volyn area in 1987-1997 in comparison with 1947-1956 has made 60-64 sm for the vegetative period, and maximal during summer-autumn floods – 81 sm. Duration of flood-lands flooding has increased from 43 till 165 days. These phenomena happen at constant water discharges during the vegetative period and at reduction of discharges during floods.

Vegetation development during the warm period of year leads to capacity reduction of rivers owing to increase of water levels and decrease, thus, in stream speed. Comparison of water discharges measured at various river conditions, testifies that at strong overgrowing of river-bed, they can decrease for 80-90 %, especially because during the warm period of year quite often stops water current on flood-lands.

The account of influence of the river-bed and flood-lands condition and its changes during the warm period of year allows estimating more authentically moving of flood waves and, thus, to forecast water runoff on the river network.

Keywords: capacity, imperforation, channel, flood-lands, levels, lag, floods.

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A SOURCE FOR A BETTER UNDERSTANDING OF FLOODS, THEIR CAUSES AND CONSEQUENCES

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Floods represent a natural experimental situation which enables – with the application of adequate sociological methods – to determine objective and authentic reactions, functioning and adjustment of individuals, social groups, local community, organs of the local and social community as a whole in the situations of elementary disasters. In order to study this problem adequately, the very process of flooding should be divided into three qualitatively different parts: flood as a potential threat; flood as a real fact; dealing with the consequences of flooding.
The goal of this paper is to point to the possiblities of visual sociology, primarily the use of drawings and photographs, in the process of research concerning social causes and consequences of floods. In the social sciences, visual sources most frequently represent an additional source of data or are completely neglected. Their inclusion into scientific-research projects enables; a) a more comprehensive insight into the problem of research; b) checking of data acquired with the application of other research procedures; c) studying the opinion of those subjects with whom one cannot apply other procedures for data-collection.
The paper is based on the data which have been collected in the settlement Jaša Tomić since 2005. Jaša Tomić is a settlement located in Vojvodina, the northern province of Serbia. Every spring, due to the melting of snow and ice in the Carpathians, the level of the Timis rises. The settlements built in its immediate vicinity, both in Serbia and in Romania, are either being flooded or are under constant threat of flooding. On April 20, 2005, Jaša Tomić was flooded. Although a threat of flooding is an integral part of the history of this settlement, the disaster was not avoided. Did, and in which way, the human factor contribute to its range? In addition to causing great material damage, the flooding which ocurred in the Banat region in April 2005 pointed to a significant unpreparedness when it comes to the collection of experiential data on the basis of which one organizes the collection and distribution of humanitarian aid, deals with the consequences of flooding and takes steps to prevent new floods. Besides the application of scientific interview which included the adult population, the children's experience of flood, its causes and consequences were investigated in the analysis of drawings. In addition to drawings, the analysis of photographs was also used to investigate the social causes and consequences of flooding.
Besides the drawings and photographs, the basic sources of data included opinion polls carried out during 2005 and 2006, as well as statistical data.

Keywords: floods, Jaša Tomić, drawings, photographs, visual sociology.

Topic 3: GLOBAL CLIMATE CHANGE AND HYDROLOGICAL PROCESSES

HYDROGEOLOGY OF THE SHALLOW AQUIFERS AT WADI EL-GHUSSEIN, NE JORDAN

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The research aimed to better understand the hydrogeology of the alluvial shallow perched aquifers in Wadi el-Ghussein in Tulul al Ashaqif area of the northeast Badia of Jordan.
Many generations of local Bedouins have dug wells by hand in the wadi and exploited the available water, which helped to support their water requirements. Recent studies have suggested that these aquifers are renewable, widespread and can be used as a water resource, provided that they are managed in a sustainable manner. This requires a full understanding of the hydrology of the aquifer.
Several techniques were used to collect data needed to better understanding of the hydrological situation in Wadi el-Ghussein. Total station surveys were used to draw a detailed topographic map for the study area, and hydrometers were used to check the elevation of the groundwater, and to draw ground water contours directly.
Very low frequency geophysical equipment (VLF) were used to determine the lateral extents and depths to the groundwater level along different profiles of the wadi and under the basalt pavements where direct measurements were not available. Samples of groundwater were collected for geochemical modeling and to check for the quality of the water.
Analysis of the results of data led to determine the flow directions of water, which were confirmed by geochemical modelling.
The general groundwater flow direction is from outside the wadi (basalt pavement) towards the center of the wadi and from the NW towards SE along the course of the wadi. Within the wadi, areas where recharge and discharge (towards deeper aquifers) were clearly detected. Geochemical modeling confirms these conclusions.
VLF data analysis also indicate that lateral extents of water is limited to the wadi bed, except in limited areas such as meanders where groundwater extends under some points of the basalt pavement.
Water quality is close to the permissible Jordanian and World Health Organization (WHO) standards, and the plot of the chemistry of the sampled water on the Piper diagram led to it's classification as carbonate water.

WEATHER ANOMALIES AND INFLUENCE ON BULGARIEN SECTION OF DANUBE RIVER

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The provision of information on recent, past and current meteorological conditions, together with data on the hydrological and tidal states, are essential components of an appraisal and forecasting procedures. Meteorological products and weather forecasts are effective applications to river management.
In this paper we analyzed the weather anomalies over Balkans and relation with the extremely water stages in Bulgarian section of Danube river during the period of 2005 – 2007. Seasonal fluctuations in water levels as well as the flooding of riparian areas are natural features of running.
Two more flood waves occurred in Bulgaria in spring and in summer of 2005.
During April-May of 2006 the river Danube in Bulgaria reached the highest levels since 1895. Flooded area of Bulgaria: 5,500 ha.
After for long drought the levels of Bulgarian section of Danube reached to standard water stages in the end of the spring of 2007.
The changes in the precipitation patterns over the year can lead to more flooding in some regions or seasons and more droughts in other, more frequent land slides and soil erosion. Annual precipitation trends in Europe are much more varied than temperature trends. Weather extremes are becoming more frequent in Europe: e.g. the summer of 2005, spring of 2006 and. The attention was paid to Danube water level in Bulgarian section during the above periods and the anomalies of synoptic situations. The results are shown on Figures. We analyzed (NAO) and relationship to regional temperature and precipitation over Bulgaria. The NAO is a phenomenon associated with winter fluctuations in temperatures, rainfall and storminess over much of Europe.

Key words: atmospheric circulation, low water stages, precipitation, flood, NAO.

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THE CONDITION OF THE UNDERGROUND WATERS IN ROMANIA CAUSED BY THE CLIMATIC CHANGES

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The increase of the temperatures during the last years and the reduction of rainfalls in certain areas led to both the decline of the natural water resources and the increase of the water demand, therefore destroying the fragile equilibrium between the resources and demand.
The rainfalls over the usual limit in certain areas generated major floods. Due to the permanent expansion of the phreatic level, it is more obvious and possible the contamination with different pollutants.
The two major objectives pursued in this study are the following: the understanding of the effects caused by the climatic changes upon the underground water resources and their study in areas with high risk of floods and drought.
Growing water demand and climate change present major water resource management challenges for Romania. Impacts of climate change on water are of particular significance because water is essential for survival, for the economy and for our way of life. This is exacerbated by major spatial differences in runoff and water demand that mean that water resources are currently fully or over-utilised in several important regions.
The future for our water is: snow pack (a possible reduction of snow pack could change water supply); glacier melt (reduced water supply from shrinking glaciers); forest fires (warmer, drier summers and earlier springs may lead to increased forest fires); extreme weather (A possible increase in extreme weather e.g. tornadoes, hail storms, heat waves, droughts, dust storms, floods, blizzards); agriculture (increased demand for irrigation and a change in crop types due to a longer growing season); river flow (lower river flow reduces water supply, water quality, and recreation activities); habitat (warmer river temperatures stress cold-water species such as trout); groundwater (reduced recharge causes lower water tables which in turn cause some shallow wells to go dry); hydroelectric power (reduced flow decreases power generation).

CARBON STORAGE IN SOME SOILS OF MT. STARA PLANINA

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Soil organic matter affects so many soil properties and processes, plant productivity, and environmental quality. Many of the effects are indirect, and indicate the cause- and- effect relationships. Soil organic matter directly and indirectly supports the essential function of the soil and its relation to ecosystem function. Soil C increase the moisture content of soils, improves permeability and water infiltration, and reduces compaction, thereby decreasing the amount of water available to leave the land. Less available water means less runoff or storm water that can cause downstream. Soil water retention is also improved, since organic matter increases both infiltration rate and water-holding capacity. (Kimble. et. al., 2007).

Soil capacity to store other nutrients is referred to as the cation exchange capacity (CEC). These cation exchange sites, which are found on clay minerals and iron oxides, are important for retention of nutrients and heavy metals. Approximately 20 – 80 % of the cation exchange capacity of the soil is due to soil organic matter, and increases in soil organic carbon increase the soil cation exchange capacity. Soil organic matter has great affinity to heavy metals. (Kimble. et. al., 2007). The quantities of readily available heavy metals are especially significant for the quality of water. The establishment of the balanced state of the organic matter inputs and decomposition at the higher contents of carbon in the soil ensures a higher soil potential for nutrient release, and in this way ensures the higher ecosystem stability.

Forest ecosystems have a great capacity of both accumulating and emitting carbon. Forest ecosystems in the region of Mt. Stara Planina represent a significant nature potential, primarily as a significant centre of floral diversity of the Balkan Peninsula. The study area is Stara Planina, the localities Babin Zub - N= 43º22'35.7'' E= 022º37'38.3'' altitude 1547 ± 4 m, Široke Luke - N= 43º14'24.7'' E= 022º 51'36.8'' altitude 1288 ± 6 m, and Prelesje - N= 43º10'42.5'' E= 022º56'20.0'' altitude 1287 ± 7 m. The study deals with the soils under forest and grass vegetation covers. Four soil profiles were opened in each the forest and pasture areas. The significance of differences between total heavy metal contents, content of soil C, as well as other characteristics of forest soil and pasture soil was tested by the analysis of variance. Relation between heavy metals and content of carbon in studied soils are presented.

The aim of this study is to determine the effect of soil carbon on heavy metal accumulation in the soils under different vegetation (forest and pasture). The differences in the behaviour of individual elements depending on various C contents in forest soil and pasture soil is primarily the consequence of the different distribution and type of humus, as well as humus accumulation and mineralisation, and heavy metal binding to individual humus compounds. The soils under forest communities have a characteristic forest type of organic matter accumulation (Košanin, 2001). It is characterised by a high content of humus in the top soil (10 – 15 cm), which decreases sharply, but the decrease becomes gradual with depth. On the other hand, the soils under grass communities have a meadow type of humus content and distribution. Under grass vegetation, in the conditions of humid climate of Stara Planina, humus accumulation is intensive and humus mineralisation is slow, so the development of humus-accumulation horizon is more pronounced than under forest vegetation (Belanović, Košanin, 2005).

Key words: soil carbon, soil organic matter, heavy metal, soil quality.

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DROUGHT AND THEIR INFLUENCE ON THE ENVIRONMENT

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Hydrological drought represents the type of the drought that is accompanied with deficiency of water in streamflow during particular time period. This scarcity can be defined as deviation from the average (expected values) of the discharge that is established for a specific waterway in a certain period of time. For the rivers that cross the territory of Serbia point of view that they are abundant with water mostly applies. However, on some waterways facts point to the trend of decrease of the discharge.
In this paper regime of daily, monthly and yearly discharges in Beli Timok river will be identified. Discharges were monitored on hydrological station in city of Zaječar, during the period from 1953 to 2007 (series of daily flows monitored during 55 years). For the purpose of the analyses following will be calculated: probability of the occurence of the minimum daily and monthly flows during the analyzed period, frequency of the occurence (by month) of minimum daily and average monthly flows, values of flow during the low flow periods periods of 5, 10, 20, 30, 60 and 90 days length, as well as the starting dates of these low flow periods (using diretional statistics). Also, the trend of discharges and their connection with precipitation in eastern Serbia region will be analyzed. In this paper year 2007 will be separately shown, deviation of mean monthly flow values in 2007 will be compared to the probability of the occurence of the average monthly flows during the analyzed period. Duration of the low flow period during this extremely long drought event will be separately commented.
Most obvious of numerous consequences of the reduced flows was the pollution of water and death of fish in this river. According to understanding between 20 and 200 tons of various kinds of fish died which instigated huge direct and indirect material loss. Several factories upstream city of Zaječar were identified as guilty party. They emit waste water in this river, judging by these facts, completely without or with insufficient prior treatment. Office for public health from Zaječar stated that several times in july 2007 multiple (over 15-fold) increase in ammonia concetration above value regulated by law was noted. This has resulted in the decrease of the oxygen available to flora and fauna in this river. In this paper elevated ammonia concentrations in connection with decreased discharge that lasted several months during 2007 will be analyzed.
Analysis of these data directly points to the fact that industry can not rely on earlier motto „water takes everything“. Consequences of the drought that occured in 2007 give the clear answer to the question what danger threatens when there is not enough water in rivers. Treatment and rigorous control of waste water that are emmited in waterways must become a reality in Serbia, not only as one of the prerequisites of joining the EU but also as a measure that enables citizens rights and the rights of the future generations to a healthy environment.

THE MODIFICATION OF THE ECOLOGICAL CONDITIONS IN THE RAZIM-SINOAIE LACUSTER COMPLEX AS AN EFFECT OF THE ANTHROPIC INTERVENTION

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The lakeshore complex Razim-Sinoie is the largest surface of water from our country (in natural system) being situated in the south of Danube Delta. In the XX-th century, the anthropic intervention determined important modifications of the hydrochemicals characteristics with effects on the ichthyofauna, on the regime of variations of the levels and the hydric evaluation, causing some problems bound with pollution, the clogging of the lakes and the acceleration of the erosion of banks. The first proceedings were done at the request of the biologists Grigore Antipa and had as a purpose cutting down on the differences of salinity from the Razim Lake and the enriching the hydrological conditions having in mind to turn to account in a superior way the piscicol resources. This meant the transformation of the so called "garle" Dunăvăț and Cerneț which lead to bringing a great amount of sweet water in the lake Razim. At the beginning of the '50 of the last century the salinity system's problem represented the object of some systematic researches, in order to increase the fish- culture's productivity and in order to guide the fauna's structure to valuables species from the economic point of view. After the year 1970 the plans of reconditioning the Razim-Sinoaie complex have been resumed, this time the accent fell on the transformation of the lakes in a hidrotechnic system with a main function regarding the irrigations and a secondary function regarding pisciculture. In this hidrotechnic system the lakes in the north compartment of the lacuster complex (Razim, Babadag, Golovița, Zmeica, including Coşna, Periteaşca and Leahova) measuring a surface of approximately 520 km2 from which about 120.000 ha were to be irrigated. Although the lake Sinoie was not a part of this hidrotechnic system, the modifications brought to this hidric system as well as the circulation of water, namely the salinity had direct and immediate effects upon the hidrobiological characteristics of the underwater ecosystem. Due to the reduction of a mineralizing, macrofolora and the phytoplancton have suffered a reduction of the typical salmastric species and the installation of some abundant association of Potamogeton pectinatus, Ceratophillum Demersus, C. Submersum but only till the deep of 1.5 m. The quantitative analyses put in evidence the fact that the benthic fauna is continue simplified through the decrease of bio-diversity, the only group that makes an exception is the one of chironomidelors, the time with the biggest special bio-diversity being met in 1978-1988 when the Laguna had a saltish hydro-chemical system. In the Sinoie Laguna it exists a major disequilibrium that is characterized through the strong decrease of bio-diversity, the sea forms with rare exception disappeared from the benthic bio-diversity while sweet waters forms consolidated their position.

Keywords: Razim-Sinoaie, underwater ecosistem, modifications.

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SNOWMELT IMPACT ON GROUNDWATER FLOW OF THE LJUBLJANSKO POLJE AQUIFER

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Snowmelt in the mountain environment fills the rivers and recharges the aquifers that millions people depend on for their water needs (drinking, energy, production in agriculture and industry). However, climate change and other factors make water resources balance from snowmelt very fragile and inconstant. Many natural events (such as the recent droughts observed in Alpine catchments and downstream rivers) clearly revealed that innovative technology to predict medium term flows is necessary for an effective sustainable water resources management.
The model of Ljubljansko Polje aquifer developed by MODFLOW was upgraded in the last version of the PMWIN software. The model takes a surface of 80 square kilometres mainly in the Ljubljana municipal area. The data of groundwater and surface water regime from 1978 to 2006 are collected and the model was run and calibrated. We collected the data for groundwater level from 25 piezometers, three well fields and one lyzimeter. The information about snow cover measured on the Ljubljana climatological station was also acquired. Data about snow cover for the Ljubljana weather station were analysed. Water balance in winter seasons of 1978/1979–2005/2006 was also analysed and the impact of snowmelt on groundwater recharge was estimated. For seasons that had at least a 0.5-m thick snow cover and the seasons from 2000/2001 to 2005/2006 the impact of snow melt and spring precipitation was analysed in detail. Surprisingly, the water from snow cover mainly evaporates during the snowmelt period. There was no significant increase in the groundwater level during snowmelt events. The groundwater significantly increases during winter rainfall events or in events with snowmelt and rainfall.
The work was done in the range of AWARE project, which is a research project that aims at providing innovative tools for monitoring and predicting water availability and distribution in those drainage basins where snowmelt is a major component of the annual water balance, such as the Alpine catchments. AWARE is funded with the contribution of the European Commission - Directorate General for Enterprise and Industry - under the Sixth Framework Programme. The duration of the project is of 3 years starting from July 2005.

Keywords: groundwater model, snowmelt, satellite images, water balance, AWARE project.

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HYDROLOGICAL CHANGES IN THE MEDITERRANEAN ZONE: IMPACTS OF ENVIRONMENTAL MODIFICATIONS IN THE MERGUELLIL CATCHMENTS

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Tunisia provides many interesting examples of rapid hydrological changes. In Tunisia, the limited water resource is considerably exploited and shared between agriculture (82 %), human consumption, tourism and industry but the multiplication of population by 2.5 in the last 40 years and the extension of irrigation have led to numerous local and regional conflicts. This study profited from the long-term hydrological survey conducted in central Tunisia, near the city of Kairouan, where one of the greatest aquifers in the country has been studied for four decades (e.g. Besbes et al., 1978; Ben Ammar et al., 2006). The present study was based on cross-checking of hydrodynamical and geochemical approaches and identified the drastic changes that have occurred in processes and in flows. The wide range of forms of these modifications may provide a useful framework for extrapolating or comparing with other Mediterranean regions where the causes and processes of changes are identical but observations rarer.

All around the Mediterranean Sea, the semi-arid climate and the fragmented environment (geology, topography, etc) has led to high spatial and temporal variability of the different components of the water budget. Major fluctuations in hydrology are consequently observed from one year to the other but serious long-term changes are also the consequence of human modifications of the environment. The different studies that have been performed in the Mediterranean region produced a wide range of results in all compartments of the water cycle.

PROVING THE ECOSYSTEM VALUE OF NATURAL FLOODPLAINS THROUGH HYDROLOGICAL MODELLING

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From an economic point of view ecosystems provide valuable functions (see e.g. Emerton 2005). Also natural floodplains and river structures offer different types of ecosystem functions such as habitat function, recreational area and natural detention. From an economic stand point the loss (or rehabilitation) of these natural systems and their provided natural services can be valued as a damage (or benefit). Consequently these natural goods and services must be economically valued in project assessments e.g. cost-benefit-analysis or cost comparison.
Especially in smaller catchments and river systems exists significant evidence that natural flood detention reduces flood risk and contributes to flood protection. Several research projects evaluated the mitigating effect of land use, river training and the loss of natural flood plains on development, peak and volume of floods (e.g. de Roo et. al. 2001, Niehoff et. al. 2002). The detention effect of natural river structures and flood plains is often ignored in flood mitigation projects.
The presented project analysis the hypothesis that ignoring natural detention and hydrological ecosystem services could result in economically inefficient solutions for flood protection and mitigation. In two test areas, subcatchments of the Danube in Germany, a combination of hydrological and hydrodynamic models with economic evaluation techniques was applied. Different forms of land use, river structure and flood protection measures were assed and compared from a hydrological and economic point of view. Deterministic hydrological models were applied to estimate the effects on a catchment scale. A hydrodynamic model was used to simulate flows to assess the extent of flood affected areas and damages to buildings and infrastructure as well as to investigate the impacts of levees and river structure on a local scale. Hydrological and hydrodynamic model results provided the basis for an economic assessment. Different economic valuation techniques, such as flood damage functions, cost comparison method and substation-approach were used to compare the outcomes of different hydrological scenarios from an economic point of view and value the ecosystem service.
The results give significant evidence that natural detention must be evaluated as part of flood mitigation projects. In all evaluated cases in small and medium size catchments and river systems natural structures reduced flood peaks and positively influenced the hydrological behavior on a local scale. In addition to the above hypothesis can be stated that the loss of detention due to land use and dikes can be called an externality and results in economic inefficiencies. Further research in the field of hydroeconomics is necessary to better quantify the ecosystem value for example of natural floodplains and externalities of human impacts and hence make environmental systems better comparable to technical measures and interventions.

Keywords: Ecosystem value, natural detention, externalities.

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DANUBE RIVER DISCHARGE VARIABILITY AND SOLAR ACTIVITY

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How much of an influence the Sun exerts on earth's climate has long been a topic of heated discussion in the area of global climate change. The main reason for the different opinions on this subject derives from the fact that although numerous studies have demonstrated significant correlations among some measures of solar activity and various climatic phenomena. The magnitude of the variable solar radiative forcing reported in these studies is generally so small, that it is difficult to see how it could possibly produce climatic effects of the magnitude observed. Supporters of solar effects theories claim that various positive feedback mechanisms may amplify the initial solar perturbation to the extent that significant climate changes really take place. Insufficient length of instrumental observation is real problem, too.

The Danube is the river with relatively high number of hydrological gauges with observation for more than 50 years. However, the longest observation period was on the Romanian hydrological gauge Orsova, which was in operation from 1840 up to 1972, when a lake was created by Water – power station Djerdap. After 1972 time-series is charged by data gained by using of electricity generation as well as by measuring overflow waters on Kladovo dam. In this way time-series of 150 years is formed by discharged data during the period 1840-1989. Hydrological gauge Orsova is one of the most reliable gauges on Danube River, because it is locates in Iron Gate which is consisted of rocks, riverbed is steadily and there is no outflow of high waters.

We have explored several discharge elements (low flow, high flow, extreme flow and flow index) in relation with several solar parameters (sunspot areas, Wolf s number, polar faculae numbers, AA index and latitudes of sunspots). The most significant results was given for decadal flow index and latitudes of sunspots (R = 0.73).

Flow Index is presented, as a parameter of high flow domination in relation to low flow. While low flow and high flow clearly presented domination of anticyclone and cyclone types of weather thus average years are mixture of synoptic situation impacts. In our opinion flow index clearly shows a relative domination of high flow years, excluding average flow years from the calculation and thereby clearly underlines the synoptic causes of flow variability.

The relation between parameters of solar activity and Danube River discharge elements is indirect and probably is in function through atmospheric circulation. Complex mechanism of these relations is in function through prevalence of zonal or meridional types of atmospheric circulation.

Keywords: Danube, Orsova, discharge, trend, global change, Solar activity.

WATER BALANCE OF SLOVENIA 1971 – 2000

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The water balance calculation is based on the circulation of water. The basic water balance equation is based on the circulation of water between the atmosphere and the surface of the Earth (Van Abs et al., 2000, Kolbezen et al., 1998).
Water balance is calculated from water inputs and outputs over a specific area. The basic elements of the water balance include all the inflows and outflows for a given basin and serve for the computation of the water regime of a catchment area. It is defined by the parameters precipitation (P), evaporation (E), discharge (Q) and the change of the water reserves (dS). For the water balance in Slovenia in period 1971 - 2000 the changes of storage were not taken into the account because the long time averaging period.
The highest precipitation and specific runoff in Slovenia are in Julian Alps. The second peak is around Snežnik Mountain area in the Dinaric Ridge. Both geographical dispositions are similar. From the most wetted parts the amount of precipitation and specific runoff are decreasing towards southwest and northeast Slovenia. The evapotranspiration has in general the opposite geographical disposition. The highest amounts are in the southwestern and in the southern Slovenia and decreasing towards the north and the northeast. The elevation and land cover has great impact on this water balance element.
In the article the overview of water balance elements in main river basins of Slovenia is presented: the Mura River basin, the Drava River basin, the Sava River basin, the Kolpa River basin, the Soča river basin and the Adriatic watershed without the Soča river basin. The lowest precipitation and specific runoffs are in the Mura River basin followed by the Drava River basin. The Sava River basin, the Kolpa River basin and the Adriatic watershed without the Soča River basin have very similar amounts of precipitation and runoff, whereas the Sava River basin has lower evapotranspiration amount as other two. The highest amounts of precipitation and runoff are in the Soča River basin.
Main results of the water balance elements for the period 1971 – 2000 for Slovenia are: Average annual precipitation in Slovenia is 1579 mm, average annual evapotranspiration is 717 mm and calculated runoff 862 mm. Compared to water amounts in the World, where the average precipitation is 750 mm, evapotranspiration is 480 mm and runoff is 270 mm, Slovenia is very watery country. Also the runoff coefficient with 55 % is much higher as 36 % of the World.

Keywords: water balance, precipitation, evaporation, runoff, hydrogeography, Slovenia.

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PREDICTION OF WATER BALANCE CHANGE AFTER CONSTRUCTION OF THE DANUBE-SAVA MULTIPURPOSE CANAL

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To satisfy the increasing demand for irrigation and canal navigation the designing of the Danube – Sava multipurpose canal is being carried out. One of the first steps in canal design was to consider its influence on the level and quality of groundwater. Groundwater level was observed on 40 newly constructed piezometers in the period of five years. According to the collected information about geological condition, groundwater level changes, infiltration and evapotranspiration, mathematical model was calibrated. The program that can simulate fluid flow and solute transport in variably saturated porous media was used.Two scenarios of canal's construction were considered. The first scenario includes construction of the first 14.8 km canal from the River Sava suitable for irrigation and another scenario anticipates construction of the canal in its full width, i.e. as a waterway. The significant differences in size and necessary excavations result in different discharges between the canal and the aquifer. The results of the performed research show that the water level in the canal is almost always lower than the groundwater level in the aquifer. In the area near the River Sava, there is a significant difference in water level and the canal will all the time drain the aquifer. The advantage of such situation is than it is not possible that some eventual pollutant from the canal infiltrates in the aquifer, and there is no risk for the pumping sites located near the canal. In the small area at the distance of 14 km from the Sava River, it is possible that groundwater higher than canal water could occasionally appear causing infiltration of the canal water into the aquifer. After the canal is in function, the original groundwater level along the canal will be decreased in the band of maximum1200 m width. As the direction of groundwater flow is from the aquifer into the canal, the quality of water in the canal used for agricultural irrigation will be very good.

Keywords: ground water, multipurpose canal, agriculture.

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CONSERVATION OF BIODIVERSITY OF THE MURA RIVER IN SLOVENIA

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Intensive water use, activities in the river and riverside space and the change of land use in the Mura River catchment (chain of hydropower plants on the Mura in Austria, flood protection structures and facilities, water supply, management of agricultural land, urban development) have considerably altered the river space. Most of all, they have had significant implications for the bed-load discharge and processes of self-formation of the river space in Slovenia. In spite of the fact that the Mura River has been straightened and the meanders cut-across, leaving behind oxbows, parts of the old channel are still recharged by the river, precipitation and groundwater. The processes of more relaxed, less controlled dynamics of the water flow, with a more frequent and easily spotted bank erosion, natural sediment transport and deposition, frequent flooding, river branches and oxbows, are especially present downstream of Veržej. The Mura river space in Slovenia, and at the reach bordering Croatia, is therefore among the richest ecosystems in Slovenia. At the European scale the Mura River is of utmost importance in terms of its ecosystem and natural protection. Therefore, a large part of the river corridor has been included in the Natura 2000 sites (SPA Mura SI5000010 and pSCA Mura SI3000215). Relevant to environmental conservation are especially the plain alluvial forests, abandoned river branches and oxbows, islands, gravel bars and erosion-prone areas in river channels.

The BIOMURA project funded by the EU LIFE NATURA 2006 is among the first larger projects aiming at restoration of the degraded river morphology in Slovenia. The project goals are improvement of riparian and adjacent riverine habitats, protection of targeted endangered species and indirect implications for preservation of other animal and plant species and their habitats, increase of biodiversity and preservation of the natural landscape. The area covered by the project has a surface of 1520 ha and is part of the Natura 2000 (SPA: SI5000010, pSCI: SI3000215). The area lies within high water protection embankments of the Mura River, between the villages of Bakovci, Dokležovje, Ižakovci, Melinci, Bunčani, Veržej, Krapje and Mota.

The insurance of biodiversity of an area and conservation and restoration of wetlands mainly depends on the preservation and rising of the groundwater table, and more intensive hydrodynamic processes in the river corridor. Within the project several measures will be taken to ensure the existence and improvement of living conditions of many protected animals and plants. The main river channel will be connected with the side channels. By provision of adequate water level at the intake of water into side branches the flow into the branches will be possible during average and low flows. In the selected reaches the main river channel will be widened. New extensive gravel bars and natural banks will be formed, and the natural character of the river will be restored, boasting the diverse channel composition, different bank inclinations and diversity of the water current. The partly buried river branches will be restored and cleaned, so that adequate hydraulic conditions for oxbows and areas of slowly flowing water are reinstated. Higher soil wetness will enable the conservation of ecosystems in the floodplains of the Mura river, with many rare and endangered species of birds, dragonflies, wetland butterflies, frogs and reptiles. The raising of the groundwater level will prevent the drying out of trees, such as oak, poplar and hornbeam, and the preservation of floodplains, wetlands and wet meadows.

PRESENT-DAY VARIATIONS OF ANNUAL DISTRIBUTION OF RIVERS FLOW OF THE DNIEPER BASIN (WITHIN UKRAINE)

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Dynamics of the climate of Ukraine as regional one to a considerably extent corresponds to the peculiar features of variations of the global climate. This is confirmed by the coincidence of perennial anomaly of global and regional air temperatures. Atmospheric circulation to be averaged for two last decades differs greatly from atmospheric circulation of previous periods, air temperature (especially in winter) on the territory of Ukraine apparently increased.

Temporal annual flow fluctuations have a rather tight connections with the types of atmospheric circulation. Present-day climate variations on the territory of Ukraine influenced the hydrological regime of rivers in our country.

The aim of the investigation is to estimate present-day variations of rivers flow in the Dnieper basin (within Ukraine). Analysis of deviations of annual air temperature to be averaged for five years periods and generalized for the Ukrainian part of the Dnieper basin from the climatic norm shows that within the seventies of the 20th century fluctuations of averaged annual air temperature has the character of sinusoid, then during last 25 years period the trend of this index has been evidently increasing. This gives the reason to mark out two representative periods in perennial fluctuations of air temperature within the Ukrainian part of the Dnieper basin. The first period that has negative deviation of air temperature from climatic norm (ΔT= - 0,1 °C) has been lasting from 1951 to 1980; the second period (with positive deviation from the norm ΔT = +0,5 °C) begins from 1981 and is continuing till now.

Unlike air temperature fluctuations there is no evident trend for variations of precipitation quantity during last 20-25 years. As it was in the previous period (till the end of seventies – beginning of eighties) fluctuations have the character of sinusoid. But interannual amplitude of fluctuations was condecreased.

Results of analysis of river flow variations in the Ukrainian part of the Dnieper basin at present time (after 1980) do not allow to conclude with confidence that there is a certain trend of variation of annual flow as a whole for the basin during last 20-25 years Perhaps, small increase of annual quantity of atmospheric precipitation is compensated by greater value of evaporation to be caused by increasing air temperature. Analysis shows considerable increase of winter low-water flow (by 25 % in the whole for the basin). This increase is more essential in north-west and east parts of the basin (up to 50-75 %). Summer-autumn low-water flow also considerably increased. During the last 25 years the flow of the Dnieper basin in summer increased by 35 %, in autumn – by 45 % as compared with the previous period.

INFLUENCE OF BRNO CITY AGGLOMERATION ON SURFACE WATER POLLUTION BY ENDOCRINE DISRUPTORS

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Endocrine disrupting compounds (endocrine disruptors) are synthetic or natural substances that have influence on balances of standard hormonal function of an animal. Endocrine disruptors have not been studied systematically in the Czech republic within the frame of monitoring programs up to this time. Purpose of the project is connection of chemical and biological approach to monitoring in order to get complex characteristics of pollution of aqueous media at selected locations in terms of agglomeration of Brno city, with emphasis primarily on endocrine disruptors. The samples were taken at 9 sampling sites including inlet and outlet of Brno's waste water treatment plant in 2007. Large scale of the individual compounds (PAH, PCB, OCP, PBDE, Triclosan, about 70 polar pesticides, antibiotics, drugs and hormones) was determined in water samples, suspended solids, sediments, abiotic passive samplers as SPMD, POCIS and samples of fish (Leuciscus cephalus). Vitellogenin and 11-ketotestosterone were measured in blood plasma of fish as biomarkers. LCMS/MS, ICP – MS analytical methods were used for the screening of chemicals and HPLC method was used for estrogen hormones determination. Biomarkers were determined by ELISA method and by histological examination of fish liver and sexual organs. Heavy metals were predominantly detected at low concentrations in water and often even bellow the level of detection. The lowest concentrations of metals in river sediment were found upstream the city agglomeration, high concentrations were found in river sediment with high portion of fine fraction (< 63 □m) upstream weirs and downstream the Brno's WWTP at Modrice. Pesticides as atrazine, desethylatrazine, diuron and terbutryne were found in river water samples. Pharmaceuticals as antibiotics, antibacterial substances, antirevmatics and chemotherapeutics were identified among other substances. The highest concentrations of those substances were found at inlet into WWTP and also at WWTP outlet to Svratka river at comparable concentrations 10 times higher than concentrations in river water upstream the WWTP. The highest concentrations of estrogen hormones (estradiol, estron, ethinylestradiol, diethylstilbestrol) were found in waste water at WWTP inlet, the highest concentrations reached ethinylestradiol (160 ng.l-1). The concentrations were lower in processed waste water at the WWTP outlet. Biomarker vitellogenin was found in 43 samples from 78 individual male fish, whereas the highest values of biomarkers as vitellogenin and 11-ketotestosterone were determined in sample from European Chub (Leuciscus cephalus) at location of Svratka river upstream the WWTP. Above results of the first phase of monitoring indicate contamination by substances with xenoestrogenic effect of surface water at all monitored locations. The secondary source of contamination by pharmaceuticals, hormones and metabolites of other organic substances may be the waste water from urban waste water treatment plant.

Keywords: Endocrine disruptors, river sediments, suspended solids, passive samplers, surface water, waste water, vitellogenin, 11-ketotestosterone.

TOPIC 3

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THE ANALISYS OF RELATIONSHIP BETWEEN WATER QUALITY AND HYDROLOGICAL CONDITIONS IN SMALL KARST CATCHMENT OF SINKING WATERCOURSE TRBUHOVICA

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A watercourse Trbuhovica is located at the topping karst of Gorski kotar in Croatia, next to the border with neighboring Slovenia where it sinks underground. Trbuhovica catchment area (900 inhabitants, without sewage system) is situated within it is hydrographically connected with the springs in Loško polje. Towards improving management of water resources at analyzed transboundary area, the project is being approved of EU commission which has a purpose to analyze water resources of that area and their appropriate protection (INTERREG III A project KEEP WATERS CLEAN). In the paper, the 1st phase results of the project are shown – results of monitoring of the hydrologic conditions and water quality at several locations of watercourse and at the springs of Trbuhovica, Mlake and Obrh. Besides climatologic (precipitation, air temperature, snow cover) and basic hydrologic characteristics (flow and water temperature), periodically, in certain hydrological conditions water quality parameters (pH, electric conductivity, alkalinity, oxygen regime, nutrients, mineral oils) and microbiology (indicators of fecal pollution) are monitored. Samples of microinvertebrates and samples of periphyton were collected in the field. Biological results are elaborated via saprobic index according to Pantle-Buck.
Results of all conducted analyses showed strong connection of hydrological condition and selected water quality parameters. The groundwater quality changes are very disposed, and the maximum pollutions occur in the period of intensive rain. The pollution of surface water intensively depends of water flow. Appearance of the first water wave is the most critical period for the pollution of springs in the area of Loška dolina. The accumulated pollution in catchment area and watercourse, quickly rinses and concentrated penetrates underground via swallows. The results of conducted biological research show that the water at the spring of Mlaka is very clean and is classified into the first to second water category, while the point station on watercourse Trbuhovica shows higher organic pollution.
Results are as expected, but because there is a rare opportunity to conduct integral qualitative and quantitative monitoring of hydrological, physical-chemical and biological parameters on same pilot areas, they deserve full attention and can be used for planning further similar researches. These researches were performed within the project „INTERREG III A Keep Waters clean“ proposed by local community – The Town Čabar in the Republika of Croatia and the county of Laška dolina in the Republika of Slovenia (2004 - 2006.). It's necessary to point out that these results would more impact on protection measures planning in the investigated catchment area in the case of equivalent researches in Laško polje, because the main aim of this project was insurance quality data for designing protection of underground water.

Keywords: transboundery aquifer, karstic water resource, hydrology, water quality, international projects.

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HYDROLOGICAL SCENARIOS OF FUTURE SEASONAL RUNOFF DISTRIBUTION IN CENTRAL SLOVAKIA

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The hydrological scenarios of future seasonal distributions of runoff in the upper Hron River basin, which was chosen as a representative mountainous region in Central Slovakia, were evaluated. Changes in the future climate were expressed by three different climate change scenarios developed within the framework of the Central and Eastern Europe Climate Change Impact and Vulnerability Assessment Project (CECILIA, 2007). The climate change scenarios were constructed using the pattern scaling method from the outputs of transient simulations made by the ECHAM4/OPYC3, HadCM2 and NCAR DOE-PCM global circulation models (Dubrovský, et al., 2005). The SRES A1, A2, B1, and B2 emission scenarios from the IPCC Third Assessment Report were used in the estimation of future increases in global temperature together with the most likely range of the values for the climate sensitivity factor, i.e., an increase in global temperature by 1.5-4.5°C per doubling of the atmospheric CO2 concentration. The values of the increases in global temperature for the emission scenarios used were compared for the low (LO), medium (MI), and high (HI) estimates of the climate sensitivity factor, i.e., the most optimistic, the mid-range, and the most pessimistic.

The upper Hron River basin to Banská Bystrica profile was selected as the pilot basin for the impact study. The basin has an area of 1766 km2 and the mean elevation of 850 m a.s.l. Seventy percent of the basin's area is covered by forest, 10 % by grasslands, 17 % by agricultural land and 3 % by urban areas.

The hydrological and climate input data for the hydrological modelling were collected in monthly time steps during the period of 1971-2000. Monthly precipitation totals were available from 23 precipitation stations; the data of the mean monthly air temperature, mean monthly water vapour, cloudiness and snow cover were collected from 5 climate stations in the basin. The values of the mean monthly potential evapotranspiration were calculated by the Tomlain method, based on energy balance equations. The mean monthly discharges were available from the Banská Bystrica gauging station.

A conceptual hydrological balance model calibrated with data from the period 1971-2000 was used for modelling changes in runoff with monthly time steps. This model, which simplifies a river basin into 2 nonlinear reservoirs, simulates water accumulation in the basin, snowmelt, evapotranspiration, runoff from impermeable areas in the basin, surface and subsurface runoff and baseflow.

According to the anticipated changes in the seasonal distribution of the mean monthly runoff, an increase in the winter monthly runoff and a decrease in the summer monthly runoff can be expected in the Hron river basin. For the most extreme results according to the NCAR scenario, the highest relative increase in runoff can be expected in February, i.e., +25 % in 2025, +45 % in 2050 and in December, i.e. +85 % in 2100. The most extreme relative decrease in runoff can occur from September to October/November, i.e., -22 % in 2025, -42 % in 2050 and -73 % in 2100. This decrease is caused mainly by the considerable decrease in precipitation (in October: -19 % in 2025, - 35 % in 2050 and -76 % in 2100). The intensity of the changes could increase towards the time horizon of 2100.

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CLIMATE CHANGE IMPACT ON THE HYDROLOGICAL REGIME OFAN AUSTRIAN BASIN

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In the last decades and especially since the last IPCC (2007) report climate change and its impact on the environment are widely discussed in the media and in the scientific community. A research project funded by the provincial government of Lower Austria investigated the impact of climate change on the hydrological regime of a small basin in the northern part of Austria. The focus was on the assessment of the potential change of both the runoff extremes like floods and droughts and the mean conditions. Also snow distribution and snow cover duration were analysed.
The expected climate change signals were used from the German REMO-UBA analysis, where two scenarios, an “optimistic” (B1) and a “moderate realistic” (A1b) were applied. A stochastic rainfall generator was adopted by IMET (see Semenov, 1997), which enables the generation of daily resolution of precipitation and temperature. This data served as input for a hydrological model developed at the IWHW (see Holzmann and Nachtnebel, 2002). The hydrological model comprises of a snow accumulation and snow melt module based on the day degree approach with 100-Meter elevation bands. The rainfall runoff module is based on a conceptual approach considering surface runoff, interflow and baseflow. The models were calibrated for a 30 year period. The simulations were based on conditions of the time period 2070 to 2100. To consider the stochastic behaviour of extreme values a synthetic period of 200 years was computed on a daily time resolution to provide representative time series for statistical analysis.
It could be shown (see Holzmann et al., 2008), that the applied models could reproduce the historical hydrological behaviour. The change in runoff will be discussed both for the annual maxima and the correspondent statistical frequencies. Low flow conditions and their duration will increase under szenario A1b. Melt runoff and the duration of snow cover will be reduced for both szenarios as there will be less accumulation of snow. Limited available water content which causes plant stress will increase for szenario A1b during July and November.

Keywords: Climate change, hydrological modelling, climate models, climate scenario, hydrological extremes, snow cover duration.

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ESTIMATION OF CLIMATE CHANGE IMPACT ON WATER RESOURCES BY USING BILAN WATER BALANCE MODEL

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Modelling of water balance under changed climate conditions has been carried out by T. G. Masaryk Water Research Institute in Prague for basins in the Czech Republic since 1990. Incremental, global and regional climate change scenarios have been reflected in meteorological time-series for given catchment and subsequently used for simulation of water cycle components in monthly or daily step by using Bilan water balance model.

These studies presently use climate change scenarios for the period 2071–2100, based on results of PRUDENCE project and derived from simulations by HIRHAM and RCAO regional climate models for SRES A2 and B2 emission scenarios (Kalvová, 2005). Predicted changes in precipitation in terms of annual means are less significant than seasonality changes (winter precipitation increases and summer precipitation decreases). Temperature is predicted to increase significantly.

Bilan model, developed by T. G. Masaryk Water Research Institute (Tallaksen, van Lanen, 2004), can be used for assessing water balance components of a catchment in monthly or daily step. The model simulates water budget at three vertical levels: on land surface, in soil layer and in groundwater aquifer. Three water balance algorithms that are applied were developed for winter conditions, snow melting and summer conditions. Surface water balance depends on evapotranspiration, which is calculated from observed meteorological conditions. Excess water forms direct runoff or infiltrates to deeper zones, where it is divided into interflow and groundwater recharge. Parameters of the model are calibrated by optimising the deviations between observed and simulated river flows.

Results of Bilan model simulations for input meteorological series (basin precipitation, air temperature and relative air humidity) not affected and affected by climate change scenarios give information for assessing the climate change impacts on output series of the model, which include basin evaporation, three components of river flow (surface runoff, interflow and base flow), groundwater recharge and three components of water storage (in snow cover, soil layer and groundwater aquifer).

The presented study assesses climate change impact in 61 basins from the Czech parts of the Elbe and Danube River basins. It was generally shown that annual runoff could largely decrease. The increased winter temperature could cause an increase in winter outflows and a decrease in snow storage, and consequently, spring and summer outflows would decrease significantly, even to their current minimum values. There was high spatial variability in outflow changes; they could be different even in the same region. The groundwater storage and base flow could also be highly reduced. For groundwater study purposes, the Bilan model, particularly in combination with Modflow model, can also be suitably used.

The described method has been used in a number of research projects and operational applications. Its typical application is aimed at assessing possible impacts of climate change on surface water resources, whose availability can subsequently be analysed by water management studies of the individual basins and studies of capacities and functions of reservoirs in the basin.

The paper summarises and shows results of a study which estimates availability of industrial water required for Temelín Nuclear Power Plant. Climate change scenarios for two time horizons were applied for estimation of possible flow decrease. The affected flow time-series were used as an input to a model of Temelín water management system, which was applied for an assessment of availability of the industrial water in conditions affected by the climate change.

Keywords: water balance, climate change, hydrological model, Bilan model, water resources.

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REVERSE LONG WAVES IN RESERVOIRS AND THEIR ECOLOGICAL ROLE

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Long waves are most the significant ecological hydrodynamical processes in reservoirs. They determine functional conditions ecosystems of artificially created water body and quality of aquatic environment.
Long waves in reservoirs are generated not only with one help of natural factors (flood fluctuation of level, pressure atmospheric drop, etc) but also with artificial factor (irregular state of hydropower station).Flush regime of operation hydropower station forms reverse long waves in channel upstream. They are more significant environmentally. In the Dniester reservoir they lead to inverse flows which break early formed structure of community water supple.
The Dniester reservoir is of channel type and offers rather narrow (average width − 730 m, maximum − 2 km) and deep water body (maximum − 54 m) with total volume of 3 km3 and net capacity 2 km3. This reservoir length is 194 km.Reverse long waves with such channel data have good conditions for spreading. They lead not only to level fluctuation but also to inverse flow. It is observed at the distance of 100 km and more from the dam.
The research on location was carried out on October, 1990 and inverse flow for the first time was registered in the section line of water intake of Kamenets-Podolskiy. At first the inverse flow was observed near the right bank after that the flow was seen at all section of reservoir. The velocity of flow changed in the range of 3-4 cm s-1 and the duration was a few hours. Consequently, the water mass flows with considerable part of sewage of town to water intake from the mouth reach of the river Smotrich (Timchenko, 2006).
The observation was carried out specially in order to refine parameters of reverse long waves in this reservoir on July, August 2007. These observations included series of simultaneous measuring of water level at different distances from the dam. It was established that height of reverse long waves ranged from 3 to 15 cm.
For the Dniester reservoir the calculated velocity of reverse long waves is 50 km h-1. It is 38 km h-1 in our research. The difference of actual velocity of inverse flow was registered in the other reservoirs, for example Kuybyshev reservoir (Hydrometeorological regime…, 1978). Therefore it is necessary to carry out investigations for every water body while testing parameters of reverse long waves.
Analysis of observation has indicated that reverse long waves are asymmetric in the Dniester reservoir. Slope of water surface is permanently changed in the extent and sometimes in direction (opposite slope was frequently observed on section from hydrometric station Ustye to Zhvanets). During the twenty-four hours grade profile of water surface has wavy form. The fluctuation amplitude is the higher the further distance is from the dam.
Reverse long waves have negative and positive functions. Level fluctuation interrupts spawning of fish. Spawn dries and dies. But forming enhanced field velocity of water course waves support investigation of stream self-cleaning function.

Keywords: Dniester reservoir, reverse long waves, inverse flow.

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ISSUES LINKED TO THE EUTROPHICATION OF STORAGE LAKES

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Eutrophication, defined as an enriching of the lake water with nutrients (nitrogen, phosphorus, etc.) determine an explosion of algae and macrophites. These plants die, form deposits on the bottom of the lake, and the cycle is replayed. The causes of this phenomena are natural and anthropological, the latter leading to an accelerated process of eutrophication. The present work tries to explain the ecological factor, the ecological measures to diminish the negative effects on aquatic ecosystems.
The second part of this work focuses on a case study of Lake Bezid, a lake which is situated in the hydrographical basin of Mureş ,where a trophical study was done; the evolution of the algae mass is considered to be the mst important ecological element to determine the eutrophication level, which is tightly linked to the ecophisiological status of a lake.

Keywords: eutrophication, nutrients, pollution.

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ESTIMATION OF THE CLIMATE CHANGE OF EVAPORATION IN OSAM RIVER BASIN

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Water is essential for life and water problems are strictly related to the present and future living conditions in the world. One of the principal aspects of present and future water problems is the rational utilization of the existing surface and underground resources, in order to satisfy the demand that is strictly connected to all the intrinsic aspects of human living and civilization.
Climate changes are directly related to water resources, which are of high socio-economic and environmental significance. The aim of presented work is to analyze the trends in the evapotranspiration time series. The data from four meteorological stations situated in Osam river basin are used. The Spearman and Man-Kendall tests are applied. In the paper the expected values of actual evapotranspiration for the years 2025, 2050 and 2100, obtained on the basis of the results from HaDCM3 and ECHAM4 climate change scenarios are given as well.

THE INFLUENCE OF THE NORTH ATLANTIC OSCILLATION AND ARCTIC OSCILLATION ON PRECIPITATION DISTRIBUTION IN SERBIA

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The North Atlantic Oscillation (NAO) is the most significant large-scale mode of natural climate variability on the northern hemisphere. It has large impacts on weather and climate in the North Atlantic region and surrounding continents from Arctic to North Africa, from Siberia to Atlantic, including Europe. NAO is defined as difference in surface pressures between high-pressure center above Azores and low-pressure center above Iceland. NAO includes two extreme phases, a positive phase that means strong activity of both centers and negative denoting weak activity of pressure centers.

Arctic Oscillation (AO) is supplement of NAO or an alternate view of NAO. AO is usually defined as fluctuations of atmospheric pressure between positive and negative phases at polar and middle latitudes. Although AO and NAO exist during the whole year, the oscillation amplitudes are greatest in winter. The changes of NAO i.e. AO phases cause changes in distribution of precipitation, pressure, wind, and temperature in wide area. Positive NAO and AO phase brings precipitation deficit over southern Europe including Serbia, while negative phase mostly means more precipitation.

Time series of NAO and AO are shown through Indices that are calculated on the basis of pressure differences between the pressure centers. Our previous analyses were based on monthly data of NAO index as well as long-term pressure, temperature and precipitation data in Serbia. The methods previously used were the Empirical Orthogonal Function (EOF) creating the rationalization maps of the precipitation field in Serbia and the cross-correlation analysis for the evidence of the teleconnection patterns. The results obtained by both methods have pointed to significant influence of NAO on climate in Serbia.

The teleconnection between the AO and precipitation regime in Serbia, are analyzed for the first time in this paper. Here are analyzed daily precipitation data for the period from 1950 to 2003 during December, January, and February from 12 main stations in Serbia. New evidence of NAO and AO influence on climate in Serbia is proved by cross-correlation between daily values of NAO and AO index and daily precipitation data from 12 stations in Serbia resulting as with maximum correlation coefficient ranging from –0.44 in Kikinda to –0.38 in Kragujevac. The results suggest that AO influence on Serbian region is more prominent than the one obtained for NAO.

The trend of longer (53 years) series of data showed non-homogeneity in the region, while last 26 years trend indicated to especially intensive AN/NAO influence. The analyses of climate indicator R95T i.e. the trend of fraction over 95th percentile of total annual precipitation, pointed to positive trend of extremely high amounts of precipitation in many places in Serbia especially in Vojvodina, while in eastern part prevails drought.

Keywords: precipitation, NAO, AO, winter, cross-correlation, teleconnection.

CLIMATE CHANGE IMPACT ON DROUGHT CHARACTERISTICS IN THE VLTAVA RIVER BASIN – CZECH REPUBLIC

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Possible consequences of climate change with respect to water resources are studied. The study is carried out in the Vltava river basin (southwest of the Czech Republic). Drought is a serious problem in certain regions of Czech Republic nowadays (e.g. 2003 drought etc.) and could be even more pronounced in the future. Therefore, analysis of the drought in present conditions as well as in the possible future conditions is an important task. Both spatial and temporal distribution of the drought events can give us a hint for possible mitigation of the drought situation in the water resources sector as well as in the other fields.

The precipitation patterns over most parts of the Europe will experience significant changes. This is the case for Czech Republic as well. Considering the IPCC A2 emission scenario, the precipitation will decline in the summer period (decrease of about 20%) – already the period of low flow on most of the Czech rivers. Also the rise of average annual temperature together with increased potential evapotranspiration is going to introduce an additional pressure on water resources. According to the results of regional climate model (RCM) simulations, an increase of temperature of about 3.5 degrees of Celsius is expected. The changes in precipitation are spatially more variable and depend also on the climate model that was used. Therefore an ensemble of 6 different RCMs is used to handle the problem of uncertainty. The method based on Standardized Precipitation Index is introduced to describe the spatial pattern of drought distribution across the Vltava river basin and changes of its characteristics due to the climate change.

WATER RESOURCES IN BULGARIA: ANTICIPATING CLIMATE CHANGE IMPACTS

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Reports of the Intergovernmental Panel on Climate Change (IPCC) point to important water resource problems and societal vulnerability at basin, regional and national scales. According to regional climate projections of IPCC-4 Working Group 1, climate change models largely agree on the direction of change in temperature and precipitation for the Mediterranean Region and adjacent Balkan areas, especially for summer. Models suggest drier conditions, perhaps worse than historic droughts in the region. Diminished water resources not only threaten water uses, but also water quality due to less dissolved oxygen and decreased dilution and processing of pollutants. Warmer winter conditions mean less inter-seasonal water storage and changing river regimes. Thus there is opportunity to plan for future water resources using both modeling and analog approaches. Our presentation will focus on modeling while mention the potentials of analog approaches.

Examples of climate-change-related work on water resources in Bulgaria help us to argue that quantitative and qualitative analyses are important and complementary in anticipating future water resource management challenges from both scientific and societal perspectives. Quantitative analyses inlcude two stages of modeling. Simplified hydrological models with inputs from the results of general circulation model simulations using IPCC scenario assumptions would provide an exploratory stage from basin to regional and national levels, helping to assess the direction and magnitude of future water resource challenges. Informed by this exploratory stage, subsequent analytical models could focus on selected issues, basins, and threats in specific time periods with different imperatives for planning. Such exploratory models could range from largely statistical to process models with distributed parameters using geographic information systems (GIS). We briefly use simplified GIS model for the Bulgarian Struma Basin to illustrate the exploratory stage. In the analytical stage, models of greater spatial and temporal resolution are needed, including both water resource and pollution management dimensions based on down-scaled GCM results. A high-resolution, GIS-based model for the Bulgarian Yantra Basin which also incorporates water quality illustrates the second stage of modeling; it is described in detail. Finally, an approach using past and present drought as an analog is suggested to examine societal vulnerability to water resource impacts, including water supply, energy, health, social and political dimensions.

Keywords: Bulgaria, Climate Change, Drought, Geographic Information Systems, Water.

FORECAST'S ASSESSMENT OF WATER CONTENT IN UKRAINE IN THE FIRST HALF OF XXITH CENTURY

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In the territory of Ukraine are considerably shown long-term fluctuations of precipitations and river runoff in the form of regular recurrence of the periods (groups of years) with high and low water content. Stable mutability of water content in time is connected with global atmospheric processes. It is characteristic as for the Western and the Central Europe.
The periods of water content will be coordinated with features of cyclonic activity above northern Atlantic which are shown in change of areas of cyclones formation, displacement of their trajectory and intensity of synoptic processes.
Most expressively long-term mutability of water content is shown in Carpathians as here owing to influence of mountain chains which are on the way of moving humid air masses from Atlantic and the Mediterranean, become more active circulating processes which cause an intensification of precipitations (Sosedko, 1992; Lukyanets et al., 1998, 2000).
Temporal consistency research of observations for 80-125 years on the basis of autocorrelated, spectral and structural analyses testify to presence of regular alternation of high and low water content periods on the rivers of Carpathians region (Dnister, Tisza, Prut river basins) and adjacent territories (the Right bank of Prypyat', Western and Southern Bug river basins). Duration of these periods makes 16-17 and 10-13 years accordingly.
During the high water content periods were observed frequent floods with destructive consequences which covered significant territories - in the past it was 1927, 1941, 1948, 1955, 1969. During high water content period which proceeded about 1992-1993 and has ended, as well as it was supposed in 2005-2006, have passed significant floods in Carpathians (1993, 1996, 1997, 1998 and 2001).
During the low water content periods the quantity of precipitations and capacity of water runoff on the average on 20-30% is less, than during the high water content periods, and in separate years or seasons can be on 40-50% less. So, during the low water content periods is likelihood an approach of the droughty phenomena, mainly in southern and east areas of Ukraine. During the same periods in Carpathians are observed less intensive and infrequent floods.
Considering laws of natural fluctuation of precipitations and river runoff, it is necessary to expect the approach in the first half of XXIth century of the following water content changes:
low water content – 2007-2019;
high water content – 2020-2036.
These periods are defined with accuracy ± 2 years.

Keywords: spectral analysis, high water content, low water content, cyclone, river runoff.

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DETECTION OF CHANGES IN THE THREE KARST SPRING DISCHARGES INTO DANUBE RIVER BASIN

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In many areas in Bulgaria karst water is the only source for different purposes including water supply, agricultural and industrial uses. This paper is devoted to three karst systems belonging to the Danube River basin. The springs discharging these systems are one of the biggest in Bulgaria. The corresponding time series for the period 1966-2006 are analyzed. The non-parametric Mann-Kendall and Pettitt tests and homogeneous hidden Markov models are used to detect annual and seasonal trends and change points in spring discharges. Due to these techniques the discharges are clusterized into dry, normal and wet seasons and years. The obtained results clearly show that the climatic changes strongly impact on spring discharges.

THE EFFECT OF FLOW REGULATION ON THE DISTRIBUTION AND DYNAMICS OF CHANNEL GEOMORPHIC UNITS (CGU'S) AND IMPLICATIONS FOR MARBLE TROUT (*SALMO MARMORATUS)* SPAWNING HABITAT IN THE SOČA RIVER, SLOVENIA

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This research examines the impact of flow regulation on the spatial distribution and dynamics of physical habitats or channel geomorphic units (CGU) of the Soča River, an upland river system in Slovenia. In order to assess the impact of flow alteration on the spatial pattern of CGU type, size, hydraulics and distribution, a river channel survey was completed along three reaches (totalling 14.3km), i.e. an unregulated stretch and two regulated reaches (with reduced flows). In addition, one regulated reach was re-surveyed at different discharges to investigate the dynamics of CGU's and their relationship with flow.

CGU's were classified and mapped on foot and from a boat using a combination of visual assessment and physical measurements of the hydraulic characteristics (velocity and depth) in each CGU. GPS was used to locate CGU boundaries to sub-metre accuracy, and the application of GIS enabled the analysis of the distribution of CGU's along each reach.

The effect of flow regulation on the hydraulic character of the river becomes apparent by highlighting differences in the types of CGU's present between the regulated and unregulated reaches. Reduced flows from river regulation also significantly reduces the size of CGU's, alters their hydraulic character, and affects the longitudinal distribution of types by creating greater habitat fragmentation. This work also highlights the need to assess CGU's along continuous stretches of river in order to understand the nature and dynamics of river habitats.

Hydraulic preferences for spawning habitat of marble trout (Salmo marmoratus) were obtained from previous research. The hydraulic character of CGU's were analysed at different discharges and combined with the hydraulic preferences of the species to evaluate the impact of flow regulation on habitat availability for marble trout. Analysis shows that intermediate measured flow provides increased spawning habitat availability in the chosen reach for this target species.

Keywords: Physical Habitat, Flow Regulation, Marble Trout, Soča River.

CHANGES IN PRECIPITATION VARIABILITY IN OSIJEK

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Osijek is situated in Eastern Croatia, region with lowest amount of precipitation in Croatia. Therefore, analyzing precipitation variability changes is important for different types of human activities, i.e. agriculture and water management. This paper analyses variability of precipitation in Osijek in three periods of thirty years, starting from the year 1901 till 1990. Precipitation variability has been calculated using different methods of mean arithmetic deviation. Besides that, the changes in precipitation amount were determined in order to establish regularity between changes in precipitation amount and variability.
Sixty-year period has been determined from the year 1931 till 1990, because none of the thirty-year period was representative. A primary minimum of precipitation is at the end of winter and at the beginning of spring (March), while secondary minimum is in autumn (October). Primary maximum is at spring and summer (June), and secondary maximum is in autumn (October). Seasonal averages show that precipitation maximum is in summer and minimum in winter.
Analyses of precipitation variability reveal that annual variability course is characterized with two maximums and two minimums of variability. Primary minimum of variability is in spring and summer (minimum in June, rarely in July or August) and secondary is in winter (minimum in November or December). Primary maximum of variability is in autumn (maximum in October, rarely in September) and secondary maximum is in spring (maximum in February). It is important to notice that May is enhanced in the period of primary minimum in spring and summer, with a slightly higher relative average variability.
It has been determined that relationship between change of precipitation and variability is not simple. Correlation analysis of ten-year precipitations averages and variability shows that there is a moderate negative connection in August and October. Correlation analysis of thirty-year averages shows that there is a moderate negative connection in June and September. Statistically, close negative connection is in October and in summer, but no strong negative connection is determined. Course of precipitation amount and variability in observed period shows close positive connection.
Increase of precipitation amount does not have to cause variability decrease. It can be assumed that larger increase or decrease of precipitation amount can cause adequate decrease or increase of variability, but the research results did not point under what circumstances that happens. Influence of possible factors of that connection could not be excluded, especially the influence of processes that cause precipitation genesis in Osijek. Nevertheless, during some months a decrease of precipitation amount and variability increase (and vice-versa), can be connected, like it is a case in October.

Keywords: precipitation, precipitation variability, climate changes, Osijek.

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THE INFLUENCE OF DAM ON ALKALIZATION PROCESSES OF THE LOWER TISA RIVER

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The changeability of plankton dynamics was represented in our study of the lower river Tisa (157 – 9.5 r km) Serbian part with characteristic changes of water trophic degrees (depending on hydrometeorological station) and influence of seasonal water supply over the old reconstructed Danube-Tisa-Danube canal network. Therefore, the monitor parameters of eutrophication processes were compared and interpreted by the statistical analyses. Phosphatase activity index was found to positively influence on sodium adsorption ratio- SAR index with oligotrophic bacteria contrary to heterotrophs at the impounded water stretch St Novi Becej. At the downstream Station, the association of PAI and suspended solids slow down considerably abundance of bacteria. The obtained results of SAR index was found to be in negative relation with the iron content in St Martonos while at the St Novi Becej neutral phosphatase enzyme was positively correlated with the iron content. Accordingly, phosphatase activities slow down at the confluence of the Tisa to The Danube River. Our study revealed that oligotrophs and centric diatoms, are partly controlling the alkalization processes in Serbian part of the Tisa River, and are suitable for investigation of Ecological potential of regulated water bodies. Additionally, the presence of brackish water diatom Entomoneis paludosa and small centric algae Cyclotella meneghiniana pointed to considerable problems of detailed canal network usage supplied by the river Tissa (Figure).

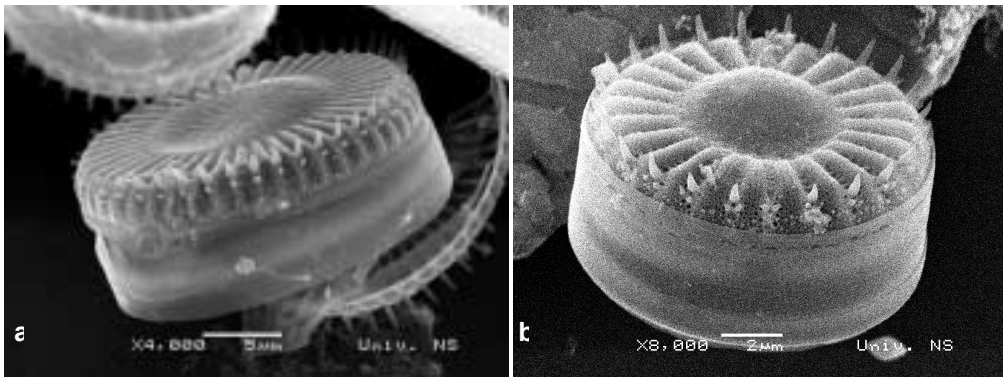

Figure 1. SEM micrograph showing Cyclotella meneghiniana of the Serbian part of the river Tisa (a) (June ’07); the drainage/irrigation DTD canal (b) (September ’06).

CLIMATE CHANGE AND WATER RESOURCES: SCENARIOS OF LOW-FLOW CONDITIONS IN THE UPPER DANUBE RIVER BASIN

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Global Climate Change will have regional impacts on the water resources and will force water resources managers and farmers to adapt. More frequent floods and droughts will likely be consequences of climate change. Both low-flow and its duration are also critical hydrological parameters, which strongly influence the state of aquatic ecosystems as well as power production, reservoir management and industry. A thorough understanding of the processes, which determine the availability of water on the regional scale through regional simulation models, forms the basis for the analysis of impacts and adaptation strategies through climate change scenarios. The project GLOWA-Danube (www.glowa-danube.de) develops integrative modelling techniques combining process knowledge from both natural and social sciences to examine the sustainability of regional water systems as well as water management alternatives in the Upper Danube watershed under Global Change conditions. GLOWA-Danube investigates among others the possible developments of the water resources of the medium sized (A=77000 km²) mountainous watershed through the course of a change in climate over the next 50 years with the network based decision support system DANUBIA. Special emphasis is given to changes in low-flow condition.
The natural science part of DANUBIA describes the processes in the regional water cycle on a physical basis and in a spatially distributed manner. It consists of a collection of tightly coupled models, which strictly preserve energy and matter and are not calibrated to maximise their overall predictive abilities. The quality of DANUBIA with respect to its ability the reproduce the historical time period of 1960–2005 is initially demonstrated using historical data from the German and Austrian meteorological network. Based on a statistical climate simulator 12 different realisations of the IPCC A1B climate scenario were used to investigate the impact of climate change on the water resources of the Upper Danube in the simulation period of 2011–2060. The change in discharge and frequency of occurrences of low-flow in the watershed for a scenario ensemble at selected gauges throughout the simulation period were analysed and are demonstrated. NM7Q, the lowest annual average discharge during 7 consecutive days, was taken as indicator. NM7Q is used by the authorities in the watershed to impose restrictions on the use of the river water resources in the watershed. The analysis shows that for most selected gauges in the watershed strong changes were simulated in the frequency of occurrences of low-flow conditions. The changing climate gradually reduces a 50-years NM7Q discharge of today to less than half of its discharge in the year 2060. The analysis of the ensemble outputs also shows, that for the most severe realisation with respect to low-flows within the next 50 years the today's 100-years NM7Q is exceeded for three years in a row. These results clearly indicate that the expected climate change will strongly alter the low-flow conditions in the Upper Danube watershed.

Keywords: climate change, mountain hydrology.

THE ECOLOGICAL POTENTIAL DANUBE-TISA-DANUBE CANAL NETWORK IN BACKA REGION

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In the assessment of trophic condition, stretches of DTD canal network were observed gradually by the data interpretation by the software Statistica 8 and SEM micrographs which clearly indicates the decisive importance of investigated parameters of the eutrophication processes necessary for Ecological potential classification (DIRECTIVE 2000/60/EC).
Following the enumeration of boundaries of irrigation distribution drainaged systems of Vojvodina Province, from the 1967, DTD canal network was divided into sectors and stretches in northern–southern direction of sampling stations: sector I: St Bezdan- The Danube, Bajski Canal, (stretch 1-2); sector II: canal Vrbas-Bezdan (St Sombor, St Vrbas: stretch 3-4), canal Prigrevica-Bezdan (stretch 5); canal Odzaci-Sombor (St Srpski Miletic-Odzaci triangle- stretch 6), and Kosancic-Mali Stapar (stretch 7-8); canal Becej-Bogojevo with St Srpski Miletic-Odzaci triangle (stretch 9-11); sector III: canal Becej-Bogojevo (St Vrbas downstream the waste water pollution, St Backo Gradište; stretch 12-15). With the sector IV we describe water quality in DTD canal Backi Petrovac - Karavukovo and Novi Sad - Savino selo (St Bac, St Backi Petrovac, St Novi Sad, stretch 16-18).
In ecohydrological stretches, in summer, canal network was characterized with acid phosphatase activities which are following the temperature changes. Alkaline phosphatase activities have the tendencies of increasing in sectors III. The dynamics of Ecological potential of diatoms was shown during the phosphatase enzyme activities increasing, while the heterotrophic bacteria were dominated during the phosphatase enzyme stabilized activities. Correspondingly, neutral phosphatase activities slow down at the confluence of the canal to the Tisa River (Figure 1). Considering the point pollution sources in sector III after the industrial waste water discharges, canal water used for irrigation was comprised of waste water and shortages of water from the sector II. Throughout the canal stretches, the nutrient regeneration in water was observed in Backa canals (Figure 2). The phosphate concentration increase during the 2002-2005 while the SAR index (sodium adsorption ratio) showed more stabilized values. Brackish water algae in the Backa Region were scarce and pointed out lower salinity of the canal waters for irrigation purposes comparing to the canal water towards Banat region of sector III. In our opinion, in these sectors the aim for increasing of Ecological potential in region will be the improving of the control regime used for gates of Danube-Tisa-Danube canal network by a more dynamic flow regime allowing canal bed development.

Keywords: DTD canal water, Backa, plankton, SAR, PAI, ecological potential.

THE RESEARCH OF MODEL OF ACTIVITIES OF PHOSPHATASE ENZYMES OF THE DANUBE RIVER IN THE CITY

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Following the seasonal dynamics of median values of phosphatase activity index (PAI), water quality of the City of Novi Sad City is changing. During the tranformation of phosphorus, iron deposition was estimated by the occurence of sheated bacteria in drainage alluvial groundwater hydrosystem. Our research is an example of usefulness of trophic indices in giving explanation of increased microbiological processes. Estimated by comparison, the assessment of sector of Danubian Ecological status by the activities of phosphatase enzymes with elemental analyses as unity approach methodology in ecological modelling of protected areas was proposed.

Keyword: PAI, Novi Sad, climate regime, The Danube River.

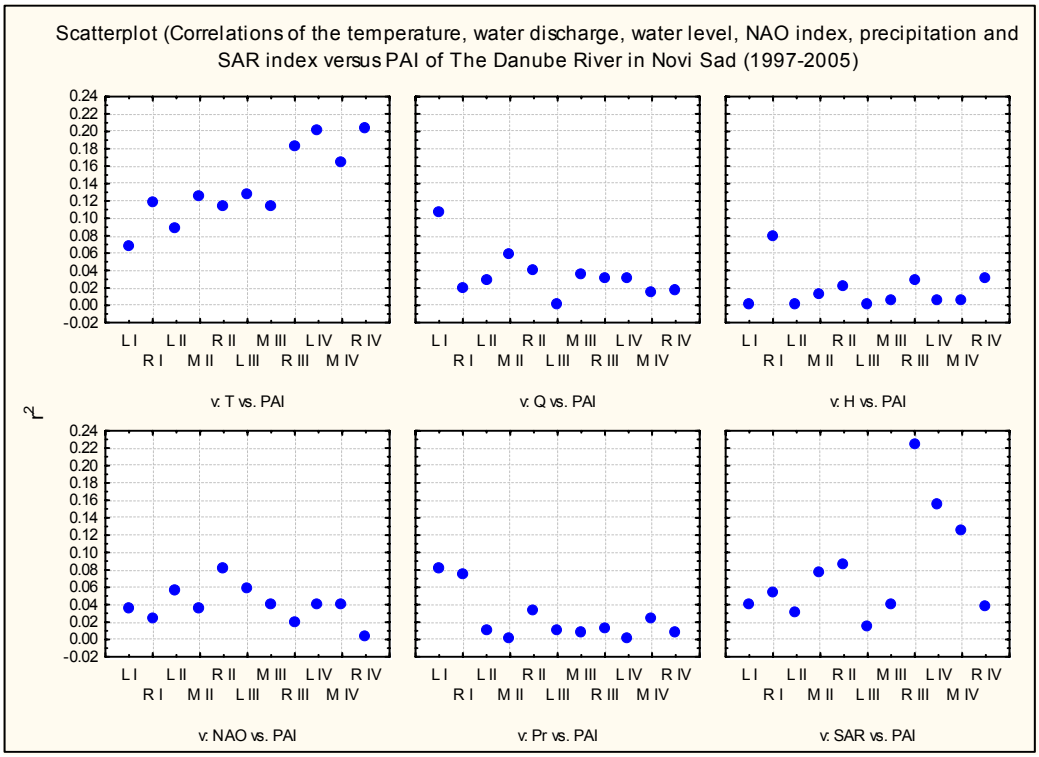

Figure 1. Correlations of the temperature, water discharge, water level, NAO index, precipitation, sodium adsorbtion index- SAR index versus phosphatase activity index- PAI (Matavuly, 1986) of The Danube River in Novi Sad (1997-2005). The research was made on four urban river stretches concerning river banks and middle current of the river when the samples were collected from the three bridges: stretch I from 1262 to 1259 r km (L1, R1); stretch II 1257 r km (L2, M2, R2); stretch III 1254-5 r km (L3, M3, R3); stretch IV from 1253 to 1245 r km (L4, M4, R4). Shown series are based on linear regression analyses of investigated parameters.

HOMOGENEITY TESTING OF DISCHARGE TIME SERIES FOR THE SAVA RIVER

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In addition to natural variability there are also artificial signals within the time series of discharge on the Sava River Basin. The goal of this study is detection of such artificial changes. For that purposes a number of 10 time series of the Sava River discharge is considered for the period 1961-2000. Alexanderson normal standard tests have been applied which belong to the group of statistical tests for testing of a relative homogeneity. There are advantages of this testing because of an absolute homogeneity testing is questionable as significant natural variability and changes are also very probable. Explanation for artificial non-homogeneity and its removing has been done.

DETECTING OF RUNOFF VARIABILITY CHANGES IN DANUBE DAILY DISCHARGE TIME SERIES 1876–2006

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It is generally supposed that the global warming will result in increasing of the hydrological phenomena extremality. In case of discharges it is expected that both low flows duration and flood frequency will increase. Approval of this hypothesis by statistical evaluation of the daily runoff characteristics depends on availability of high quality homogeneous data series of long periods. The aim of this paper is to analyse the mean daily discharge of Danube in Bratislava in different sub-periods of the period 1876–2006. We compared the moving averages of 65-years, 30-years and 15-years periods. The statistical tests did not confirm the increase of daily runoff extremality of the Danube River in 1876–2006. On the contrary, the daily discharges variability decreases. In last 30 years the discharge increased in winter-spring season and decreased in summer season compared to previous periods. It can be explained by the higher air temperature in the upper Danube basin. A warmer climate causes an early snowmelt in winter-spring period, and thus less runoff in summer, when the precipitation totals are maximal. In 130-years time series of mean daily discharge of Danube in Bratislava we did not detect any important change of the basic statistical runoff characteristics in one direction (discharge increase or decrease).

Keywords: Danube River, daily discharge variability, statistical analysis.

Acknowledgement. This study was supported by projects MVTS „Flood Regime of Rivers in the Danube River Basin“ and VEGA-0096/08.

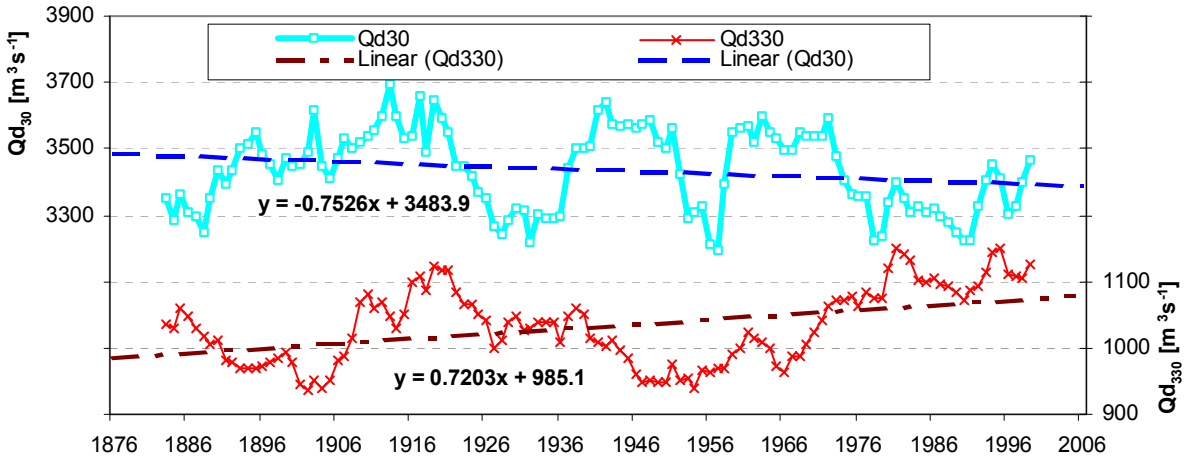

Fig. 1. Trends of the15-year moving averages of 30-day and 330-day discharge of Danube: Bratislava.

WINTER CLIMATE VARIABILITY AT DANUBE PLANE, NORTH BULGARIA

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Winter climate plays a key role in a number of environmental and socioeconomic systems in most countries. In this respect snow cover is essential, first of all for appropriate vernalization of various plants as well as water supply, transport, road maintenance, winter sports and tourism. The last long lasting droughts, especially the 1983-1994 period with unusually warm and dry conditions as well as scarce snow cover (Knight et al. (eds.), 2004), caused significant damages on many crops in Bulgaria and considerably decreased runoff. Snow determines the timing of peak river discharge during the melting of the snow pack in the spring. When assessing the impacts of climatic change on river basins one of the key controls will reside in snow amount and durations (e.g. Benisston et al., 2003). Snow cover accumulated in the mid-latitudes, where temperatures are often close to freezing, is quite sensitive to variations and change in climate. High-quality, long-term snow cover records are not only necessary for climate accessing and modeling: they also play an important role as reference data for annual runoff prediction and daily avalanche forecasts (e.g. Laternser &. Shneebeli, 2003).
This contribution is an investigation on winter climate variations and tendency in the course of winter precipitation and air temperatures as well as snow depth and snow cover duration over the period 1931-2005 at 14 meteorological stations located at the Danube Plane in North Bulgaria. For assessing climate variations and trend statistical techniques such as moving averages, trend estimations and distribution functions are applied. Warming with a significant temperature increase and an overall decrease in winter precipitation are observed in many areas in North Bulgaria during the period 1931-2005. This fact has respectively resulted in a decrease of maximum snow depth and snow cover duration. The lower maximum snow accumulations have been more frequently observed in the time series over the investigated period.

Key words: Danube Plane, North Bulgaria, climate variability, winter precipitation, winter temperature, snow cover, statistical methods.

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THE OPPORTUNITIES OF THE PRESENT METHODS OF THE WATER RESOURCE ASSESSMENT IN SLOVAKIA

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At present, the increased occurrence of drought and water scarcity (that is the availability of domestically and commercially usable water) is one of the most significant problems of 21st century. Water is primary means between potential climate changes and the future development of natural subsystems and socioeconomic sectors. There is evidence that as a society we are attempting to consume this precious resource in a conservative manner, this is particularly important in regions that are suffering from drought.

Often water is used for more than one purpose simultaneously; however these purposes can contradict each other.

Water balance assesses all aspects of water management, including water quality and quantities. Additionally it specifies which regions and periods of time indicated that water resources where not at levels that met society's demands. Water balance is utilized as a key tool in the assessment of available water resources. The aim of the water balance is to specify where and when water requirements have or have not been met.

As a part of consistent approach to the implementation of new water guidelines by the European Commission, it is important to clearly identify any discrepancies and build strong points of contact between individual balance procedures. Any future assessment of water resources needs to be consistent with the water balance.

In present, the water balance may be utilized for other purposes which are yet to be discovered. One such area of potential use is in water-legal process, it can provide useful information to those who need to make decisions regarding water use. By including these new assessment approaches into the quantitative water balance it can become a useful tool in the assessment of the current state of water resources and their usage. This approach is not only useful for simply reviewing past water usage but also for planning purposes, particularly when seeking approval for water usage.

EXTREME VALUES OF WATER RESERVES IN SNOW COVER IN UKRAINIAN CARPATHIANS

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Water reserves in snow cover is very important for hydrological calculations, especially for assessment of water resources in river basins, forecasting of spring floods etc (Snizhko S., Scherban' I., Kovalenko A., 2006).
In our research is considered the dynamics of water reserves in snow cover of the Ukrainian Carpathian region and river Tisa catchment for last 20 years (1985-2006).
In region which we have choose for researching information about water reserves in snow cover is very important for hydrological forecasts of spring floods in the catchments of mountains river of Ukrainian Carpathian regions and for any transboundary rivers, for example Tissa.
We have used the information about snow characteristics and for 6 meteorological stations (Turka,Slavske, Posheshevska, Nyshni Vorota, Yasinya, Play) during last 20 years (1985-2006).
The meteorological stations are placed in different heights in mountains. Two stations (Play and Posheshevska) have highest position: 1330,0 and 1451,0 m above sea level. Only the station Posheshevska situated on the north-east slope of Ukrainian Carpathians.
In the mountains (the height more than 1000 m) the snow cover appears in 3 decade of November and stay until March and at the high mountains stations until Mai, sometimes until June.
At the all of 6 monitoring stations were fixed over 150 mm of precipitation. Maximal sums were fixed at the stations Play and Posheshevska – over 270 mm.
In March 2001 at the foot-hills stations were observated about 200 mm and at the hight mountain stations over 340 mm of precipitation. Such considerable volumes of moisture resulted in flash floods.
Comparison of sums of atmospheric precipitates for different stations in mountain districts, shows that between of receipt of precipitation is a difference. For example, station on the south-west slope (Play) became more precipitation as other stations.
On the south-west slope (station Play) maximal amount of precipitation falls out in November. On the north-east slope (station Posheshevska) maximal amount of precipitation falls out in October and in March. Minimal amount of the precipitation is fixed for both cases in January.
In Ukrainian Carpathians is observed the long-term tendency to increase of precipitation amounts in the winter period.
Maximal values of water reserves are fixed in February-March, but during last 20 years can see maximal values often and in February. So in February at the high mountain stations water reserves in snow cover increase to 170-220 mm, at the slope stations – to 60-80 mm, in a valley – to 50 mm.
The water reserves in snow cover are changing (accumulated) during winter. Maximal water reserves is observed in the spring and spring is very dangerous period for snow avalanches and for river floods.
The results of researches can be very valuable for study of regional processes of water balance formation and spring flood forecast in Danube river catchment.

Keywords: snow cover, water reserve, seasonal dynamics, long-term tendencies.

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THE CLIMATE CHANGE IMPACT ON THE MESTA RIVER BASIN RUNOFF

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The paper presents an attempt for assessment of the Climate Change impact on the Mesta river runoff (cross section Hadji Dimovo) using HBV mathematical model. The HBV model originally developed at the Swedish Meteorological and Hydrological Institute in the first half of the seventies (Bergstrom, 1976) has gained widespread use for a large range of applications. The used version is developed for the project "Climate Change and Energy Production", a Nordic project aimed at evaluating the impacts of climate change on the water resources. The HBV model describes numerically the runoff processes occurring in a natural river basin. Simulation of the natural discharge means that the models are used to simulate runoff from meteorological data input available in the basin or in its neighbourhood. The HBV model has a simple vegetation parameterisation including interception, temperature and evapotranspiration calculations, lake evaporation, lake routing, glacier mass balance simulation, special functions for climate change simulations etc. It can be classified as a semi-distributed conceptual model. The main input variables used in this report are the average monthly temperature, monthly totals of the precipitation, the potential evapotranspiration and the monthly discharges.

This paper presents a study for the application of the HBV model using monthly data for the Mesta River basin (cross section Hadji Dimovo) in Bulgaria and the obtained results. The Mesta river basin is the highest in Bulgaria compare with the other main river basins. It is situated in the South - West part of the country and surrounded by three relatively high mountains – Rila, Pirin and the Rhodops. The River Mesta flows from North to South up to the Aegean Sea. Two different Climate Change scenarios are used (HadCM2 and ECHM4). The calculations are for years 2025, 2050 and 2100 using 30 years base period (1961 – 1990). The obtained results are promising and they show the potential possibility for the HBV model use to assess the climate change impact on the elements of hydrological cycle for the Bulgarian river basins using monthly data.

Keywords: *hydrology, modelling, climate change, scenarios.*

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WATER CONTAMINATION BY FLY ASH FROM ROAD CONSTRUCTION

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The paper present determining the extent of surface water and groundwater contamination by fly ash from road construction. Groundwater and surface water are fundamentally interconnected. It is often difficult to separate the two because they feed each other. This is why one can contaminate the other. Water is an ideal solvent, some products placed on or in the soil will eventually end up in the groundwater. The extent to which human activities threaten groundwater quality depends on the types and amounts of materials use how they are used, and the risk of spills or accidents. Road construction and road reconstruction have significant environmental impact specially on surface water and groundwater. According to the sustainable development guidelines the non-renewable sources of natural material need to be protected, some types of waste materials and industrial by-products are being used in road constructions for a number of years already as a substitute for standard materials.
There are a number of reasons for this, one being a rational consumption of good quality stone material reserves and the other being large quantities of waste materials stockpiling on the dumping sites.
From a wide range of alternative materials used in road construction, fly ash, with its advantages, holds a significant position in relation to other materials, because it can be used in its original form, without any processing and change in composition.
Fly ash is a by-product produced in the electric utility industry or power plants during the process of combustion of coal in boiler furnaces, an amorphous glassy material consisting of silica, aluminum, iron and calcium oxides plus other minor constituents. It has been used in a variety of applications in road construction including as an addition to cement and concrete, for grouting mines and caverns, as a fill material for embankments, in road stabilzed mixes etc. The already mentioned application options of fly ash and a long term experience in such applications prove its advantages. However, one must not forget that this is only waste material with variable chemical and mineralogical composition whose uncontrolled application could have harmful effects on environment. Namely, properties of fly ash depend on the type of coal used in the combustion process and the process itself in the power plants, and this significantly influences the change in ash composition, possible radioactive properties and heavy metal concentration.
It needs continue measurement contaminate concentration with stochastic models of transport contamination or measurement in site. Control concentration specific pollutant or group of pollutants in water, air or soil must be in function for protecting human health and environment.
Good water management is the key to protecting water quality. Sustainable development requires protect unreturned resources natural aggregates; it means made the best and economic uses all existing resource.

Keywords: concentration contamination, water, fly ash, road construction.

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INFLUENCE OF VEGETATION COVER ON AIR AND SOIL TEMPERATURES IN THE ŠUMAVA MTS. (CZECH REPUBLIC)

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Plant transpiration modifies climatic conditions at the land surface and in the soil during the vegetative season (Eagelson 1987, Pokorný 2001). In mountainous areas of Central Europe transpiration recycles about 50% of the rainwater during the vegetative season. Evaporative cooling induced by transpiration reduces the maximum plant surface temperature by about 15ºC on a hot and dry day. Dissipation of solar energy in a landscape controlled by plant transpiration is the core of the terrestrial hydrologic cycle. Transpiration is substantially influenced by the form and functioning of the vegetation cover. This is one reason for the large differences in microclimatic conditions among regions lying in similar natural conditions but covered by different vegetation, and may underlie the thermal and water regime changes during the vegetative season.

Air temperature at heights of 5 and 200 cm above soil surface, as well as soil temperature at depths of 15, 30 and 60 cm, were measured in the cold climatic zone at three localities (catchments) under different plant cover during the growing seasons 2002–2007. The catchments Kout (dead forest), Doupě (clearing) and Stolec (mature spruce forest) are situated in the National Park of the Šumava Mts. (Czech Republic) at an elevation of 1105–1330 m a. s. l. This region is part of the metamorphic complex – Moldanubicum. It is formed mainly by metamorphosed rocks (paragneiss with smaller anomalies). The three catchments have very similar natural conditions, but differ significantly in vegetation cover. The catchments are covered with acid brown soil developed on paragneiss.

In the experiments reported here, the clearing and dead forest catchments both existed as small islands inside an extensive spruce forest. Also, there was sufficient soil moisture to prevent any reduction in plant transpiration during the period of study. Given these conditions we conclude that (1) The daily air temperature of the catchment covered by the dead forest fluctuated more than in the stands covered by clearing or mature forest. (2) The air temperature of catchments covered by mature forest had the smallest daily fluctuations. (3) The more extreme air temperatures in the dead forest caused the systematic raising of the soil temperature at a depth of 15 cm compared to the clearing and mature forest. These conclusions are valid for a cold climatic zone during a vegetation season in which plant transpiration plays a governing role in solar energy dissipation.

Keywords: plant transpiration, climate, thermal regime.

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TRENDS OF RIVER DISCHARGES IN SLOVENIA

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Trends of river discharges are very important in recognition of climate changes and also in water management. In last years droughts and floods are more and more frequent, therefore monitoring and investigating of hydrological situation became one of the guidance scientific approach.
Hydrological study made by Global Runoff Data Centre (under auspices of the WMO) was made with determination of time series of hydrological extremes of main rivers all over the world and also on Slovenian River Krka. A present study of trends of river discharges is expanded analyse of time series made for twenty-two important gauging stations on main Slovenian rivers, with at least 50 years long continuous observation period and reliable data. We analyzed data of minimum, maximum and average annual discharges, based on time series of the daily mean discharges. The analyze was made by using Hydrospect program (Kundzewicz et.al, 2004). Statistical significance trend of the river discharges was recognized with consideration of 10% level of confidence. Results with more than 90% were accepted as typical appearance of changing river discharges or some other hydrological indexes.
In analysis of mean annual discharges made in Agency of the Republic of Slovenia for the Environment in last years, statistical significance trend was find out only by rivers of northwest alpine region (Ulaga, 2002; Frantar, et al., 2006). In recent research of time changing discharges, presumption of generally decreasing of water quantity all over Slovenia was confirmed. Discharges on all analyzed rivers shows decreasing trend of mean daily discharges. Also trends of annual extreme of maximum high discharges are mostly in decrease although with higher spatial changeability of statistical significance. Higher level of confidence was recognized on decreasing trends on rivers with mostly high-mountain and karstic river basin. Increasing trend of maximum high discharges was recognized only on some rivers of eastern Slovenia. Spatial disposition statistical significance trend of minimum low discharges is quite similar. North, west and central part of Slovenia have decreasing trend of minimum water discharges, while east and south part shows increasing of trend. High spatial changeability of statistical significance was recognized also in trends of all hydrological indexes.
Our basic conclusion was quite simple – in Slovenia it is well recognized decreasing of water quantity in long period of observation. This fact and also worsening of water quality became alarming problems of our future, especially in the dry months of the year.

Keywords: trend, river discharge, statistical significance, decreasing of water, Hydrospect.

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CLIMATE CHANGE AND EXTREME SOIL MOISTURE EVENTS

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According to hydrological forecasts the probability, frequency, duration and intensity of extreme hydrological events and soil moisture situations (flood, waterlogging, overmoistening versus droughts, sometimes during the same year, in the same place) will be increasing in the future due to:
high (and increasing) spatial and time variability, hardly predictable irregularity of atmospheric precipitation; frequency of heavy (intensive) rainfalls;
changing rain:snow ratio and quick snowmelt;
macro-, meso- and microrelief;
changing land use and cropping pattern;
soil characteristics.
Under such conditions (in Hungary, situated in the deepest part of the hydrogeologically practically closed Carpathian Basin) – it is a significant fact that soil is the largest potential natural water reservoir. Potentially a great part of the atmospheric precipitation can be stored in the 0–100 cm layer of the soil and this water storage capacity may reduce the risk of extreme soil moisture regime and hydrological stresses. This potential water storage capacity, however, cannot be used efficiently, because of the following reasons:
infiltration is prevented or limited by full water saturation (as a consequence of a previous water supply) („filled bottle effect"); frozen topsoil („frozen bottle effect"); a compact, hardly permeable soil layer on or near to the soil surface („closed bottle effect");
the infiltrated water is not stored in plant available form because of low water retention or high wilting percentage of the soil („leaking bottle effect").
The consequences of these cases are increasing surface runoff, evaporation and deep-filtration losses, and may lead to harmful environmental impacts, as soil erosion, salinisation/sodification due to the rising groundwater table, unfavourable changes in biogeochemical cycles of plant nutrients and soil pollutants, limited biological activity and ecosystem deterioration.
Consequently, all efforts have to be made to help infiltration and storage of the infiltrated water within the soil in plant available form. These operations are an unavoidable part of watershed management and efficient measures of environment protection: prevention of soil degradation processes; control of biogeochemical cycles; maintenance of favourable biodiversity, etc., as well.

CLIMATE CHANGE AND CONSEQUENCES FOR WATER MANAGEMENT IN SOUTHERN GERMANY – FINDINGS OF THE RESEARCH PROGRAMME KLIWA

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In recent years signs have significantly increased that a global warming is on its way. On one hand they result from global circulation models (GCM) and on the other hand from temperature measurements near the ground (IPCC 1996, 2001). In mid-latitudes this will generally lead to an acceleration of the water circle by intensifying rates of precipitation and evapotranspiration. In a climate change report of the federal government of Germany an increase of the extent and frequency of floods as well as consequences for water availability were forecasted.
For water managers the question arise which consequences on the water circle have to be expected. This knowledge is only rarely available but is an essential prerequisite to establish a forward looking water management policy based on scientific results.
A few years ago, the water agencies of the German federal states Baden-Wuerttemberg and Bavaria as well as the German Meteorological Service (DWD) have agreed on a joint, long-term co-operation for regional studies on the subject “Climate change and consequences for water management (KLIWA)”. For this purpose an action plan was initiated which has five main issues:
Sector A: Assessment of changes in climate (“retrospective analysis”)Trend analysis of time records of climate and water budget (e.g.: areal precipitation, discharge, potential and actual evapotranspiration, snow cover) as well as extreme values (e.g. extreme values of precipitation, floods, low flow periods)
Sector B: Estimation of consequences of potential climate changes on the water budget (“forecasting by models”)Modelling of the water budget of meso-scale catchments driven by the output of regional climate models or regionalized output of CGM’s
Sector C: Monitoring programme for the registration of present changes of climate and water budget Integrated monitoring network consisting out of gauges with long-term records of relevant hydro-meteorological and hydrological quantities, which enables evaluation of present events and early recognition of possible trends
Sector D: Adaptation strategiesDevelopment of sustainable provision concepts for water management policy on account of climate-induced changes of the water budget
Sector OE: Public relationsDistribution of results of KLIWA-studies to the scientific community as well as to the general public.
The findings from the long-term behaviour of measurement time series as well as the possible changes on the water balance in regional catchments on the base of different regional climate change scenarios will be presented. As a first result an adaptation strategy for flood protection in Southern Germany was derived; the target is to compensate the impacts of climate change on increasing flood runoffs. The strategy will be described.

COMPARISON OF SPRING DISCHARGE OF THE THREE MOST IMPORTANT HIGH-KARST RIVERS IN CROATIA – KUPA, GACKA AND UNA

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Kupa, Gacka and Una are the three most important high-karst rivers in Croatia due to their exceptional source zones. Presently, only the Gacka source zone is used for water supply (Pavičić, 2000), but future needs may call for broader exploitation of underground water reserves in these zones. Therefore, we have performed a hydrological analysis of water discharge from Kupa, Gacka and Una springs. Special attention was given to preservation of mentioned springs, since all of them have been proclaimed as a natural heritage and categorized as hydrological monuments of nature (NN, 2005).
Herein we analyzed the characteristic time series of discharge using yearly distribution of flow, recession curves, auto-correlation and cross-correlation functions (Salas et al, 1990). In our analysis we emphasized two key points: (i) assessment of water discharge on a broad regional scale and (ii) reaction rate of karstic aquifers at each source zone in response to variable hydrological conditions. Both cross-correlation and auto-correlation functions indicate distinct similarity in water discharge of Gacka and Una rivers. On the other hand, reaction rates in response to variable hydrological conditions are similar for Kupa and Una, but differ greatly for Gacka. Kupa and Una tend to quickly drain their aquifers, while Gacka springs have soaring underground water reserves. In that sense we recommend that plans for future development of water supply should not include Kupa and Una springs, especially because their value as pristine monuments of nature is much more important.

Keywords: hydrological analysis, water supply, karst springs, water discharge, karstic aquifers.

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Topic 4: WATER MANAGEMENT

GIS INTEGRATED WATER QUALITY MANAGEMENT SYSTEM AT RIVER BASIN SCALE

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Taking into account the WFD' provisions, an integrated system for water quality at river basin scale was created. This system proposes a way to support the water stakeholders' decisions easier, more rapidly and efficiently.
The components of the system are: a Conceptual Data Model, a GIS geodatabase and a plug-in tool, called GESRO, which extends the functionality of ArcGIS.
This tool can automatically frame river water into quality classes on the base of quality indicators' measurements. Its powerful functionalities refer to a combination of a computational tool programmed in .NET and the geospatial advantages given by the digital map representation in world coordinates. GESROM classifies chemical and biological indicators, the vulnerability to nitrates, the drinking water and ichthyofauna.
GESROM provides a toolbar that can be loaded in ArcGIS. The functionalities of this toolbar refer to entering measured data through a friendly user interface both from up to date measurements or directly by an existing database import (Excel or *.dbf); computation of the quality classes for a limited period of time or annually, for a reach or a whole river.
Reports with the quality classes can be created and exported to different formats in order to be used by the national water directorates. Maps with the quality representation of rivers in a river basin are also obtained. Last but not least an identification of potential polluting sources is performed automatically on the base of economic agents and diffuse polluting sources at the river basin scale.

THE SAFETY LEVEL AND THE RISK MANAGEMENT IN THE LONGITUDINAL DEFENCE RIVER WORKS

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In the paper work are analyzed different theoretical models for establishing the risk level of the defence river works failure, defining the acceptance risk and establishing at the end the safety level for different longitudinal defence river works. A computation model for the longitudinal defence river works is elaborated, model which take into account among others the water level in the river, the period of the critical wave flood, the characteristics of the defence structures and of the fundament terrains.
The approaches from the paper work allow highlighting some non-structural measures in the risk management, respectively in the safety longitudinal defence river works, inclusively for the passing process from existent systems to the one proposed, conformably with the new European defence concepts.

Keywords: work failure, risk management, non-structural measures.

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WATERSHEDS DELINEATING FOR THE MOST SIGNIFICANT BULGARIAN RIVER BASINS

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On the initiative of Bulgarian Ministry of the Environment and Water watersheds for 550 rivers were delineated by specialists of the National Institute of Meteorology and Hydrology - Sofia. That created a basis for planning and management of water resources in Bulgaria.
The present paper discuss the GIS based methodological approaches used for the mentioned above delineation, the degree of accuracy received and the possibility to increase that accuracy using advanced, but more complicated techniques. The results of the work were presented in digital format in ESRI (.shp) and MapInfo (.tab) formats. ESRI software products ArcGIS Desktop and ArcInfo Workstation were applied. Initial dataset included various GIS layers like DEM, river network, channels, elevation points and contours, lakes and reservoirs as well as topographic maps. Watersheds were divided in five layers with attribute data:
Layer base (subbasins) – watersheds of tributaries of upper order and drainage areas to the rivers segments between tributaries.
Layer 1(subbasins) – watersheds of tributaries of first order.
Layer 2 (subbasins) – watersheds of tributaries of second order
Layer 3 (subbasins) – watersheds of tributaries of third order
Basins – Danube, Black sea and Mediterranean basin
To avoid errors and for automated checks it was created GIS DataBase. The GIS DB model is based on the ESRI GeoDataBase format. File geodatabase was set up because of many advantages over personal geodatabase. All shape files migrated in new geodatabase. Created geodatabase schema, feature dataset and feature class. In geodatabase was set topology – spatial relationship, set topology properties, topology rules and validation. Topology rules allowed to define the valid spatial relationships between features (watersheds cannot overlap another and there can not have gaps between them, subbasins must be covered by basins). Create geodatabase relationship classes and relationship rules (watersheds, hydrological and meteorological stations).

OPERATIONAL SYSTEM FOR SURFACE WATER RESOURCES EVALUATION

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One of the important tools for water resources management is the one dedicated for operational evaluation of the available surface water resources. The present paper presents the development of such operational instrument for annual valuation of resources based on limited input data and makes possible the availability of the result few months after the end of the year. The product is shaped as MSExcel program with easy and friendly user interface.

The methodological approach consists of the following:

- Monthly averages of the river flows are used as basic input data for the past 50 years. Two type of series are used: registered flow and one transformed to natural one (see below);
- It is assumed that the historical period can be divided on two parts – first before 70s with natural flow characteristics, second after 70s influenced by a number of hydro-technical facilities and reservoirs. Statistical estimates are calculated for both periods, relationships between them are established. Those relationships are used to transform the registered flow into natural one for the basins influenced by significant use of surface waters;
- The country is divided in territorial units. Using available information for registered and natural flow measured at hydrological stations the approach is to valuate flow on territories not covered by measurements. There are two types of relations between parameters in certain river valley and parameters in river valley with similar conditions set up in the model.

Relation $Q = f(F)$ between Qobserved [m3/s], Fobserved [km2] and Qunobserved [m3/s], Funobserved [km2]. Where Qobserved [m3/s] is measured water discharge at hydrological station with watershed area Fobserved [km2] and Qunobserved [m3/s] is water discharge for watershed with area Funobserved [km2] without direct measurement.

Relation $M = f(Hsr)$ between specific discharge Mobserved [l/skm2], Hsrobserved [m] and Munobserved [l/skm2], Hsrunobserved [m]. Where Mobserved [l/skm2] is modul for measured watershed with average altitude Hsrobserved [m] and Munobserved [l/skm2] is specific discharge without direct measurements.

Additionally characteristics of the annual flow variability are estimated, so tht the operationally evaluated present year can easily be classified with respect to moisture conditions. Humid, average and dry periods are outlined and relations to the climate change scenarios for the next 20 – 30 years are drown up.

WATER MANAGEMENT IN UKRAINE

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Water resource is important factor which determines and provides sustainable economical and social development of a country and its environmental safety. Nowadays dependence of society on water resources increases and the level of demands to its quality and quantity raises as well. Rational use, protection and water resources renovation with ecological priority are the barest necessities for every country. The main goals of state water policy are to provide water supply of economy and population with water resources and to solve water economy and water ecology problems.
Being situated in the centre of Europe Ukraine shares its main river basins (the Dnipro, the Dnestr, the Danube, the Siverskiy Donets and the Western Bug) with neighbour countries that stipulate importance of transboundary dimension for water system state. Taking into a count importance of integrative water resource management Ukraine has great interest in developing effective strategy on rational use and protection water resources.
Necessity implementation of water resource management in accordance with basin principle is declared in water legislation of EU and in Ukrainian legislation as well.
The State Committee of Ukraine on Water management with other state authorities realize state policy which based on integrated approaches to water resource management by creating state interdepartmental and river basin councils, international consulting bodies on integrative river basin management within transboundary rivers, collaborate on international ecological projects with neighbour countries, take part in scientific conferences, workshops round tables.
A creations river basin authority is one of the steps in this direction. It includes a working out regulating documents, examination existing and providing appropriate methodology, restructuring of functions of regional water organization.
First stage (2006-2009) – reorganization of management structure, including creation new river basin authorities; developing and implementation of pilot projects for economical and practical elaboration of the water resource management model based on the basin principle.
Second stage (2010-2012) working out and preparation the whole pack of legislation and regulations papers on implementation of the basin principle in Ukraine.
Third stage (2013-2015) - completion phase - creating legislative base and a new structure of river basin organizations, realization water policy with accordance integrated approaches.

Keywords: the integrative water resource management, basin principle, river basin authorities.

INTEGRATED WATER RESOURCES MANAGEMENT IN BANAT AREA

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Water is one the most important natural resources found in the world. Today water resources are under pressure all over the world. In this situation is necessary to talk about integrated water resources management for a sustainable development. If in the past the water resources management has been based only on technical requirements, in our days the water resources management are based on technical requirements but also on economical requirements.
As is know Romania is a poor country in water resources, with a specific resource of 1700 mc/habitant and year, Romania occupy the 14th place in Europe. The resources are non-uniform distributed in time and space. To satisfy the water requirements the water management should develop activities necessary for water uses, to diminish the drought or the floods negative effect, to assure the protection of water quality and aquatic ecosystem.
The paper tries to present the concept of integrated water resources management, the principles of water management in Romania. In the last part it is presented a study case regarding the water resources management from Banat area.

Keywords: water resources, integrated water development, sustainable development.

GROUNDWATER MONITORING IN THE PROXIMITY OF AN ASH STORAGE PIT

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In this paper we present the way an ash storage pit of a thermal power plant is able to influence the environmental factors such as soil and water. A real and very threatening to the environment and health case study will be presented. In the proximity of the Arad thermal power plant that provides the heat carrier for Arad city (Romania) is performed also the tapping of groundwater. There are 102 drillings that supply the necessary drinking water for a city of 200.000 people. Because the ash storage pit is not conformable to standards on windy periods of time the ash is blown towards the drilling area and a nearby locality. Due to this fact we are able to show the influence of these fine ash particles upon the soil and water-bearing bed from the surrounding area especially after long raining periods. After the sampling of soil and water the laboratory analyses results are examined and used as entry data for comparison reports which started in year 2000 and continue to the present. The transport of ash particles to the surroundings and their impact over the environment needs an implementation of a groundwater monitoring program in the area of Arad city. The purpose of the groundwater monitoring program for the Arad city area is to provide all the data necessary to take immediate decisions and actions in the field of water management in real time. In this way it is possible to know at any moment the status of water and environmental resources at local and national levels. The paper demonstrates the high possibility of the polluting ash wave to interfere with the groundwater drilling area of Arad city. A mathematical model of pollutants transport in water-bearings is built and a real time monitoring solution for the monitor drillings of the power plant is presented.
The paper strongly demands the necessity of implementing a groundwater monitoring program.

Keywords: ash storage pit, mathematical model of pollutants transport, groundwater monitoring program.

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INTEGRATED MODELLING AND THE IMPACTS OF WATER MANAGEMENT ACTIONS ON LAND USE

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River systems and the quantity and quality of water depend on the catchment, its structure and land use. In central Europe especially land is a scarce resource. This causes conflicts between different types of land use, but also with the interests of flood protection, nature conservation and the protection of water resources and water bodies in the flood plain and on a catchment scale. ILUP - Integrated Land Use Planning and River Basin Management was a project, funded by the European Union, to address the problems of conflicting interests within a catchment (Dorner et. al. 2007). It addressed the problems of conflicting land use from a hydrological perspective and with regard to the resulting problems of water management. Two test river basins, Vils and Rott, both with a catchment size of about 1000 square kilometers, were considered for the German part of the project. Objective of the project was to identify means of managing land use with regard to water management objectives and adapt planning strategies and methodologies of water management authorities to the new needs of catchment management and planning.
Catchment models were derived to simulate hydrological processes, assess the safety of dams and improve the control strategy of detention reservoirs with regard to land use in the lower system. Hydrodynamic models provided the basis to assess flood prone areas, evaluate flood protection measures and analyze the impacts of river training and discharge on morphology. Erosion and transport models were used to assess the impacts of land use on water quality. Maps were compiled from model results to provide a basis for decision making. In test areas new ways of planning and implementation of measures were tested. For concerned agricultural areas suggestions were made how to establish alternative land uses and crops to reduce the vulnerability due to hydrological risks and improve the water quality and habitat function of the flood plain (e.g. Schätzl&Hofmann 2007)). As a result of model scenarios in combination with the socio economic situation in the catchment new methods of land management and land use management were derived and implemented in model areas (e.g. Schacht 2006). The results of the project show that new ways of managing land use in river catchments are necessary to fulfill quantitative and qualitative criteria of new European legal regulations. The paper presents means to use hydrological models and data as a basis of land use planning and river basin management.

Keywords: flood detention pond, control strategy, land use, water management.

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PROBLEMS SOLVED IN CONTEXT OF FLOOD DIRECTIVE IMPLEMENTATION IN THE CZECH REPUBLIC

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The Flood Directive (Directive of the European Parliament and of the Council on the assessment and management of flood risks) has been ratified this year. According to this document all Members States shall:
undertake a preliminary flood risk assessment,
prepare flood hazard maps and flood risk maps,
establish flood risk management plans.
An implementation of this document to the national system of law represents complicated process of precise definitions of concepts, of responsibilities for particular subject, state administration and municipalities.
There already were developed and verified tools for flood risk assessment in the Czech Republic. There were also suggested methods for quantification of potential damages and a cost benefit analysis of proposed flood-protection measures. The cost benefit analysis is relatively explicit in case of technical measures. But questions arise in case of other types of measures. One possibility for effectiveness appraising of operating, legislative and economical measures is an analysis of changes in number of inhabitants (or flats) potentially affected by flood. The evaluation of change of this parameter is proposed to do in an appropriate interval. There are some sources in the Czech Republic, which allow doing this. We can mention results of the Population and Housing Census, the Fundamental Base of Geographic Data and flood extent maps with return period of 20 and 100 years. According to 10-years period of Census the exact number of inhabitants is available just up to its date. The building offices register every new or destroyed building (or flat) with an accuracy of one month. This allows the highest level of current information. Such designed relation geodatabase system is used for effectiveness appraising of mentioned measures.
The implementation of Flood Directive requires identifying such areas for which potential significant flood risks exist or might be considered likely to occur. For this the relation geodatabase system is prepared in the Czech Republic. Its description and results are presented in the paper.

Keywords: Flood Directive, preliminary flood risk assessment, flood hazard maps, flood risk maps, flood risk management plans, inhabitants potentially affected by flood.

DEVELOPMENT OF DPSIR INDICATORS FOR THE SAVA RIVER CATCHMENT

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The Sava River (945 km) is the biggest tributary to the Danube River and has 95551 km2 large catchment. It extends over four countries, Slovenia, Croatia, Bosnia and Herzegovina and Serbia and Montenegro. In the project SARIB we have integrated data and information of river quality and environmental and health risk with pressures and their driving forces. We developed two tools, SARIB Database and SARIB GIS for that purpose. In the first tool, relational data base structure is developed and the structure of SARIB GIS has been developed in regard to spatial data collected within the SARIB project. Data on chemistry and ecotoxicology obtained during SARIB research activities, are integrated into one data base, the SARIB Database. It contains a list of sampling locations, results of laboratories analyses and information on hydrology that is related to a longitudinal profile. Information on on water and related information needed for indicator evaluation are organised in DPSIR concept. All information are related. The main table is table with monitoring locations. In the SARIB DataBase this is table with sampling campaighn locations, that are also included into GIS theme with the same name. In the SARIB GIS each theme is related to one of the DPSIR indicator. In the system 13 thematic layers have been prepared, 9 of them beeing clasified as one of DPSIR indicator.

In the project investigation, the main focus is determination of chemical compounds in the Sava river sediments and running water. For the interpretation of results and for the need of further water management consideration, two hydrological indicators (S - state) have been analysed. First is a determination of water balance and second is sediment granulometric characteristics.

For the water balance WatBal model has been used. It was applied also for the whole Danube river basin water balance assessment in the frame of the IHP UNESCO project “Basin – Wide Water Balance in the Danube River Basin” (Petrovič, 2002). The Sava river water balance analysis shows decreasing of average monthly runoffs in all balance regions in the period 1960-2000. Analysis shows decreasing 40-years trends of discharges and precipitation and increasing 40-years trends of actual evapotranspiration, but those trends are inside natural multi-year oscillation amplitudes.

Since no geodetic measurements have been performed during SARIB project, river morphological parameters, such as longitudinal profile and bed load granulometric characteristics have been obtained from historical data. Present gravel bars have been detected from aerial photographs. Granulometric characteristics of bed load (grain size distribution of river bed) have been determined by volumetric (bulk) and line transect sampling (Mikoš, 2000b). The samples were evaluated numerically, by pebble count and by weighing. The bulk samples were evaluated by weighing, while the evaluation of the line transect samples was done in two ways: first numerically, and later, the numerical analysis was recalculated into the weight-volumetric one and rigidly composed with the Fuller grading curve into a volume sample.

According to the results of the Sava river gravel bar samplings between 1952 and 1976 it was established that the bed-load arithmetic mean grain in the stretch between its source and Zagreb (Croatia) (Mikoš, 2000a) was of quite a uniform size of around 30 mm. The results of 2006 gravel bar sampling show a decrease of the arithmetic mean grain size, which is also more variable along the stream channel, while the grain sorting has become lower. It should be noted that the sample weights of the older samplings were much greater than those from the 2006 sampling. The latest Sava river sampling offers the grain size distribution data about the gravel bar surface layer, which were not traced in the previous research works. The analysis has shown that the arithmetical mean grain of the surface layer is on average approx. 1.5-times larger that the arithmetic mean grain of the subsurface layer.

THE CREATION OF THE DATABASE OF THE CALCULATED HYDROLOGICAL INFORMATION WITH USING OF THE GEOGRAPHICAL INFORMATION SYSTEMS

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The calculated hydrological information (average annual runoff, depth of runoff of flood for different probability, maximum discharges of flood, coefficient of variation and others) uses for the decision of the design and scientific problems. For receiving of the calculated hydrological information on the base of the traditional technology the methods of the mathematical statistics and theory of chances, cartographic images, geographical interpolation, hydrologic analogy and others are using. Such approach is labour-consuming and subjective (Gorbachova, 2006b).
Using of the geographical information systems (GIS) allows to optimize the calculations and presentation of the hydrological values in space-wide-spread type on the base of the digital thematic layers. So it is reasonable to create on their base the Database of the calculated hydrological information. Database must consist of three blocks: "Hydrological posts", "Hydrological information", "River basins". The block-module principle was used for creation of the Database structure. This principle allows to keep information in the independent Databases, which are bound by the attributes. (Gorbachova, 2006a).
The realization of the Database was carried out on the base of the GIS MapInfo Version 7.0 programme. The thematic layers of the electronic map of Ukraine with the scale 1:200 000 was used for creating the new digital layers in the Database. As a result the digital maps of the spatially distribution of the hydrologic posts on the Ukrainian rivers, the watershed, the gravity centres of the catchment areas, the average annual runoff were created (Gorbachova, 2007).
Thereby, the Database of the calculated hydrological information consists of the digital geographically-coordinated databases with the function of the periodic replenishment, as well as series of the digital maps with the different thematic layers, which possible as a whole or fragment to get and in the paper type. The digital maps which are created in the Database on the basin principle with the different combination of the thematic layers can be used as the information for the management decisions and for the planning of the rational use of the river basins.

Keywords: database, calculated hydrological information, average annual runoff, watershed, geographical information systems.

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IMPLEMENTATION OF THE NATIONAL IRRIGATION PLAN IN THE REPUBLIC OF CROATIA

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Based on the size of irrigated surfaces of approximately 13.000 ha in 2007, Croatia was among the last countries in Europe, meaning that the abundant water potentials and fertile soil are not sufficiently used. At the beginning of 2004, the Government of the Republic of Croatia initiated the National Project of Irrigation and Land and Water Management in the Republic of Croatia (NAPNAV). The National Project was fully developed by Croatian experts, both agricultural and hydrotechnical, and, following the conducted professional discussions and a public hearing, it was adopted by the Government of the Republic of Croatia at the end of 2005. In the system of water management, regional and local self-government and end users, the National Project implementation started in 2006. In this context, the organisational prerequisites were fulfilled by the competent ministry, Hrvatske vode, regional self-government and end users. It was determined in the National Plan that Croatia disposes of about 2.9 million ha of agricultural land, of which 244,000 ha are suitable for irrigation, and, with minor limitations, this number rises to over 800,000 ha. Within the Project, the priority ranking procedure for nominated projects was defined as well as stimulation measures and criteria for financing preparation of project documents and system construction.
To date, the implementation of the NAPNAV has been carried out in three phases: preparation of county irrigation plans, irrigation pilot projects and project documents for individual irrigation systems as well as the rehabilitation/reconstruction of the existing and construction of the new irrigation systems. The paper further presents the implementation of the National Irrigation Project, with a detailed overview of organisation, implementation method, implemented projects (period 2004-2007) as well as the action and investment plan for the period 2008-2010.

Keywords: National Irrigation Project, contents and implementation of the Project, method and dynamics of implementation.

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INFLUENCE OF SPREADING URBANIZATION IN FLOOD AREAS ON FLOOD DAMAGE

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Damage caused by natural disasters in Slovenia is frequently linked to the ignoring of natural factors in spatial planning. Historically, the construction of buildings and settlements avoided dangerous flood areas, but later we see increasing construction in dangerous areas. During the floods in 1990, the most affected buildings were located on ill-considered locations, and the majority was built in more recent times. A similar situation occurred during the floods of September 2007.
Comparing the effects of these floods, we determined that damage is increasing due to the urbanization of flood areas. This process furthermore increasingly limits the "manoeuvring space" for water management authorities, who due to the torrential nature of Slovenia's rivers can not ensure the required level of safety from flooding for unsuitably located settlements and infrastructure.
In the past, settlement avoided dangerous areas. Today the ever-increasing pressure from investment and construction in flood areas shows no regard for the threat of future floods or their inevitable intensification due to global climate change. A lack of consideration of natural disasters reduces the capacity of the environment and its self-regulation capability, which is reflected in ever greater damage due to natural disasters and in social instability or injustice (Natek, 2008, 158–159).
In the article, case studies from Slovenia are presented. In Ljubno and Nazarje (Privšek, 2007) the flood of November 1, 1990 influenced changes to the spatial planning documents of the two municipalities. The flooding most affected the new parts of settlements that spread onto the flood areas after 1970. Flooding in Celje is a geographical inevitability, the consequence of locating a large city at the confluence of the Voglajna, Ložnica, Hudinja, and Savinja rivers but human influence on the natural process is also considerable (Natek, 1992, 172). Also the Selška Sora River has caused floods at least 10 times in the last century.
The basic problem in areas such as those described above is not floods as a natural phenomenon per se but rather their influence on human activity. Valley floors are actually enlarged channels for excessive flood water. We have exploited these narrow and valuable valley bottom areas by constructing buildings and roads and in a way ignoring natural conditions. The number of buildings of public importance such as factories and hospitals as well as infrastructure in flood areas has grown, and the flood risk in threatened and vulnerable settlements has increased due to their growing number of buildings and the rising value of real estate.
We can conclude that planning the use of space must consider natural limitations and employ different standards for different needs. The basic paradigm for dealing with these problematic areas should be sustainability, working responsibly with a long-term orientation.

Keywords: geography, natural disasters, floods, torrents, damage, urbanization, spatial planning, Slovenia.

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HOW TO TAKE ACTION FOR INTEGRATED WATER MANAGEMENT

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Water management development and river regulations go back to ancient times, they gradually developed in the 19th century and intensified in the second half of the 20th century with irrigation, water power development and river regulations for development of inundated land. Regulation and deterioration of rivers has a long history. The process was lead by specific, economically defined interests and simple decision-making schemes. The main task in urban areas was how to take and develop, safely for different economical purposes, space of river corridor.
Today different interests overload the water resources and that is main call for implementation of sustainable development to sustain proper resources in longer term. The integrated approaches seem to be proper solution for today actions in water management. A good practice is in overall integration or at least partial inaugurations. There are some lacks in implementation because of particular interest, knowledge, development, organisation and trans-boundary impact. The integrated approach of water management has different aspects of integration in space, time, hydrological cycle, professional disciplines, administration etc. There are also some practical lags in improving between scientific development and practice in society, including legislation and the organisation of the government.
Water management policy proceeds from development to management. The importance of environmental sustainability has been recognized overall. The decision making process should integrate more interests, calls for a greater decentralization, more participation and greater financial viability. Efforts and actions must involve a pro-active participation and contributions of both governmental and non-governmental stakeholders.
Regardless of the approach chosen, water management asks for a flexible, tailor-made set-up. Each necessary step can be taken at different points in time, depending on available resources and capabilities. It is thus advisable to apply a well-defined logical framework, consisting of a comprehensive set of logically related tasks in water management cycle.
Each phase can be subdivided into several tasks, where relevant stakeholders should always be involved as early as possible in the process. To achieve the objectives set, all the phases and tasks are best performed when they follow a certain logical order. You can start at any phase of the cycle, as long as certain tasks are followed by specific other tasks, as laid down in the logical framework.
In the article contribution will be done to the example of slovenian organisational scheme of water management and proposal of improvement according to the theoretical starting point.

SLOVENIAN COOPERATION ON INTERNATIONAL WATERS

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In the article the tradition of common Water Commissions with neighboring countries on tributaries of Danube River: the Sava River, the Drava River, the Mura River, will be presented. Also presentation of Water Commissions on Soča River Basin and other small water basins with direct flow to the Adriatic Sea will be added. Special attention will be put on different cases of the cooperation on subjects of water scarcity, border issues and surface and ground water use.
Also some attention will be put on international cooperation on Danube River Basin and on its main tributary - Sava River and also at the Adriatic Sea under the umbrella of the Barcelona convention. The intention of the author will be to show historical changes of the ways of cooperation and solving conflicts and the need of capacity building, training and multidisciplinary approach. Special point of importance of long relationship on common waters will be added at the end of the article.

FLOOD FORECASTING & FLOOD RISK MANAGEMENT IN THE BAVARIAN DANUBE BASIN RESULTS OF EC FP6 INTEGRATED PROJECT "PREVIEW"

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GMES - a joint initiative of the European Commission (EC) and the European Space Agency (ESA) – aims at designing and implementing an European capacity for the provision and use of operational information for Global Monitoring of Environment and Security (GMES). In 2005 the Integrated Project "PREVIEW" has started. Its objective is to develop, at the European scale, operational GMES information services for risk management in support of European Civil Protection Units and local/regional authorities. PREVIEW covers "risk areas" spanning from fire, flood, storms and earthquakes to industrial risks. The consortium consists of 58 European partners gathering required technical skills from scientific community, operators and industry as well as relevant expertise of end-users bodies. All phases of risk management cycle – prevention, preparedness, response and recovery – are covered in a consistent and harmonized approach, allowing the exchange of information between the different operators and actors involved. PREVIEW GMES services are supposed to build on integrating Earth Observation data, in-situ measurements, ancillary data, new modelling and, last but not least, recent research and technologies results. Services will be designed, developed, demonstrated and validated under pre-operational conditions. Seven German partners work on improving "Short Range plain flood forecasting & flood risk management" in the Bavarian part of the Danube catchment. The main objective is to develop, demonstrate and validate a prototype of an integrated Flood Risk Management Service, supporting flood prevention, forecast and alert as well as crisis/post-crisis management. The proposed service portfolio comprises flood risk mapping, pre-warning and flood forecast, flood event analysis and damage assessment. Key aspect is the integration and operational provision of information for better support of decision makers. Main element of this sub-project is the development and application of meteorological as well as hydrological ensemble flood forecasting approaches, and their appropriate use in flood management. The benefits of addressing the uncertainties which are inherently present in the operational flood forecasting chain by this methodology are studied in close cooperation with end-users ranging from operational flood warning centres, water resources managers as well as rescue services. The natural hazard floods are covered by four tasks subdivided in forecasting of flash floods, short term flood forecasting and managing of plain floods, medium range forecasting (early warning), and Scandinavian floods as well. A prototyp consisting of the main components of a local up to regional integrated flood risk management system will be developed on he basis of the requirements and organisational structures of the Bavarian part of the Upper Danube.

Keywords: GMES, integrated flood risk management, ensemble flood forecasting, flood risk maps, flood information system.

HYDROPOWER PLANTS ON THE SAVA RIVER

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On the Sava River a chain of hydropower plants from Medvode to the border with Croatia is planned. Along with the Drava River hydropower plants, this should be the greatest power producer in Slovenia. The planned chain of hydropower plants is also the only available renewable source of energy in Slovenia.

Nowadays, three hydropower plants are operating in the upper part of the Sava River, those being the hydropower plants of Moste, Mavčiče and Medvode. In the lower part of flow two hydropower plants are operating (Vrhovo and Boštanj), one is under construction (Blanca) and the hydropower plants Krško, Brežice and Mokrice are being installed. The planned hydropower plants, between Medvode and Zidani most, will connect the upper and lower hydropower plants chain in a united chain on the Sava River. The middle hydropower plants will operate in the flow regime with daily denivelation. The inference of all hydropower plants in the chain will provide the maximum possible exploitation of available water potential for energy production. There are also other expected positive side effects in the region: enlarged flood protection, better water supply, waste water treatment, regulation of traffic, regulation of electric distribution and positive socio-economic development.

THE USE OF GIS TECHNOLOGY IN WATERSHED MANAGEMENT

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Effective watershed management requires the integration of knowledge, data, simulation models, and expert judgment to solve practical problems and provide a scientific basis for decision-making at the watershed scale. The GIS technologies nowadays occupy a prominent place among the modern computer tools and constitute an invaluable support in the decision making of problems with a spatial dimension. Such problems have to be addressed with numerical models that can compute runoff in large (basin scale) complex watersheds with varying soils, land use and management conditions. GIS provides the framework within which spatially-distributed data are collected and used to prepare model input files and evaluate model results. In this work Geographical Information System is used as a pre-processor to the SWAT model. Input parameters for this model were obtained using AGWA in conjunction with available topographic, soil and land cover data. The purpose of this work is to investigate the potential possibilities of the AGWA-SWAT model and its adaptation to Vrana River which is situated in the North-Eastern part of Bulgaria. The Vrana basin is influenced by moderate continental climatic conditions. The feeding of the river is mainly rainy and rainy-snowy. The runoff regime in the Vrana catchment is characterized by considerably variability caused by precipitation fluctuations and landscape elements. The high flows period occurs from February to the end of June, the low flows period is good noticeable during August – November. Digital elevation model (DEM) was generated using the digitized contours. DEM along with the digitized drainage was used to automatically delineate the sub-watersheds. Data inputs, including land cover, soil, weather, and groundwater required for the SWAT model were automatically derived by the AGWA tool. The daily weather data (1980– 2003) for Targovishte climate station were used for rainfall and air temperature. Major SWAT model components describe processes associated with water movement, sediment movement, soils, temperature, weather, and land management. Surface runoff is calculated using a curve number technique. In order to apply the SWAT hydrological model, several data layers were created or acquired for integration into a GIS: digital elevation model (30-meter resolution); land cover (CORINE Land Cover sets); soil type (FAO classification); digitized drainage network and flow paths; slope and aspect of the terrain. These data layers were combined into a GIS data base and provided spatial information for the watershed-modelling program. Based on its topography and existing stream network, the Vrana basin was divided into 22 smaller, hydrologically connected sub-watersheds. All possible combinations of soil types and land use covering more than one percent area were included. Other model parameters such as length and slope of overland flow path, and channel geometry, which relate to physical dimensions of the watershed, were calculated too. The hydrologic components of SWAT were calibrated to fit the observed annual streamflow data from a NIMH streamflow gauging station Kochovo for years 1991-2002. This period was chosen because it represents a combination of dry, average, and wet years. Values of selected model parameters were varied iteratively within a reasonable range during various calibration runs until a satisfactory agreement between observed and simulated streamflow data was obtained. Quantitative measures of agreement were based on observed and simulated annual streamflows, the determination coefficient (R2) and Nash-Sutcliffe model efficiency (NSE). The calibration result showed that there is a good agreement (R2=0.62, NSE =0.50) between the simulated and gauged annual flows. The obtained results of runoff simulation can be accepted as satisfactory for this stage of the investigation. In the future is necessary to continue this study to obtain the optimal results for watershed management in the study region.

Keywords: GIS technology, hydrological modeling, AGWA-SWAT, watershed management.

MODELING LIKE A TOOL OF EVALUATION PROCESS OF FATE AND BEHAVIOUR OF ACTIVE SUBSTANCES OF PLANT PROTECTION PRODUCTS IN SOIL AND IN GROUNDWATER

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The groundwater is the largest and the main source of drinking water, but it is very sensitive to the potential pollution and it needs to be protected not only from the quantitative but also from the qualitative point of view. It is necessary to avoid the pollution and to improve the protection against new emissions and pollution by deleterious chemical substances, which pesticides are. Pesticides are active substances and plant protection products with characteristic influence on target species with influencing the basic processes in living organisms. They are used in agriculture or for regulation of plant grow on non agricultural areas, because they have a potential to kill or regulate harmful organisms. According to economical benefit which comes with pesticides usage is some possible risk moderately acceptable, because plant protection products contribute to affordable agricultural products in very good quality. Just now the pesticides are representing an important potential source of pollution. If we compare the usage of pesticides in Slovakia to other EU Member States, the rates are accentuated lower, but from the year 2006 an increasing trend in using pesticides was noticed. EU Member States are now more and more focused on this problem and the risk evaluation process of plant protection preparations became stricter. The Directive 91/414/EEC created a harmonized system for plant protection products use regulation, authorization and registration based on human health and environmental risk analyses. The registration process is applied in two levels – European Commission and Member States level. The evaluation is applied in two levels. First it is the revision process of risk assessment of old (already registered) active substances and the registration process of new active substances. The result of the evaluation process of fate and behavior of pesticides (active substance respectively the preparation) in soil and in water is the definition of risk in the form of expert opinion, which is one of the conditions to be registered, that means to get permission for distribution. Fate and behavior section (WRI) asses three key elements: the routes and rates of dissipitation of an active substance and its metabolites, the mobility and transport of the active substance and its metabolites in the environment and we determine the like hood and levels of exposure in various environmental compartments (soil and groundwater.) The result of the assessment is the proposal of risk elimination precautions according to protection of groundwater and surface water. FOCUS groups (FOrum for the Co-ordination of pesticide fate models and their USe) provided the tools for estimating predicted environmental concentrations of active substances for the purpose of their evaluation for inclusion in Annex I and national registration. Mathematical modeling was used to derive predicted environmental concentrations PEC of active substances and their metabolites in various environmental compartments (ground water, surface water, soil, and air).

Keywords: pesticides, active substances, plant protection products, trigger values, FOCUS group models, risk assessment.

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INTERNATIONAL COOPERATION OF UKRAINE IN THE AREA OF HYDROMETEOROLOGY WITHIN TRANSBOUNDARY RIVER BASINS: HISTORY, PRESENT STATE, NEW CHALLENGES

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Generally, Ukraine is downstream country. About 76% of surface waters come in Ukraine from other countries and only about 24% of waters are formed within the territory of the country. On the other hand, river floods and inundations are characteristic for most of transboundary rivers. The very serious problem of transboundary riversis increase of their polluton. All these factors define the motivation the cooperation of Ukraine with neighboring countries in the area of hydrometeorology for an development of integrated water resources management.

At present the principal form of international cooperation on transboundary rivers between Ukraine and neighbouring countries is intergovernmental agreements. In the frames of agreements international working groups on hydrometeorology have been created. The main tasks of these working groups are: coordination of work on the development of hydrological and meteorological observation networks; shared investigation of the condition of the technical infrastructure of the observation network; organizing common observation programs in the transboundary sections of the rivers; exchanging hydrometeorological information and forecasts; giving warnings on unfavorable hydrological and meteorological conditions that might spread into neigbouring areas.

During the last years significant efforts have been undertook by the State Hydrometeorological Service to develop the water quantity and water quality observation networks and hydrometeorological forecasting system in order to improve the water resources management and protection within transboundary river basins. Most Important directions in this field are: modernization of hydrometric instrumentations; implementation of remote sensing techniques for obtaining hydrometeorological information; implementation of modern means of data processing. In the field of water quality, effective monitoring calls for updating of water quality standards, improvement and harmonization of systems for collection information, standardization of laboratory procedures, and international laboratory intercalibration.

It is very important to continue these efforts in the field of modernization of technical equipment of hydrometeorological observation networks and improvement of technologies of forecasting and exchanging od hydrometeorological data and forecasts.

Keywords: transboundary rivers, cooperation, history, present state, new challenges.

TREND OF THE HYDROCHEMICAL PARAMETERS OF THE WATER QUALITY FOR THE UKRAINIAN PARTS OF THE PRUT AND TISZA RIVERS BASINS

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The purpose of this paper is to analyze the data on long-term trends in the series of hydrochemical parameter values for the tributaries of the Danube river - Prut river and Tisza river for period from 1982 to 2006. Both them are typical mountain rivers. They are characterized by frequent reiteration of flash floods of different origin (rain, snow, snow-rain) during all year.
This paper is based on:
data of observation, granted by the network of water quantity and water quality monitoring, which belong to the State Hydrometeorological Service of Ukraine;
data on consumption of water resources and the data on recirculating waters, granted by the State Committee of Ukraine on Water Management;
National Reports on the environment condition in Ukraine, made by the Ministry of Environment Protection of Ukraine.
The water quality for rivers has been estimated by combining such hydrochemical parameters as: a mineral composition, content of biogenic elements (nitrates, nitrites), oil products and toxic components (Cu, Zn, Cr). This estimation has showed an increase of pollutants concentration in waters in the end of 1980s – beginning of 1990s. An irrational human activity within river basins and an increase of sewage waters from urbanized areas are main factors, affecting a growth of river water pollution.
In spite of the decline in industrial and agricultural activities in Ukraine there has not been observed the significant water quality improvement in rivers from 1992 to 1998. An increase of concentration of pollutants in waters of Prut and Tisza rivers has been observed again from 1997 to 2006. An increase of economical activity within river basins is main reason of it. The main concern is the presence in waters of oil products and toxic substance.
The general estimation of water quality of rivers has been carrying out according to the Soviet ecological classification of surface waters which has been adopted in Ukraine. According to this classification, surface waters are divided into 5 classes: from I class (very clean) to V class (very contaminated). According to this classification, Tisza and Prut rives belong:
in a mineral composition – to I class;
in BOD5 - to III class (slightly contaminated);
in content of nitrates and nitrites – to III class;
in content of oil products – to IV class (contaminated);
in content of toxic substances (Cu, Zn, Cr) – to III class.
After analyzing water quality of the Tisza and Prut rivers, it is obvious that examined rivers are under the impact of the human activity. The main concern is the presence in the water of oil products and the toxic substance.

IMPORTANCE OF DANUBE –SAVA MULTI-PURPOSE CANAL FOR ECONOMIC CONNECTION OF ADRIATIC AND DANUBIAN AREA

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The development of inland waterways system was laid down in the documents on spatial planning and transportation in the Republic of Croatia. The construction of the new port of Vukovar and the Danube-Sava multipurpose canal (DSMC) from Vukovar to Šamac according to the Vb class parameters of international waterways presents the integral part of the documentation. The construction of DSMC would enable the shortening of the waterway along the Sava and Danube rivers in the direction of the Middle Europe for 417 km, and for 85 km in the direction of Eastern Europe (Black Sea). In addition to considerable shortening of the waterway, the economic and environmental benefits of river and inland waterway traffic compared to railway and road traffic should be correctly and independently evaluated. The indicators of the countries with developed inland waterway network should be considered.
On June 24, 1997 Croatia signed in Helsinki, and the Croatian Parliament confirmed on November 12, 1998 the Agreement on major inland waterways with international importance (AGN agreement). The Agreement involves not only the sections of the Danube (138 km), Sava (376 km), and Drava river (22 km) included into the system of European inland waterways (22 km), but also the project Danube – Sava multipurpose canal from Vukovar to Šamac – in the length of 61,4 km, according to the parameters of the V.b class of the international inland waterways. The DSMC project is a component of Croatia's traffic and economic development, and of the programme of enhancing the traffic and economic linking of the countries of Danubian and Adriatic area. Bearing in mind basic indicators from the previous study and DSMC's project documentation, one should emphasise its importance for the better functioning of drainage systems and creation of irrigation conditions on 33.000 km of agricultural land, along with enrichment of low waters. The DSMC project aims to contribute to comprehensive and sustainable management of water and soil at the catchment area of Bić, Bosut and Vuka, covering 430.000 ha. Its construction would enhance the more balanced economic development of Croatia and would contribute to more efficient traffic and economic connecting with the Danubian countries.

Keywords: Multi-purpose canal, Danube, Sava, inland waterways, development, traffic, economy.

TRANSBOUNDARY IMPACT OF ENGINEERING WORKS ON THE HYDROLOGICAL PROCESSES IN THE DANUBE DELTA

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The consequences of water engineering both in the Danube basin and within the Danube Delta have the transboundary character. These engineering works influence significantly the hydrological processes and the hydrographic network dynamics of the entire delta.
The most large-scale hydrotechnical works where carried out in the Danube Delta in order to improve the transit navigation between the Danube and the Black Sea. These particular water engineering works have resulted at the most vivid changes in the Danube Delta hydrological processes including those having transboundary character.
In mid-nineteenth century the work commenced to build a deep navigable canal through the Sulinskiy Arm. As the result of a complex of bed straightening and dredging works, totalling to some 25 million m3, in early twentieth century gradual decrease of water content of the Kilijskiy Arm began. By 1980 its share of water runoff decreased from 70 to 59 % of total water runoff of the Danube.
Additional impulse for the increase of the tendency of the discharge re-distribution in favor of the Tulchinskiy Arm system was given by big water engineering activities in the Georgievskiy Arm in 1981-1992. During that period six biggest bends were streamlined there. This resulted at significant increase of the share of discharge of not only the Georgievskiy Arm, but also the Tulchinskiy Arm and, correspondingly, at further decrease in the Kilijskiy Arm discharge, the size of which at present equals to that of the Tulchinskiy Arm.
Significant scope of water engineering activities has been also carried out in the Kilijskiy Arm of the delta to improve navigation conditions. The most large-scale straightening and dredging in the Ukrainian part of the Danube Delta took place during 1956 – 1993, then building and operation of the navigable cannel through the Prorva Arm. However, the water engineering activities in the Prorva Arm does not change the tendency of water discharge re-distribution in the knot of the Ochakovskiy – Starostambulskiy and does not have any transboundary impact.
During the new deep water navigable channel building between the Danube and the Black Sea through the Ukrainian part of the delta the issue of anthropogenic pressure minimization on the unique natural complex of the delta was solved by means of choosing of the optimal option for the navigable channel through the Bystroye Arm. This option takes into account the natural peculiarities [3] of this watercourse.
The results of the regular hydrological monitoring show that small increase in the water discharge of the Bystroye Arm stimulated with the bar dredging is within the existing natural tendency of this arm activation.
Thus, big water-engineering activities carried out in the Romanian Danube Delta to reconstruct the riverbed network, have quite obvious transboundary consequences, the main of which is the increased tendency of water discharge re-distribution in the upper part of the delta in favour of the Tulchinskiy Arm and in the prejudice of the Kilijskiy Arm. This process goes on for about one hundred years and has already resulted at decrease in water amount in the Kilijskiy Arm and the majority of deltaic watercourses in the Ukrainian Danube Delta.

Keywords: Danube Delta, water engineering activities, transboundary impact.

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TEMPERATURE AND OXYGEN CONDITION FEATURES of the RESERVOIRS-COOLERS OF NUCLEAR AND THERMAL POWER PLANTS

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The reservoirs-coolers of the nuclear and thermal power plants belong to the especial water objects, ecosystems of which test the considerable thermal loading. The temperature regime of the reservoirs-coolers, except for natural factors, is determined power of working power units.
Differences of hydrochemical and hydrobiological regimes of reservoirs-coolers from similar reservoirs with natural terms stipulated first of all by the features of their thermal regime.
So, comparing the water temperature in the coldest zone of reservoir-cooler of Zaporizhya NPP and adjoining area of the Kachovka storage pool, evidently, that in reservoir-cooler water temperature on 5-18 degrees higher comparatively with natural condition during throughout the year. The most difference in the water temperature of the explored objects was marked in the cold period of year.
It is necessary to mark that in the summer period at the high temperature the maximal heating of superficial layers of the reservoir is observed about 20 hours. The temperature of superficial water layer from 6 a.m. till 20 p.m. can be multiplied on 4 °C, at that time as in the Kachovka storage pool this value changes maximum on 1.8-2.0 °C.
The features of the oxygen regime of the reservoir-cooler and conditions and factors which influence on its forming found out the conducted researches. A content of the oxygen dissolved in water is one of the major hydrochemical indexes which determine physical and chemical terms of natural waters, intensity of oxidation-reduction processes.
The regime of the dissolved oxygen in the reservoir-cooler, as well as in the natural reservoirs, is formed, foremost, in accordance with temperature condition, character of hydrobiological, physical-chemical and hydrodynamic processes. After passing of water through heat exchangers its temperature rises almost on 10 °C, as a result in the discharge canals there is water supersaturating by oxygen and its evasion to the atmosphere (Romas', 2002).
As a result of the permanent artificial warming up in the reservoir-cooler intensify the physical-chemical and hydrobiological processes of different direction. At water aeration and strengthening of photosynthesis water is enriched by oxygen, and during intensification of biochemical processes of destruction of organic substances and oxidation-reduction processes its maintenance diminishes.
Weather is also the determinative condition of the oxygen regime forming. In the period of high water and air temperatures, at calm, windless weather and as a result – absence of wind-wave interfusion of water masses – there is a clear vertical stratification of the oxygen maintenance in the reservoir-cooler. At saturation of upper water layer by oxygen (to 170 %), that is during the concentration of dissolved oxygen to 14 mg/dm3, beginning from a 4-meter depth, is observed diminishing of its content to 1.5 mg/dm3 (19% saturation) and complete (or almost complete) absence on the 6-meter depth (Mostova, 2006). Consequently, in a spring-summer period in the reservoir-cooler is formed the bottom water layer which does not interfuse with a superficial circulation stream.
Carried out researches testify to significant thermal loading on ecosystem of the reservoir-cooler which determines a course of hydrobiological and physical-chemical processes.
Because of constant artificial heating, character of hydrobiological, physical-chemical and hydrodynamical processes in reservoirs-coolers are formed peculiar conditions of formation of the dissolved oxygen regime.

Keywords: reservoir-cooler, water temperature, dissolved oxygen, vertical stratification.

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REGIONAL GEOLOGY AND WATER QUALITY IN SOME STORAGE LAKES OF CENTRAL SERBIA

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Natural resources of healthy water are relatively scarce in the Republic of Serbia and are getting even scarcer with the growing needs. Water management plans and legislation give priority to the surface storage reservoirs on selected rivers. A number of dams have been completed and some twenty more are planned for construction. After some time of storage, however, water in a lake begins to change in quality from what it was in the flowing stream. This paper considers the influence of regional geology on the chemical composition of water in artificial lakes. An affirmation of artificial storage lakes as the sources of public water supply requires the identification of ecotoxic metals not only in the storage basin, but in the drainage area as well. The variation of heavy metal concentrations in a storage lake is described on the case example of the Grlište reservoir. Water was sampled from the middle of the lake from three depths: at the surface, mid-depth and near the bottom, through the period 1991-2005. The elements analysed were copper (Cu), manganese (Mn), iron (Fe) and zinc (Zn). Analytical data are calculated and presented on diagrams in relation to time for each sampling place in the middle of the lake and for each element. A discussion of the results is followed by conclusions reached and recommendations for future projects. Furthermore, the influence of the catchment geology on the chemical composition of lake water is explained for three other storage reservoirs used as the drinking water supply sources.

Keywords: water-storage lake, geology, water quality, water supply, catchment.

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WATER QUALITY MANAGEMENT OF THE WETLANS "PERINA" AND "KALIMOK-BRUSHLEN" - INVENTORY, CHEMICAL AND BIOLOGICAL ANALYSES, MENACES AND RECOMMENDATIONS

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Material discusses the work carried out for development of Integrated Plans for Management and Administrative Capacity Building for two Danube wetlands "Persina" and "Kalimok–Brushlen" in the water quality part. The task is directly linked with the Water Framework Directive implementation (WFD or Directive 2000/60/EC) which aim is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater within the European Union. This task comprises review of the existing projects, hydrochemical and biological monitoring and analyses, inventory of the pollution sources, water quality assessment, main and secondary goals definition: limitations and menaces, recommendations and priority tasks determination.

In relation to wetlands, this means that the wetlands must be associated with a "water body" which are directly influencing the status of the related "water body". A surface water body comprises the quality elements described in the Directive for the classification of ecological status. On the territory of the wetlands there are several water categories as rivers, lakes and groundwater. Anyway the different water categories in the wetland and different chemical/biological data as well predestine a different ecological status of the water bodies. A member of the EU Bulgaria is in the process of appliance of the European legislation.

The main water quality problems in the wetlands are linked to the increased nutrient content and organic pollution at some places especially after municipal waste water inflows and stock-breeding activities. Detailed hydrochemical and biological information is presented, summarizing the results of several investigations fulfilled the last years in the studied Danube wetlands, finalized with a general water quality assessment of the present conditions. Water quality in wetlands is directly related to that of the Danube River, which feeds them. Main characteristics are being determined even before the river enters Bulgarian territory. Due to its size, the Danube carries a significant pollution burden. In addition, some local sources of pollution can also be considered cross-border because of their geographical location. Though of local importance, some influence comes also from the Bulgarian sources of pollution such as sewerage and river inflows.

The main goal of the management plans is the conservation and the improvement of the water quality in the wetlands – "Persina" and 'Kalimok–Brushlen" leading to the restoration of the biodiversity. A second goal defines the reduction of some human activities in the regions described in the material. The identification of menaces is formulated as: oil outflows, municipal waste waters and different agricultural activities enumerated in the text. Recommendations and operatives tasks are proposed including a monitoring program.

Keywords: wetlands, water quality, management.

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HARMONIZATION OF CROATIAN REGULATION ON METEOROLOGICAL AND HYDROLOGICAL MONITORING OF STORAGE RESERVOIRS WITH THE EU WFD

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Monitoring of the environmental status of reservoirs has a long tradition in Croatia. Scope and contents of the monitoring are determined by the regulation in force, project requirements and issued water acts, as well as environment impact assessment. Monitoring starts in the project planning and designing stages (by determining the existing state) and continues during the period of structure operation to achieve structure safety and improve of use. Meteorological and hydrological monitoring is a part of environmental monitoring.
The EU Water Framework Directive emphasizes the importance of surface waters and groundwater monitoring, to obtain baseline information and impact assessment of the water status for hydro technical structures. The member states are required to monitor status of all waters for each river basin, in order to achieve clear and comprehensive overview of water status. Article 8 of the EU Water Framework Directive explicitly stipulates the obligation to establish monitoring of surface waters and groundwater status.
Since Croatia is in the accession process to the EU, Croatian legislation in the field of water policy has to be harmonized with the EU legislation for the same field. According to the Amendments to the Water Act (OG 150/05), Croatian Waters is responsible for monitoring of all water status, while according to the Construction Act (OG 175/2003.), the obligation to carry out the monitoring of hydro technical structures is the responsibility of the users as well.
Croatian Chamber of Architects and Civil Engineers, Department of Civil Engineering has initiated the development of technical regulation for monitoring of reservoirs and retention storages. The paper will present the approach, objectives and the goal of the meteorological and hydrological storage reservoirs' monitoring as a part of the integral water status monitoring.

Keywords: water monitoring, technical by-laws, EU Water Framework Directive, storage reservoir.

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THE COAL MINE REHABILITATION IN JIU AREA

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The sustainable development of human society imposed the monitoring above the effect of atrophic actives on environment. Along the time the human utilized the resources without restrictions or minimum measures of environment protection without thinking at the future. The degradation and environment pollution increased in the same time with the civilization.
The transformations on the landscape due to the mine coal exploitation in Europe are through the most important transformation which can be observed to the land surface.
The mine coal exploitation use only temporary some surface land and when the activities are stopped is necessary the rehabilitee of this land.
For this it is necessary to have a rehabilitee plan which should be detailed for the affected areas by the mine coal exploitation. Unfortunately in Romania exist a lot of mine coal exploitation which have stopped the activities and in this case the exploitation have been abandoned without to take rehabilitee measures.
This paper present the specific elements of location in Romania, Jiu catchment area, respectively Danube catchment area, mine coal exploitation correlated with catchment area characteristics. Also will be a study about mine coal.

Keywords: degradation, environment, coal mine, rehabilitiation.

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THE ENVIRONMENTAL OBJECTIVES REQUIRED BY THE WATER FRAMEWORK DIRECTIVE AND THE GROUNDWATER DIRECTIVE, APPLICABLE FOR BANAT HYDROGRAPHICAL AREA

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The Water Framework Directive is the most substantial piece of water legislation and will provide the major driver for achieving sustainable management of water in the EU Member States for many years to come. It requires that all waters within defined river basin districts must reach at least good status by 2015 and defines how this should be achieved through the establishment of environmental objectives. The components of the Water Framework Directive dealing with groundwater cover a number of different steps for achieving good (quantitative and chemical) status by 2015. Article 17 of the Water Framework Directive includes the strategies to prevent and control pollution of groundwater.
The new Groundwater Directive is created for groundwater protection against pollution under the Water Framework Directive. The groundwater directive complements the Water Framework Directive. The new groundwater directive establishes a regime which sets underground water quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. The directive establishes quality criteria that takes account local characteristics and allows for further improvements. Member States will have to establish the standards at the most appropriate level and take into account local or regional conditions.
For the purposes of assessing the groundwater chemical status in accordance with Article 4, the following groundwater quality standards will be the quality standards referred to in Table 2.3.2 in Annex V to Directive 2000/60/EC and established in accordance with Article 17 of that Directive.
Is necessary to do: to implement the groundwater aspects of the Water -Framework Directive and the new Groundwater Directive 2006/118/EC; to come to a solid and logical program of measures; to get experienced in implementation on local scale, and after that is necessary for every groundwater body to establish natural background values (NB) and threshold values (TVL), and the programs of measures.

Keywords: groundwater bodies, the old Groundwater Directive (80/68/EEC), the new Groundwater Directive (2006/118/EC), natural background values (NB), threshold values (TVL).

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**The Water Framework Directive (2000/60/EC)
**The 2004 Report of the Banat Hydrographical Area Management Plan

AN ENVIRONMENTAL MANAGEMENT PROGRAM DEVELOPMENT TO FACILITATE CONTINUOUS IMPROVEMENT IN ACCORDANCE WITH THE SUSTAINABLE DEVELOPMENT PRINCIPLES

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There has been a trend toward the standardization of environmental management system approaches with the launch of ISO 14001. International standardization is intended to provide the core elements of effective management, while still being applicable to diverse geographical, cultural, economic and social conditions. For examples, just like a study case, an environmental management program development for a waste landfill to facilitate continuous improvement could has good results for integrated water management in according with sustainable development. in this case the program must be included all environmental factories, water, air, soil.
Key elements of the ISO 14001 Standard which form the basis for an industry's environmental management system (EMS). are: initial environmental reviews; developing an organization; issue or site-based environmental policy; development of a legislative compliance system; environmental aspect compilation and assessment; defining procedures for operation control (i.e. compliance and performance monitoring, risk management, and emergencies); environmental management program development to facilitate continuous improvement; training to develop environmental competence amongst staff with environmental responsibilities; environmental research, survey and analysis; environmental audits; defining an effective management review system to achieve real results.
Perhaps one of the most significant voluntary mechanisms available to industry is the adoption of an environmental management system (EMS). Environmental management systems are a relatively new environmental management tool which seek to consider and control potential environmental impacts in a structured and systematic way. Environmental management systems (EMS) are usually applied as a system of management within industry to help them manage pollution control and environmental impacts. The attraction of improved management, with greater efficiency and improved use of resources, has prompted a useful trend of environmental self-improvement within industry. This voluntary approach has proved very successful in complimenting traditional regulation-based approaches. Worldwide, public administrators responsible for managing development, infrastructure and utilities, are also finding EMS a useful tool for organizing the planning and implementation of environmental initiatives.
The environmental program is important and has been responsible for research studies aimed at the development of waste and water management at the regional level, including identification of important waste and substances that can derive from the landfill and that can combine each other and infect the shallow groundwater bodies.
An alternative means to encourage environmental protection is through the use of economic instruments, which provide market-based incentives. There are many examples of economic instruments and this is a evolving field in developing countries. The most frequently mentioned example of an economic instrument is the 'polluter pays' principle. This involves the establishment of a set of monetary charges to industry for the discharge of waste. The basic concept is that more money is paid as more waste is produced. The premise is that there will be financial gains to individual industries as a result of their efforts to reduce waste and protect the environment.

WATER RESOURCE SYSTEM BALANCE OF THE TUNDJA RIVER BASIN AND ITS CONNECTION WITH THE MINIMUM REQUIRED RUNOFF

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The main objective of the EU Water Framework Directive is the protection and improvement the quality of surface and ground water resources, which can be implemented through the development of river basin management plans. They consider predominantly the qualitative aspects of waters – chemical and ecological status of water bodies. But at the same time an irrevocable part of RBMP is the provision of water needs of human beings and different branches of economics while maintaining enough water in the river for ecosystems protection and river bed sanitation. The solution of these conflicting objectives is very important particularly in the dry periods.

For this reason a water resource system balance of the Tundja river basin in Bulgaria is developed where a quantitative estimation of water resources in the watershed is made and the degree of water demand satisfaction is established considering a set of scenarios of regional economic development and different climatic conditions. The results obtained show that the present and future water demand is completely satisfied. The simulation-modeling technique is used.

The river runoff quantities after the significant abstractions are determined for two hydrological cases: the available runoff series of 34 years and for dry period. The obtained values are compared with the minimum required flow determined in accordance with the Regulation of the Ministry of Environments and Waters. The analyses made show that the obtained disturbed flow does not meet always the requirements of the Regulation and some measures had to be outlined and taken.

The mentioned investigations are carried out according to the current legislation concerning the water resources utilization in Bulgaria.

The obtained results are presented in tables and graphics and are given to the Basin Directorate of the East Aegean District to help the decision makers in implementation of EU WFD.

Keywords: river basin, water resource system, water resource system balance, disturbed natural flow, GIS.

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IMPLEMENTATION OF THE EU WATER FRAMEWORK DIRECTIVE IN BAVARIA: WATER QUALITY MONITORING, RISK ASSESSMENT & RIVER BASIN MANGEMENT PLANS

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The key aims of the EU WFD are the management of water in river basins, the expanding scope of water protection to all waters - including surface waters and ground water, and the combined approaches of emission limit threshold values and water quality standards. The EU WFD sets the following clear deadlines for implementation: Therefore, till March 2005 the EU WFD required the analysis of river basins concerning pressures, impacts, and economic aspects.
Bavaria took the responsibility for the reports about the Danube, Rhine (Main and Alpenrhein/Lake Constance) and Elbe river basins within Germany's national boundaries. These reports contain a risk assessment for surface and ground water, judging whether the acceptable status (as defined in the EU WFD) could be achieved before 2015 or not. In our assessment of surface waters we defined four risk classes: (1) organic pollution, (2) nutrient pollution, (3) hydromorphological alterations, (4) hazardous substances. The ground water risk assessment is based on the concentration level of nitrate.
The establishment of high quality long-term monitoring programmes, to the end of 2006, is essential for the effective implementation of the WFD. The monitoring should be cost-effective and rationally risk-based. Our judgement is that inadequate investment in monitoring, including network infrastructure, data quality and management, will lead to a significant risk of missing the WFD's environmental objectives.
Four pilot projects were set up in Bavaria for testing the effectiveness of monitoring programmes concerning number of monitoring sites, quality elements for operational monitoring, sampling frequency and sampling methods. Each project focuses on a specific environmental hazard, e.g. for running waters. Concerning groundwater monitoring, we chose a groundwater body at risk – situated in an area with intensive agricultural land use and with high groundwater vulnerability. These four pilot projects identify the most suitable measuring methods and instruments to identify the impact of pollutants upon surface and ground waters.
Once the analysis results of the above monitoring pilot programs are compiled at the end of 2006, we will produce river basin management plans supplemented by more detailed programmes and "measurement plans for sub-basin, sector, issue, or water type, to deal with particular aspects of water management". Therefore we set up two pilot management projects for establishing detailed programmes for sub-basins in Bavaria- for surface water and ground water. For that we developed catalogues of measures to determine the specific detected impacts e.g. for reducing impacts from agriculture and hydromorphological alterations.
The presentation focuses on describing the concept of the monitoring programmes and the current work for the development of the river management plans as base for the more detailed plans for measures. The present state of the implementation of the WFD in the Danube basin will also be reported.

BUILDING A EUROPEAN CATCHMENT DATA BASE ON FRESHWATER BIODIVERSITY

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The goal of the "European catchment database on freshwater biodiversity" is to provide quantitative data on catchment parameters and environmental trends (hydrology, water temperature, land use, water stress) in combination with species diversity patterns (wetland birds, amphibians, fish, odonates, and crayfish) for entire Europe, western Russia, Caucasus and Anatolia (Tockner et al. 2008). It has been implemented in MS Access and is linked with GIS-layers.
Up to now information for a total of 160 catchments, covering 72% of the European continent, are included in the data base. Currently a "European Catchment Pressure Index" is calculated for each catchment by combining information on land use, water stress, river fragmentation and the proportion of non-native fish species.
The first analyses of the data show that more than 75% of the European catchments have to be classified as heavily impacted and thus likely to threaten freshwater biodiversity. At least two fish species endemic to the River Drin, Albania, are extinct at the continental scale. However, up to 40% of native fishes have disappeared at the catchment scale, especially long-migrating species such as sturgeons, allis shad (Alosa alosa) and lampreys. In contrast, 76 non-native fishes belonging to 21 families have been introduced into European freshwaters, with about 50 of these having self-reproducing populations. Most non-native fishes originated from North America (34 species) and Asia (26 species), and between 30 and 50 fishes have been translocated within Europe. The share of non-native fishes exceeds 40% in some catchments. This phenomenon is most prevalent on the Iberian Peninsula and the Atlantic region of France (Tockner et al., 2008). The highest proportion of irreplaceable fish (i.e. species with a limited geographic distribution), is found on the Iberian Peninsula, the southern Balkan and Anatolia; regions that are expected to face an even higher increase in water stress, pollution, and erosion in the near future.
The European catchment data base will be expanded by adding information on faunal groups such as Trichoptera, Ephemeroptera, and Plecoptera. Furthermore, the primary catchments will be divided into sub-catchments. It is foreseen to provide the same information at this finer, sub-catchment scale as for the primary catchment level.
Thus it is the aim to broaden the scientific basis for actions such as the identification of i) priority areas for the development of efficient conservation and restoration strategies as well as ii) the appropriate spatial scale at which conservation and restoration strategies need to be implemented.
An additional focus will be on the distribution and state of key ecosystem types and key landscape elements for freshwater biodiversity. They include river deltas, floodplain ecosystems, or vegetated islands. Moreover, emphasis will be placed on key ecosystem processes such as dispersal of organisms, sediment transport, or nutrient retention.

Keywords: river-catchment, biodiversity, ecosystem services, species diversity patterns, environmental pressures, conservation – restoration strategies.

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THE NOTES ABOUT ECOLOGICAL ASPECTS OF HYDROLOGY OF KILIYA'S DELTA OF DANUBE RIVER

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External water exchange, dynamics of water, hydrophysical characteristics of water and sediments are the ecological elements of hydrology which have significant importance for Kiliya's delta (Danube River).

The water budget of delta is formed mainly by inflow through entrance cross (112 km3/year) and flow through arms in the sea. Lateral inflow in the delta – 1,5 km3/year. The irretrievable water intake – below 0,5 km3/year. The Kiliya's delta is washed out by the Danube water almost 118 times or once for 3,1 days (in the spring - for 2 days, in the winter - for 7-8 days). For example, lower reach of Dnieper River has the period of water exchange 5,1 days.

River flow, wind-induced surges to and from sea, ice dams and waves determine dynamic of water masses in Kiliya's delta of Danube River. Flow velocity in the basic arms of delta changes from 0,25 up to 2,5 m/s.

Amplitude of water level fluctuation decreases downwards on river from 620 cm (Reni) to 261 cm (Vylkove). The water level in cross, where Kiliya's arm ramifies on Ochakov and Starostambul arms, is on 35-45 cm above sea level. Sometimes this difference reaches 1-1,2 m. In some cases the water level in Vilkove area can be on 5-15 cm below than sea level. It is possible to note two aspects of influence of water level regime on structural and functional organization of Kiliya's delta ecosystem. First is, that the raising of water level in channel causes for the raising of water level in floodplain. And the vegetative and animal communities of floodplain ecosystem react to it in appropriate way. Second is fluctuation of water level. It provides water exchange between a channel and waterbodies of floodplain. Thus different water objects can participate in processes which form quality of water environment.

In most cases the wind waves play a positive role for delta ecosystem. They activate hydrodynamic of water weights and clearing ability of river.

The hydrophysical characteristics of water weights in Kiliya's delta are formed on upper sections of river (before entrance in a delta). In connection with short time of stay water in a delta, its hydrophysical characteristics are identical almost.

The heat provision of biological processes in water of delta is estimated in 2900-3000 degree day. It means that the factor of temperature don't limit here chemical and biological processes.

About 10 million ton of sediments come to delta for year. Sediment concentration of water was more then 100 g/m3. The tendency of some reduction of sediment concentration in delta is noticed. As result the transparency of water and photosynthesis of aquatic plants are increased. The large meanings of pH (to 8,8) and the concentration of oxygen (122 %) for period of vegetation confirm this fact.

The silt loads of a mineral origin prevail in structure of sediments of a delta (85-98 %). All rest – sand or clay. Saltation load don't exceed 10 % from suspended sediments.

The ecohydrology characteristics were used for evaluation and forecast of ecosystem state and quality of water in delta.

Keywords: Kiliya's delta, hydrology, ecology.

RIVER ARCHAEOLOGY – A NEW TOOL FOR HISTORICAL HYDROLOGY

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River archaeology is a new field of research (Bonnamour, 2000; Dumont, 2006; Tóth, 2006a) consisting of underwater research of the rivers themselves, and also the archaeology of the valleys/floodplains with special interest in human-environmental interactions (reconstructing space, environment, economy and society on the basis of the material culture and traces of human impacts). As historical hydrology is occupying similar questions from the hydrologist's point of view (Brázdil and Kundzewicz, 2006) the combination of different approaches offers fruitful cooperation for both disciplines. Geology (geomorphology, sedimentology, geophysics), dendrochronology etc. should be taken into consideration as partner discipline (Brown, 1997; Howard and Macklin, 1999; Hudson-Edwards et al., 1999; Tímár – Sümegi – Horváth, 2005; Tóth et al.,1997; Grynaeus, 2003).
The case of the Dráva river is described in detail. At Drávatamási a logboat site has been discovered and study of it's relation to paleo-hydrological-environment has been started recently (Tóth 2006b and 2007).
Although a number of historical, archaeological studies discussed special problems related to river environment, even in the case of the Danube Basin, complex, interdiscilinary studies are still awaiting. At this point it is enough to refer to the close relation between Early and Middle Neolithic sites and the Tisza river in the Great Hungarian Plain (Kosse, 1979) and studies concerning the history of navigation on the Danube (Neweklowsky, 1952-1954-1964) or the mentioned Drava based on depictions and written sources. Underwater archaeology came into the picture much later, but studies on some European rivers are accessible (Saône: Bonnamour, 2000; Charente: Dumont et al. 2003; Ljubljanica: Gaspari 2003). The idea and first example for combining underwater archaeology and natural sciences diffused from France (Dumont 2006) due to international cooperation programmes. The circle of research fields and disciplinas are broadening and the purpose of this paper is to inform hydrologists about this new field of research. Proposed fields for cooperation: Paleochannel study (formation, evolution, characteristics); Question of driving forces: extreme, violent events (floods), and gradual changes; Traces of human impacts on river environment (e.g. built elements, like bridges, ports as part of the long-term artificial landscape in Roman Tiberis river: Graham, 2005); River and sediment types and strategies of archaeological cultures (e.g. Howard and Macklin, 1999; Hudson-Edwards et al. 1999); Islands as special places in culture and history (Roman and Medieval towns were often founded near river islands, and the life of these islands influenced the evolution of the settlements); Land use, changes in vegetation cover, and climat change and their influence on rivers and local communities GIS connecting interdisciplinary data.

Keywords: river archaeology, historical hydrology, underwater survey, GIS, Drava river.

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THE UN CONVENTION ON INTERNATIONAL WATERCOURSES AND INTEGRATED WATER MANAGEMENT: A BRIDGE

(LEGAL AND ADMINISTRATIVE CHALLENGES FOR INTEGRATED WATER MANAGEMENT)

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The Convention on the Law of the Non Navigational Uses of International Watercourses was adopted by the General Assembly of the United Nations (hereinafter UN) in May 1997. The Convention incorporates principles regarding the management of international rivers and lakes and makes an attempt to compromise the rights as well as the interests of the upstream and downstream states. The most important principles are the duty of the riparian states to cooperate, not to cause significant harm, to protect the aquatic environment and to utilize the watercourses reasonably and equitably.
The lack of hierarchy between these principles of international water law within the UN Convention signifies that what the necessary step for the sound management of shared natural resources is an integrated approach that takes into account economic development, human needs and environmental protection. The holistic approach of the international legal text is reflected in article 6 of the Convention, which enumerates a list of non exhaustive relevant factors that the riparian states should respect when managing an international watercourse. The path curved by the UN Convention is the most appropriate, efficient and aligned with the notion of sustainable development.
Moreover, the UN Convention, as the first international legal framework for the management of water resources, proved to be useful for the International Court of Justice (hereinafter ICJ) when it was challenged with the settlement of the Gabcikovo- Nagymaros dispute between Hungary and Slovakia for the Danube River. The Court used the Convention as a cornerstone tool in order to reach its decision and highlighted its importance by reminding the riparian states of their obligation to abide by its principles.
On the other hand, the ICJ has used the Convention in the pending case of Pulp Mills between Uruguay and Argentina for Uruguay River. Despite the fact that the dispute regards the environmental protection of the river, the Court has not failed to notice in its dictum for provisional measures the obligation of the states to respect the principles of the UN Convention in toto.
This paper is going to make an attempt to examine the UN Convention and show that the intention of the drafters of the text was to create an international legal framework, which is going to provide the states with the general guidelines in order to create regional conventions for the protection of shared rivers, lakes and aquifers, bearing always in mind that integrated water management could deal with the emerging challenges of international water law and help to avoid potential future conflicts.

CASE STUDY OF INTEGRATED WATER QUALITY MANAGEMENT: SERBIAN WATER QUALITY INDEX

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This paper gives a general analysis of the river water quality in Republic of Serbia for the period 2001 -2006 using Water Quality Index (WQI) methodology based on the composed quality indicator that aggregates ten quality parameters (dissolved oxygen, BOD, ammonium, pH, total oxidized nitrogen, orthophosphates, suspended materials, water temperature, conductivity and coliform bacteria) into one indexed quality assessment in range from 0 to 100. The indicator is created by using combined water quality index according to both "Regulation on water classification" and Water Quality Index methodology. For example, the surface water that can be categorized in the class I according to the "Regulation on water classification" can also be evaluated using WQI if the appropriate index is in range 84-85. Consecutively, all the other categories have corresponding WQI ranges (II class - WQI 72-78, III class - WQI 48-63, IV class - WQI 37-38). Moreover, for each WQI range a descriptive quality indicator has been defined, ranging from very poor (0-38), poor (39-71), good (72-83), very good (84-89) and excellent (90-100). Using correlations between Serbian and European legislative a new descriptive surface water quality indicator has been developed - Serbian Water Quality Index. Surface water quality, requested for drinking water abstraction, has been represented on the river network map, marking each control profile with an appropriate color (very poor - red, poor - yellow, good - green, very good - blue, excellent - light blue).
Descriptive indicator Serbian Water Quality Index (SWQI) provides a general overview on the river water quality for 143 measuring locations with an average sampling once per year done by the Hydrometeorological Service of Republic of Serbia for the period 2001-2006. This paper presents the water quality indicators calculated for each measuring location, grouped by the high/low water quantity season. During the high water quantity season (winter/spring), 14% of samples were evaluated as excellent, 25% as very good, 41% as good, while 19% and 1% were evaluated as poor or very poor. During the low water quantity season (summer/autumn), 12% of samples were evaluated excellent, 20% as very good, 42% as good, 24% as poor and 2% as very poor. Applied methodology and results of the analysis in creating SWQI should be seen as a contribution to the European integration of Republic of Serbia in the field of environmental protection through the implementation of the Water Framework Directive on the national level.

Keywords: water management, water quality index, descriptive indicator.

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PUBLIC OR PRIVATE WATER MANAGEMENT: EXPERIENCE FROM DIFFERENT EUROPEAN COUNTRIES

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Faced with liberalisation proposals and an increasing internationalisation of water resource management, the question arises as to how a change of the regulatory framework would affect the market structure and the supply conditions in this area. While the term “privatisation” relates to the ownership structure of the providers, the term “liberalisation” implies extensive free market ideas. Privatisation involves the outsourcing of public services from the public authorities to a privately organised organisation. Through this, however, nothing needs to change in terms of the market or the intensity of competition for the commodity in question. Within the framework of privatisation it can also occur that the public monopoly is only transferred to a private monopoly. The term “liberalisation“ in addition refers to the basic regulatory constraints: liberalisation signifies the cessation of limitations to competition and supply monopolies, and open competition between several suppliers for the consumers.
In the EU-15, the only country where the provision of operational services in the water supply has been totally passed to the private sector is the United Kingdom, but this is only true for England and Wales. Another singular case is France, where there is a mix of mainly private operating companies and municipalities which have divided the regional supply areas among themselves. In six other EU-15 countries where some privatisation took place, either the municipalities or (majority) publicly owned companies are controlling water supply. In the remaining seven countries, the water supply is organised by municipality companies only. In the supply of drinking water, the pipe network represents a natural monopoly but not the production of drinking water. As drinking water is provided in different qualities, this is not a homogenous commodity such as, for example, electricity. Operation of the network and production of drinking water can be separated from one another only with difficulty. The high fixed-cost component in the supply of water makes the laying of parallel networks by the competing bidder unprofitable – the classical case of a natural monopoly. In an international comparison, there are three basic models for the regulation of natural monopolies in the public water supply: the Anglo-Saxon, the French and the German model. The delimitation between supervisory bodies and operations in the water supply is strongest in the first model and weakest in the last. This has led to three basic types of privatisation: "full privatisation", "privatisation through delegation" and "privatisation with regulation by the supervisory bodies". These have led to three clearly distinguishable forms of competition: substitute competition simulated by the regulation authorities between private supply-enterprises, competition between private operators for the right to the temporary provision of water supplies, and competition in the product and service markets in the provision of water. In my paper, these different forms of privatisation and liberalisation are described and their impact on competition, prices and the quality of water supply is analysed.

Keywords: water management, natural monopoly, privatisation, liberalisation.

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WATER UTILIZATION AND WATER MANAGEMENT BALANCES OF THE LOM RIVER BASIN IN BULGARIA

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The paper presents the received results from water management balance (WMB) for existing multi - purpose water resources system (WRS) in the Lom river basin – one important feeder of Danube river in North-West Bulgaria. The general principles in developing WMB are recapitulated and formulated. It is done a short description and are marked the specific features of present water resources use in the river valley. Based on the developed scheme for water use and different variants of the individual user's needs are made water management balances (WMB). Characteristics in the scheme are discussed because they are important for the choise of the water balances points. Experimental simulational researches for WMB are carried out with prepared input information for the inflow and water demand. Sequences for the inflow and irrigation demand in the relevant points are 44 years long by months. The WMB results are obtained from the experiments with the software programme SYMIL (network simulation-optimization computer programme). The results for different variants of WMB are analyzed and it is made assessment of water availability of the different users. It is expounded that the Lom river basin problems are consequence of the economical, political and climate changes and these problems reflected on the received results of WMB. It is emphasized that at the moment the Lom river basin does not have nodes with big breaches, inadmissible shortages and conflict between the users. The established shortages are a signal that in these water catchments there is a problem which needs a decision. WMB could bind these water demands with the available water resources.
In conclusion, for the Lom river basin are proposed some recommendations and are drawn concrete deductions and proposals.

Keywords: river basin, water management balance, water supply availability, water resources management, computer model, simulation, climate change.

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ENVIRONMENTAL MANAGEMENT OF THE DANUBE BANKS AS THE BASE OF INTEGRAL PLANNING – AREA OF SERBIA

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The opening of Serbia to Europe also signifies a greater utilisation of the Danube potentials at the local and regional levels. Local community, or the municipality to which it belongs, and a part of the riparian area, lose the priority in the realisation of their own demands, if they are not harmonised with the general, regional plans.
Sustainable utilisation includes the economical use of the capacities of each natural resource, which affects directly the definition of multi-criteria goals in the utilisation of the river Danube and the riparian part to which it is historically linked.
This paper analyses the environmental aspects of integrated management of the Danube resources in Serbia, referring to water protection against contamination, protection of natural ecosystems, entities, and rare species of plants and animals, protection of cultural-historical values and the heritage, introduction of the new contents which will contribute to the actual demands of regional development, media campaign and education of the population.

Keywords: bank revitalization, natural and historical values, integral planning.

Topic 5: FLOODS, MORPHOLOGICAL PROCESSES, EROSION, SEDIMENT TRANSPORT AND SEDIMENTATION

RIVER BANK EROSION AND ITS PREVENTION IN KOSOVO

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Using water for different purposes, without considering impact in nature, we are endangering ecosystem. Part of this ecosystem are river catchments and along with them river banks that are threatened by erosion.
Soil erosion is amongst the most serious problems of environment. The catchment s erosion is a result of human activities, urban runoff due to the precipitations as well as runoff from agriculture and waste landfills. River bank s erosion depends on the flow rate, vegetative cover and the river bank material. The impact of those erosion factors causes the decrease of ecological values, preclusion of aquatic life and aesthetic roughness.
According to the non authentic evaluation of the state of erosion in Kosova, the lack of research and the erosion data, the catchments and river banks soil erosion are treated in this paper. The focus is given on erosion s understanding, the causes of its appearance and its influence on water quality. Also, some solutions for the prevention of erosion are given in this paper.
Soil erosion prevention can be achieved by rational use of land within the catchments area and the recommendations given in this paper will enable it. Despite many options for river bank protection against erosion, vegetative measures enable natural diversity and are more sustainable. The riparian vegetation, consisting of authentic plants is estimated as most appropriated. It helps bank stabilization using authentic materials and makes available the filtration of many pollutants and the development of aquatic life in the river and its banks.

Keywords: erosion, river bank, catchment, vegetation cover, prevention.

3D NUMERICAL MODELLING TO PREDICT MORPHOLOGICAL CHANGES IN VARIOUS REACHES OF DANUBE IN HUNGARY

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Two problematic Hungarian Danube reaches were chosen to analyze morphological changes due to planned river training works. The first one is a 5 km long sandy-gravel bed reach of river Danube located in Central-Hungary, presenting problems for navigation for a long time. As a conventional remedy, groin fields have been implemented to make and maintain the reach sufficiently deep, navigable even in low flow periods. The second study reach is a 6 km long reach situated in the southernmost part of Hungary next to the border with Serbia presenting navigational problems due to their over-widened and shallow main channel in the sand-bed part of Danube.
Detailed hydrodynamical and morphological surveys of the two study reaches were carried out in 2007, including acoustic Doppler current profiling with moving and fixed boat, suspended sediment, bed-load and bed material sampling, bed geometry and free surface slope measurement, as well as the observation of dune dimensions and dune movements. Results from the measurement campaigns were used to calibrate a three-dimensional numerical model, which solves the Navier-Stokes equations to calculate flow velocities using the k-ε turbulence closure while the sediment transport is computed with empirical formulas by van Rijn (1984).
In both river reaches two schemes of river training work configurations were conceived in order to narrow thus to enforce deepening to an extent providing safe navigation in low flow conditions, with far the longest duration in a typical year. All variants were investigated with the numerical code and results are plotted in terms of estimated bed changes fields, changes of cross-section shapes, sediment concentrations, etc. Besides model results formulas for suspended sediment and bed load fluxes were also worked-out taking into account the difference between sandy-gravel and sand bed material.

COMPLEX HYDRO- AND SEDIMENT DYNAMICS SURVEY OF TWO CRITICAL REACHES ON THE HUNGARIAN PART OF RIVER DANUBE

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Detailed hydrodynamic survey of two critical river reaches was performed from hydro- and sediment dynamics points of view, in order to explore the main features, moreover, provide calibration and verification data to related 3D flow and sediment transport modelling. As to the study reaches, the first comprises a 5 km long sandy-gravel bed reach of river Danube located in Central-Hungary, presenting problems for navigation for a long time. As a conventional remedy, groyne fields have been implemented to make and maintain the reach sufficiently deep, navigable even in low flow periods. As is usually the case, these works resulted in rather complex flow characteristics and related bed topography at places. The second site is another 5 km long reach of river Danube, close to the southern border to Serbia. There the river presents navigational problems similar to the previously mentioned reach, however, having entirely sand bed conditions, abundant in a variety of dunes, especially in the shallower parts.
The hydrodynamic, and sediment measurements as well as the bed topographic surveys have been carried out to get adequate data to calibrate and verify a three-dimensional CFD model. In the hydrometric analysis both fixed and moving boat measurements were performed with an ADCP providing the opportunity to compare flow parameters derived from long-term mean velocity profiles and from instantaneous data. Time-averaging long-term fixed boat ADCP data, logarithmic velocity profiles were fitted and depth-averaged flow velocity (um), roughness height (z0) and shear velocity (u*) were successfully estimated. It was shown that by horizontally space-averaging 30 neighbouring elements a fairly good estimation similar to the fixed boat ones could be obtained.
Filtered velocity data, sampled suspended sediment profiles and bed elevation changes were compared with modelled results showing satisfactory agreement. Having the model validated, the impacts of designed hydraulic structures were analysed. Defining a steady bed-forming discharge at the upstream boundary, five month long time periods were modelled in both study reaches with bed topography modified by the planned groyne field. Model results showed a reasonable impact, i.e. in the contracted section of the navigation channel considerable erosion took place, whereas zones with almost zero velocity between the groynes resulted in sediment deposition. Though modelling results indicate positive effects on fluvial navigation, it has to be considered that due to local bed erosion in the study reaches, a large quantity of sediment will be transferred in downstream direction. Since the second investigated river reach is situated close to the border with Serbia, any kind of river engineering intervention has to be considered carefully.

Keywords: ADCP, Danube, river flow and sediment measurements, 3D turbulence modelling, morphological modelling.

SEDIMENTATION MONITORING DURING CONSTRUCTION OF DEEP WATER SHIPPING WAY IN UKRAINIAN PART OF THE DANUBE (BYSTRY BRANCH)

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There are many factors that influence the hydrological regime in the river catchments and basins, directly related to changes of use of the water supply. These factors include not only climatic, hydrological and hydrogeological effects, but also encompassing the changes caused by human activities and the changes in socio-economic structure, land use intensity and legislation, which, due to ever-increasing development of industry and agriculture, price of the water, population density, growth of satellite settlement centres around towns and intensity of use of natural resources. All these factors are important when considering the cross border nature of rivers and basins. Conflicts arise over different usage of resources, priority of national interests over international ones and disagreements over management or interpretation of agreements and legislation.

The Danube delta is a very specific area located in Romania and Ukraine. This is so called buffer zone receiving contamination from Central and Eastern Europe. Except of this influence to the delta the important role consists of technical constructions such as water pools of hydropower stations, jetties, deep water shipping ways organization etc. There is water discharge redistribution between Romanian and Ukrainian parts of delta. Decreasing of water runoff in Ukrainian part is negative factor for the common ecosystem and conditions of Danube Biosphere Reserve. From other side organization of new deepwater shipping way in Ukrainian part (via Bystry arm) troubles Romanian side. So, it is necessary to estimate trans boundary effects using together tradition and satellite data and methods.

Preliminary analysis location of erosion (Romanian part) and accumulation (Ukrainian part) zones in the Black sea coastal area near the Danube mouth had been done. There are different reasons of its formation and one of them are jetties, river runoff changes, possible dragging works. It is necessary to find common decision for both countries for safety and rational using of natural recourses.

There are some questions linked with the process of works in the marine canal, marine jetty and dumping place. The sampling was done in the open sea directly near the places of bottom sediments dragging and damping. The results of investigations give the opportunity to estimate spatio-temporal scale of suspended matter distribution i.e. anthropogenic influence to the river-mouth ecosystem.

Granulometric analysis, mineral fraction composition of bottom sediments and hydrological conditions in the Bystry mouth gave an opportunity to preliminary estimate reasonability of building new marine jetty and influence of other factors to sedimentation processes. New anthropogenic influence to the delta should be started after mole construction in the mouth of Bystry. It is necessary to study in frame of joint Ukrainian and Romanian monitoring as well as the adjacent area between Starostambulsky branch (accumulation zone) and to south of Sulina branch (erosion zone).

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THE INFLUENCE OF THREE CROATIAN HYDROELECTRIC POWER PLANTS OPERATION ON THE DRAVA RIVER SEDIMENT REGIME

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Since 1975, numerous hydrotechnical works have been carried out on the 60 km long section of the River Drava from Slovenian-Croatian border to the River Mura mouth. Three hydrotechnical power plants with three reservoirs and three long inlet and outlet canals have been built. Massive construction on the Drava river basin and on the river itself during the last centuries, as well as recent climate change and/or variability has caused many different and possibly dangerous changes to its hydrological and ecological regime. Changes in water level, discharge and suspended sediment yield along the River Drava measured in Croatia, downstream of the three reservoirs, during the last thirty to hundred thirty years are presented. The investigation focuses on changes that have occurred during last thirty-odd years, caused by the anthropogenic influences on the River Drava watercourse and its catchment in Croatia and Hungary, and probably by climate change or variability. Methods of rescaled adjusted partial sums, statistical tests, as well as regression and correlation analyses are used in order to explain changes in water level, discharge and suspended sediment yield. There is evidence in the time series of decreases in the minimum, mean and maximum annual water levels and minimum and mean discharges on the lower part of the River Drava. One of the main objectives of this paper is to examine the effect of dams and reservoirs operation on the changes of the downstream suspended sediment regime. The amount of suspended sediment has been greatly reduced, which can cause serious consequences.

Keywords: water level, discharge, suspended sediment, River Drava (Croatia).

BETTER UNDERSTANDING OF SEDIMENT PROCESES – A CONDITION FOR THE SUCCESS OF ADAPTIVE AND INTEGRATED WATER RESOURCES MANAGEMENT IN THE DANUBE BASIN

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The actual situation of sediment research in the Danube basin was summarized at the workshop in Budapest 24-25 March 2006. At that occasion a project has been defined aiming at improved understanding of sediment phenomena in the Danube basin. The first step would be to clarify the sediment balance of the Danube river system - the SEDBAL Project, to be coordinated by Professor Hans Peter Nachtnebel, BOKU, Austria. This initiative has also been supported at the meeting in November 2006 organized by the project SedNet at the UNESCO Regional Bureau in Venice, at which the project SEDBAL was specified as a component of a wider project entitled Towards integrated management of the Danube sediment-soil-water-system as support for the implementation of the EU Water Framework Directive At the 21st Working Meeting of IHP Cooperation in Hydrology of the Danube countries in Novi Sad, Serbia, 25th 28th June 2007, it was agreed to start the SEDBAL Project activities by 1st September 2007, and to have a first joint workshop in Vienna in December 2007.

It should be underlined that in the light of recent initiatives to instigate adaptive and integrated water resources management in the Danube Basin (see WP3.5 Case Study - Tisza River Basin - www.newwater.uos.de/caiwa/), the improved understanding of sediment phenomena in the Danube basin is even more pressing, taking into account the many uncertainties that these phenomena entail. The present paper intends to elaborate on some aspects of the key issues that should be in the focus of ongoing and further research. The Conference in Bled will be an excellent opportunity to appraise the progress so far of these initiatives and to recommend further actions to be pursued in that context.

FLOODPLAIN AREAS PROTECTION IN THE UKRAINIAN PART OF THE DANUBE DURING THE FLOOD OF 2006

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In March – June 2006 the extreme high flood was observed in the Ukrainian part of the Danube. The reasons of the phenomenon were significant store of show in the river basin, warm weather contributing to active snow melting and heavy rains during spring months. On April 26, 2006 the water level at Reni measuring post reached 562 cm over the «0» of the gauge, which exceeded the historical maximum of 1970.

Water levels during the flood exceeded the dangerous marks and their standing time in Reni was 23 days, in Izmail – 60 days, in Vilcovo – 65 days. At that, some berths in ports and industries were water-logged, as well as some districts of town Vilcovo.

The dikes built in the Ukrainian part of the Danube from Reni to Vilcovo are capable of protecting the adjacent areas from flooding during passing by of maximum water levels of 1% probability. Their height reaches 4 meters, edge width - 3 to 5 meters, total length - 219 km.

At the water levels exceeding 400 cm over the «0» of Reni gauge all the dikes in the Ukrainian part of the Danube change to the pressure regime of operation. During the flood of 2006 the protection dikes have been working under the pressure regime for about 3 months.

The peculiarity of the flood-protection dikes operation is that the only possibility to check their reliability happens only during extreme floods. For the last 50 years such floods occurred only twice: in 1970 and 2006.

The main measures required for normal letting through of high floods are: permanent supervision of technical state of the dikes, their timely strengthening and elimination of seepage. Taking of these measures and availability of reliable hydrological forecasts enabled us to successfully let the historical flood of 2006 pass by.

Keywords: extreme flood, flooding, protective facilities.

PLAN OF TORRENTIAL FLOOD MANAGEMENT ON UNREGULATED WATERCOURSES

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Torrential floods occurred in the past, and are still occurring. We are the witnesses of numerous torrential floods occurring from the last decade of the past century to the present day, both in the world and in Europe. These floods are accompanied by major damage, destruction of structures, and even human sacrifices. For this reason, the floods and the flood control have aroused the public interest.
Torrential floods are characterised by occurring during a very short time period (sudden inflow and very short duration of flood wave). They occur after one to two hours after heavy rain. Flood of the torrential type is characterised by a steep front, which has a high destructive power, it ruins the banks, destroys the vegetation and the structures in the channel and on the banks, carrying all the waste from the flooded belt.
The classical forecasting system of the potential flood risk is suitable only for large basins and it is not applicable to small torrents.
Modern radar meteorological observation enables a prompt detection of storm clouds and the estimation of the expected rainfall quantity and its duration. In this respect, the forecasting of torrential storm is possible several hours beforehand. Consequently, the link between the radar meteorological centre and the defence staff in the risk zone is very important.
The need of such flood management increases from day to day because of the spreading of all urban contents into torrential floodplains. For this reason, the system of classical torrent regulation is difficult to perform and the damage is inevitable.
The Institute "Jaroslav Černi" in Belgrade has developed the procedure of Plan osnove flood protection on unregulated watercourses. The plan contains the previously collected data on the magnitude, intensity and duration of the flood wave and all calculations that enable prompt interventions of the authorised institutions and the public. The authorised institutions and the public respond to warnings and undertake the appropriate works and measures for flood protection by the previously defined plans.
The flood management plans are sub-legal acts and a significant part of Serbia has already been covered by such Plans.

Keywords: torrential floods, flood management, radar observation, plans.

THE CHANGES OF THE INTENSITY OF EROSION ON SOME TRIBUTARIES OF BLACK SEA AND AEGEAN SEA RIVER BASINS (IN SERBIA AND MACEDONIA)

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The mapping of the intensity of erosion in Serbia has begun in 1966 and it has been completely finished in 1971. The map is done by empirical method and filled in tables which are used for determining the basic parameters which are included in composition of pattern for estimation of erosion coefficient. The map has been published in 1983. By new field investigations and mapping of erosion in several river basins on Serbia territory (Kolubara River, Rogacica River and Temstica River) as well as by application of modern computer techniques based on analyses of satellite images, it has been stated that the intensity has been changed in last 40 years. As outstanding changes of physical-geographical factors have not been detected, there the cause of the intensity decreasing could be only of indirect anthropogenic influence. That way appeared possibility of comparison of present condition of the erosion on field with mapped values from the period when map of erosion of Serbia has been done. On that way it is possible to draw a conclusion about factors influencing such changes. In order to check this condition in river basin of Black sea as well as to compare to other river basins, we have realized comparison with several water currents in Macedonia (Pcinja River, Bistrica River). Particular investigations have shown similar trend of the intensity of erosion even on this space. That's why we did parallel perceiving of changes. That allowed forming precise conclusions about factors as well as about the intensity of changes. The aim of the above mentioned investigations is to establish changes, to arise need for modification of present maps or for creating new models of erosion by using GIS technology. On that way, with application particular layers there will be possibility for continual bringing up to date of date. The map would present actual, contemporary base for planning human activities in space.

Keywords: soil erosion, empirical method, erosion coefficient, Serbia, Macedonia.

CHANGES OF HYDROLOGICAL SYSTEM IN THE LOWER COURSE OF THE KOLUBARA RIVER

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Changes of hydrological system, through forming of meanders and cutting the "necks" are recent geomorphologic-hydrological process, which is dominate in the lower course of the Kolubara River. This situation is caused by moving of Kolubara River in riverbed of its tributary Pestan River. The above mentioned situation has been realized during the seventies of last century, in order to provide necessary conditions for undisturbed exploitation of lignite. Reorganizing of Kolubara River into riverbed of Pestan River caused significant and obvious morphologic changes of riverbed of Kolubara River as well as of the mouths of almost all its tributaries. On the base of comparative analyses of historical-geographical and topographic maps as well as satellite images, reconstruction of hydrological system has been done for the periods of the biggest changes. By field investigations during the summer 2007 we have examined consequences of anthropogenic influence not only over this hydrological system but over the entire geographic space. Obtained results may present good base for further geomorphologic, paleographic and hydrologic investigations. Beside its fundamental significance, results of this investigation are applicable before all in the field of water resources management, hydro-technical work as well as in different aspects of the protection and promotion of the environment (particularly within the concept of sustainable development).

Keywords: Kolubara River, Pestan River, Tamnava River, hydrology, meanders, antropogenic influence.

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ANALYSIS OF FALL VELOCITY FOR THE DEZ DAM COHESIVE SEDIMENTS

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The most common parameter for analysis of sedimentation and consolidation process is the fall velocity of sediment particles. Settling columns are normally used to determine characteristics of the stagnant water and measure the fall velocity of the sediment particles. Extensive studies have been conducted in the past to determine fall velocity for non-cohesive sediments but less is done for cohesive sediments. Water with different concentration of cohesive sediment from Dez Dam reservoir in south west of Iran were allowed to settle in a 3.0 meter height and 0.30 meter diameter in this study. Samples of water and sediment mixture were taken at different depths of the column and sediment concentration was determined using a weighting technique. The concentration diagrams were constructed in order to estimate fall velocity of the cohesive sediments based on the McLaughlin's differential equations. At the beginning of the settlement, particles at low flow depths accelerate faster and reach higher velocity as result of flocculation. Depend on level of concentration; the process of flocculation thus maximum fall velocity at a point is reduced gradually as flow depth increases. The turning point from acceleration to deceleration of particles appears sooner and at lower velocity as result of slowing down of the flocculation process at deeper points of the column.

Keywords: cohesive sediment, fall velocity, concentration, flocculation.

TORRENT CLASSIFICATION – BASE OF RATIONAL MANAGEMENT OF EROSIVE REGIONS

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In nature, there are a great number of torrents. The most widespread are the small torrents called gullies. Their lengths are several hundreds of metres and watershed areas are of proportional sizes. Their characteristic is that water and sediment flow in their channels only during and immediately after a heavy rain. On the other end of that huge spectre of torrents are the large torrential rivers, whose lengths and watershed areas amount to several hundreds and thousands of kilometres. The prefix torrent is derived from the characteristics of flood waves which occur very quickly, carry significant amounts of sediment, but instead of flooding, they destroy whatever is in their way.
During the twentieth century, Serbia was impacted by a great number of torrents of all magnitudes. They damaged and destroyed the settlements, the roads and interrupted the railway and road transport.
The State was faced with a great problem, because it did not have even an approximate knowledge of the number of torrents and could not plan the defence against torrential floods.
For this reason, in the first half of the twentieth century, the torrents in Serbia were inventoried. More than fifty thousand torrents of various magnitudes were listed. This is on the average one torrent per square kilometre of the hilly and mountainous part of Serbia.
Soon after the first inventory of torrents in Serbia, it was determined that the collected data were not sufficient. The main deficiency of the inventory was the fact that it was designed according to the model of watercourse classification, which codes the main recipient and the tributaries of the first, the second and further orders. Such a classification is adequate for the inventory of large rivers and their tributaries. The unsolved issue was how to classify a gully, which is a torrential tributary of the first order of a large navigable river, as well as a series of other questions.
A complex methodology for torrents and erosion and the associated calculations was developed during the second half of the twentieth century in Serbia. It was the “Erosion Potential Method“. One of the modules of that complex method was focused on torrent classification. The module enables the identification of hydrographic, climate and erosion characteristics. The method makes it possible for each torrent, regardless of its magnitude, to be simply and recognizably described by the “Formula of torrentiality“.
The above torrent classification is the base on which a set of optimisation calculations is developed for the required scope of erosion-control works and measures, the application of which enables the management of significantly larger erosion and torrential regions compared to the previous period. This paper will present the procedure and the method of torrent classification.

Keywords: soil erosion; torrents; torrent classification.

EROSION CONTROL WORKS AND THE INTENSITY OF SOIL EROSION IN THE UPPER PART OF THE RIVER TOPLICA DRAINAGE BASIN

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The River Toplica (South Serbia) is the largest left tributary of the Južna Morava with the basin area which is altogether 2,180 km2. The building of the storage "Selova" on the river Toplica is in its final stage . The drainage basin of the storage covers the upper part of the river Toplica basin, on the east slopes of the mountain Kopaonik The storage "Selova" will be a source of water supply for the population of Niški and Toplički Districts. The total area of the basin to the dam position is 346.05 km2, and the storage volume is 70x106 m3.
Aiming at the protection of the future storage »Selova« against erosion and sediment, and also to protect the settlements and roads in the drainage basin against torrential floods, erosion control works in the upper part of the river Toplica basin, upstream of the storage »Selova«, started in 1947. The works included building-technical works (check dams) and biological works (afforestation and grassing of bare lands and other erosion risk areas). During the period 1947 – 2006, the following erosion control works were performed: afforestation of bare lands on the slopes 2,257.00 ha, grassing of bare lands 1,520.00 ha, and altogether 54 dams were constructed in the river Toplica tributaries. The effects of erosion control works are reflected in the decrease of erosion intensity and sediment yield on the slopes, as well as on the checking of a quantity of bedload in the storage area of the dams. This caused the decrease of sediment transport in the main flow of the river Toplica.
This paper, based on the field research in two time periods: 1988 and in the period 2004-2007, presents the state of erosion in the basin before erosion control works; type and scope of erosion control works and their effect on the intensity of erosion in the river Toplica basin upstream of the future storage »Selova«.

Keywords: soil erosion, sediment transport, effect of erosion control works.

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SOIL EROSION PROCESSES AND MODELLING IN THE UPPER BREGALNICA CATCHMENT

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Bregalnica is one of the largest rivers (225 km long, 4307 km2 watershed area) in the Republic of Macedonia, which drainage surface waters from most of the eastern part of the country. Because of suitable, sensitive natural factors (geology, soils, topography, climate, hidrography, vegetation) and human-related excess deforestation, huge area of Bregalnica catchment is characterized by strong erosion potential. This is especially evident upstream from Kalimanci dam, where most of the tributaries are torrential, and landscape represent real system of gullies, earth pyramids, badlands and landslides formed in soft pliocene lacustrine sediment rocks. Aside of that are numerous deposition fans in the torrents bottom, as well as large flats of sedimentation. It is interesting that here are registered huge amphitheatral semicircle badlands calling "mel" with overload production of eroded material. For that reason, in this upper part of Bregalnica catchment (1124.7 km2), are recorded sites with high annual erosion rates, among the highest in the Republic of Macedonia. In respond of such erosion risk, from the 1960-ties detailed studies with erosion modeling and mapping for the area are performed, dominantly based on conventional tools and empiric methods. Main goal of these research was to contribute to the erosion potential modeling and to contribute to protect the reservoir Kalimanci from fast fulfilling with sediments, which is partially made. This catchment was an area for large number of various researches in past. There is a erosion map created by direct filled observing and mapping in a scale 1:50000 according to the Erosion Potential Method (by Gavrilovic).The map was created 15 years ago and in the meantime there happened changes on the landscape. Having in mind fast transformation in the landscape, previous approach is modernized by creating digital model of soil erosion risk. This is prepared using two approaches: relative cluster classification and absolute quantitative method implementation. Both approaches are based on digital elevation model, satellite imagery and other digital data's. Final results in form of digital maps and quantitative parameters are compared with those of former classical research and with sediment transport and deposition measurement on the Bregalnica River. In general, they show close fitting, which indicate that applied digital model can be fully utilized for soil erosion risk assessment, and identification of sites with increased erosion risk. That will be a base for proposing and implementing necessary protection measures.

Keywords: Soil Erosion, Deposition, Digital Terrain Model, Satellite Imagery, GIS.

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SIGNIFICANCE OF FLOOD ZONE DEFINITION OF THE DANUBE TORRENTIAL TRIBUTARIES AND POTENTIAL MULTIDISCIPLINARY IMPLEMENTATION OF THE RESULTS

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Torrents have small drainage basins and lengths and they are predominantly hydrologically ungauged, with undefined floodwater discharge of and borders of floodwater channels.
In the Danube Basin, there are numerous torrents and many of them are also direct tributaries. In the torrential plains which are potential flood zones, there are significant buildings, roads, settlements, industrial zones, managed reclamation areas and headwaters. This is primarily caused by the absence of clear identification of flood zones. The floods of torrential tributaries in the Danube Basin during the last years show the disadvantages of this state, leading to major damage and destruction.
The construction of the HE Đerdap caused the change of the natural regime of water level both in the Danube, the Sava and in other tributaries in the backwater zone in Serbia, many of which are small torrents.
Small torrents have their flood zones, just as all watercourses. Torrents have some specificities related to stream characteristics and the times of flood wave origin and duration, which are, as a rule, very short. Morphological characteristics of an inundation are important for the defining of torrent discharge capacity, whereas the main channel does not have a significant impact on the discharge capacity of the entire river valley. This characteristic conditions a different approach to the flood zone calculation compared to similar calculations for major watercourses. This made the study of the laws of flood occurrence and the flood zone calculation even more difficult.
The observed interdependent laws of torrential floods and their different forms require the elaboration of different scenarios of this type of flood.
The methodology of defining the torrential flood zones has been applied already for some time, so this paper presents the obtained practical results and the potentials of further application in practice.
The demand of protection against torrential floods conditioned large-scale works on stream regulation, including the construction of embankment systems. All these structures reduced significantly the natural flood zone. This made the protected regions even more attractive for human activities (settlements, roads, industry), many of which led to the deterioration of runoff regime from torrential drainage basins, which caused new risks of torrential floods, which were not counted upon during the original design of the defence systems.
Remote sensing applied in the methodology of flood zone definition, by using the maps resulting from other disciplines, enables the collection of numerous data of diverse contents with great opportunities of data interpretation, under several times lower prices compared to the classical soil surveying. Therefore, remote sensing offers high potentials for integrated assessment of risk zones and possible damage within the flood zones. This paper will present the results which have a very wide spectre of implementation in all disciplines dealing with spatial planning and design in the potentially hazardous areas.

Keywords: remote sensing, erosion, torrents, forests, land use.

REMOTE SENSING AND IDENTIFICATION OF PLACES SUSCEPTIBLE TO SEDIMENTATION IN THE DANUBE RIVER

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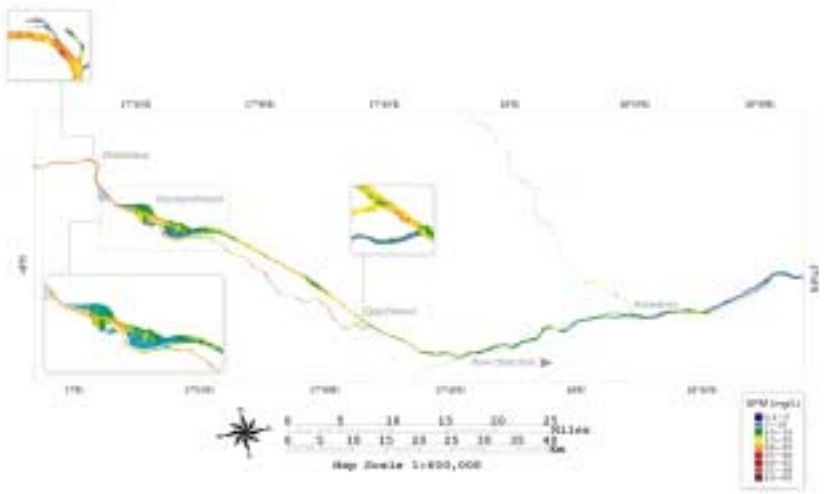
Alternations in river channel morphology result in a disturbed natural transport of suspended particulate matter (SPM). Suspended particulate matter serves as a transport medium for various pollutants, e.g. heavy metals. It is therefore important to understand how artificial obstructions alter the natural transport of suspended matter. Measurements of SPM in rivers are traditionally carried out during in situ sampling campaigns, which can provide only a limited view of the actual spatial distribution of suspended matter over large distances. Several authors have studied how space-borne remote sensing could be used for mapping of water quality in standing waters, but with only little attention paid to rivers. This paper describes the methodology how a Landsat ETM image was used to map the spatial patterns of SPM in the Slovak portion of the Danube River. Results of our investigation reveal that the Danube River in Slovakia exhibits gradual longitudinal decrease in concentrations of SPM. Based on a strong relationship between the Landsat near-infrared band (TM4) and field measurements, we developed a map of suspended particulate matter in the Danube River with a standard error (SE) of 3.2 mg/L. This study aims to show how archived satellite data and historical water quality data can be used for monitoring of SPM in large rivers and consequently to identify places that are susceptible to sedimentation.

Keywords: suspended particulate matter, Landsat ETM, Danube River, archived water quality data.



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SMALL TOWN KUŽELJ (CROATIA) - FLOOD PROTECTION

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The river Kupa springs below the village Razloge as a picturesque spring in the shape of a lake which is situated at the hill of cca. 320 m of the height above sea-level at the foot of a high vertical cliff. The spring of Kupa has the characteristics of a Karst spring which in its most upstream part of the flow is entered by several other more powerful Karst springs whose contribution in water is even more significant than the one of the mentioned main spring. Along the upper flow, the river Kupa has the characteristics of a torrent water flow with a prominent oscillation of the flow during the year. Following the oscillations of the flow of the river Kupa during the year, especially during autumn and spring months, an outflow of the water from the mostly unregulated bed takes place along with the flooding within the foreshore areas along the flow. A large part of the road (Čabar – Brod na Kupi) as well as parts of the towns situated within the mentioned foreshores are exposed to floods due to the relatively narrow valley and small disposable areas

One of the largest right-hand tributary rivers, the Velika or Kuželjska Belica flows into the river Kupa in the town Kuželj. This right-hand tributary river has a constant flow because its spring part, situated at the foot of the mountain Drgomalj, plays an important role in its entire water balance. The area of the basin is 10.45 km2, while the flow at the profile of the river mouth oscillates form 0,5 m3/s till cca. 118 m3/s. A part of the town Kuželj is situated by the confluence of the Velika Belica into the river Kupa and is repeatedly exposed to floods just like the road Brod na Kupi – Čabar.

The natural backwater of rhe river Kupa, the verticality of the confluence of the Velika Belica into the river Kupa and the sandbank which is situated at the river mouth of the Velika Belica into the river Kupa jointly influence the height of the water level of the Velika Belica and contribute to the frequent occurrence of floods in the small town Kuželj. The past hydrological measurements were performed exclusively for the purpose of measuring the abundance of the spring serving the water supply. On the river Kupa in the town Kuželj there are no hydrological measurements of the water level height, that is, of a corresponding flow. The nearest stations are upstream in the location Hrvatsko where the water level height and the flow have been measured since 1949, and downstream on the Slovenian side in the town Perina which is situated opposite of the town Brod na Kupi. At those stations, the water level height and the flow have been measured since 1955. Therefore the input figures into the simulation of the flow along the Velika Belica and the Kupa rivers were obtained by parameter methods.

The work will try to establish the cause of creation of backwater in the downstream part of the Kupa river by the bridge for the Slovenian Kuželj, under which there is a large local backwater due to the narrowed section which occurs when large water waves of the Kupa river roll by. The issue of the high water in the water flow of the Velika Belica could be resolved in terms of quality by reducing the backwater by the bridge.

Keywords: Velika Belica, backwater of the Kupa river, floods, large water waves, simulation of the flow.

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GRAVEL BAR SAMPLING ALONG THE SAVA RIVER

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The gravel bar sampling along the Sava river was carried out as one of the SARIB (SAva River Basin) FP6 project activities. The main objectives of the project were to develop and validate specific tools for the estimation of the pollution of sediments and impact on water biota, based on the combination of chemical analysis and biological effect methods. For that purpose an informational data base was developed, which contains also the data about the Sava river gravel bars. The sole previous sistematic sampling of the Sava river gravel bars dates back 40 years. The intention of the new sampling was to state the changes of the gravel bar grain size distribution over the past 40 years and thus to broaden the knowledge about today's bed load discharge of the Sava river. It is also important because the hydropower plant chain is being currently constructed in the lower Sava river (Posavje) and the construction of another chain in the middle Sava river (Zasavje) is planned for the future decades.

The gravel bar sampling was underway between 6th and 16th November 2006. The investigated reach of the Sava river extended from the river source to the boundary hydrological cross-section with Croatia. Two line transect samples per gravel bar were taken from 11 sites and one bulk sample per gravel bar from 7 sites. Characteristic grains (such as d_{10}, d_{20}, up to 90-percent grain – d_{90}) were determined from the grain size distributions for both sampling methods, respectively. The arithmetic mean grain dm was determined with the integration of the grain size distribution curve. Characteristic grains d_{16} and d_{84} were used for the calculation of the geometric sorting index.

According to the results of the Sava river gravel bar samplings between 1952 and 1976 it was established that the bed-load arithmetic mean grain in the stretch between its source and Zagreb (Croatia) was of quite a uniform size of around 30 mm. The results of 2006 gravel bar sampling show a decrease of the arithmetic mean grain size, which is also more variable along the stream channel. The grain sorting has become lower. It should be noted that the sample weights of the older samplings were up to 4 times greater than those from the 2006 sampling. The latest Sava river sampling offers the grain size distribution data about the gravel bar surface layer, which were not traced in the previous research works. The analysis has shown that the arithmetic mean grain of the surface layer is on average approximatelly 1.6-times larger that that of the subsurface layer.

Keywords: gravel bar, line transect samples, bulk samples, Sava River, grain size distribution, characteristic grains.

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RESPONSE OF CONSERVATION MEASURES FROM SMALL CULTIVATED WATERSHEDS, CONCERNING RUNOFF AND EROSION, UNDER THE IMPACT OF EXTREME RAINFALL EVENTS

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The study has been made in a representative small watershed with gently to hilly slopes from Tutova Rolling Hills, Romania. The system of conservation measures is represented by stripcroping, bufferstrips, bench terraces, a grassed waterway and a drainage network. Concerning land use types, 17 ha are designated to grazing and 100ha to cropping.
The monitoring of hydrological response of agricultural units has been made in two cross section corresponding to each of the land use type by means of two concrete triangular weirs. An automatic weather station registered the main climatic parameters influencing hydrological and erozional processes.
The most important soil losses were caused by three extreme rainfall events from August 29, 2004 (76.3 mm), May 07, 2005 (53.5 mm) and September 05, 2007 (88.5 mm).
At the date of the first rainfall event, generally, the soil was very well protected against erosion by the vegetative cover, excepting parcels that were just ploughed after the mash crop. In that case, it was estimated that the values of soil losses ranged between 20.0 and 24.5 t/ha while for the other crops like corn and soybean, soil losses they were 1.0-1.5 t/ha and 0.5-0.8 t/ha respectively.
Maximum values of runoff were 4.14 m3/s for the cultivated land and 2.81 m3/s for the grazing land. It was calculated that through cross section corresponding to the cultivated land run about 9100 m3 of water that represent cca. 12% from the total precipitation.
Damages caused by the rain from September 2007 were much more important because at that time about 30% from the entire surface was just prepared for rape seeding. Maximum value of erosion was 95 t/ha on a parcel with 16% slope and 50m length along the slope. Net erosion for the entire watershed was estimated to 22 t/ha. Runoff through the main cross section has a maximum of 6.25 m3/s and the surface drainage network discharged about 13000 m3 of water. They were the highest values registered in Gheltag basin since it was monitored.
A very important role has the intercropping system because the alternation of strips with high density of plants by strips without vegetative cover produced a dispersion of flows and a significant diminution of soil losses.
It can be concluded that much as professionally realized, soil conservation measures can be affected in different degrees by erosion if the rainfalls go beyond the limits took into account in designing activity. However, on places where conservation practices were applied, soil losses caused by the extreme rainfall events were about three times more reduced than those from the parcels disposed up-and-down the hill. Alternating crops, contouring system, stripcrops system, and generally, all conservation practices from agricultural land play more and more important roll in controlling runoff and erosion because rainfalls are already much more aggressive due to changing climate.

Keywords: runoff, soil losses, grassed waterway, stripcroping, bench terraces.

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MODEL BASED ESTIMATION OF SEDIMENT EROSION IN GROYNE FIELDS ALONG THE RIVER ELBE

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Environmental issue of river water quality is still a vital environmental issue, even though ongoing emissions of contaminants are being reduced in several European rivers. Resuspension of contaminated sediments impacts the water quality and thus, it is important for river engineering and ecological rehabilitation. The erodibility of the sediments and associated contaminants is difficult to predict due to complex time depended physical, chemical, and biological processes, as well as due to the lack of information (Gerbersdorf et al., 2005). Therefore, in engineering practice the values for erosion parameters are usually assumed to be constant despite their high spatial and temporal variability, which leads to their large uncertainty.

The goal of the presented study is to compare a conservative approach assuming constant critical erosion shear stress (see Mehta, 1988) and an innovative statistical approach which takes the critical erosion shear stress as a random variable. Furthermore, a quantification of an effective value of the critical erosion shear stress and its applicability in numerical models are estimated as well.

The results presented here are based on field measurements and numerical modelling of the groyne fields of the river Elbe. During two years measuring campaign, undisturbed sediment cores were taken in three different groyne fields of the River Elbe. Depth orientated critical erosion shear stress was measured using the SETEG-System (Kern et al., 1999). The measured data showed high spatial and temporal variability. Therefore, it was very difficult to assign the effective value of the critical erosion shear stress, which represents each groyne field in a river section and has to be used in numerical models.

Based on a theoretical distribution of the measured data, random values of the critical erosion shear stress were generated for each groyne filed in a simulated domain of the 112 km long reach of the Elbe. The numerical simulations were performed by a 1D multi-strip model, which predicts suspended sediment transport in rivers trained by groynes (Prohaska & Westrich, 2006). The statistical approach, which treats the critical erosion shear stress as random variable, was compared to the deterministic conservative approach, which assumes that erosion can be estimated by using a mean constant value of the critical erosion shear stress. The suggested statistical method applies, in an indirect way, the erosion progression in time, where deeper layers with different value of the parameter can be exposed to flow. The analysis gave the effective value of the critical erosion shear stress to be smaller compared to the mean measured value. Therefore, the results showed that the conservative method for determining erosion lead to underestimates of groyne field erosion.

Keywords: groyne field, critical erosion shear stress, field data, numerical modelling, River Elbe, sediment.

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FOREST-BELT IN THE BANAT PLAIN FOR ENVIRONMENTAL PROTECTION

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This paper established the tendency of environmental dryness and desertification of Aranca Plain, on the climate, vegetation and ground water level and soil data bases.
Are proposed forest-belt, the position and the type of belts, making a case study on Beba-Veche territory.
The climate change and the degradation land phenomena due to the human activities are in present a certainty. Differences appear only in environmental degradation phenomena concerning their size and extension.
For this paper we used the dates regarding the climate (weather stations), hydrology and hydrogeology (Apele Romane), forest vegetation (Directia Silvica Timis), soil (OSPA Timis and the personal investigations). The real study for the forest-belts depends on the stationary investigations.

Keywords: forest belt, environmental, degradation, groundwater.

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ASSESSMENT OF THE BALANCE AND MANAGEMENT OF SEDIMENTS OF THE DANUBE

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The paper attempts to analyse the quantitative balance of sediment (historical and current situation) in the Danube with a special focus on the extraction of sediment for the maintenance of waterways and commercial dredging as well as the retention in impoundments of hydropower plants. It includes an analysis of the water tables and their development in the river, and a description of the most important impacts on the hydromorphological system of analysed stretches highlighting the importance of sustainable management of sediments in order to preserve and improve the hydromorphological situation.
The main consequences of dredging and river regulation include hydromorphological degradation and channel incision followed by lowered water tables and reduced flood frequency in the floodplain. The massive reduction of morphological dynamics (i.e. fixation of river banks) can also increase the fine-sediment aggradation on banks and floodplains during floods. Furthermore, erosion downstream from hydropower dams leads to sediment accumulation further downstream and associated reduction in the average water depth, which hampers navigation and therefore necessitates additional dredging.
Calculation of the historical sediment balance for the Danube based on the existing quantitative data is very difficult. The existing data covers only the last 50 years and the sampling methods differ across the countries.
Using figures from the 1960s, the average sediment transport in Vienna would be about 8-10 million tons per year (t/yr) (including 1-2 million tons of gravel bed load), and about 52 million t/yr would reach the Danube Delta (99% of this amount is suspended load), e.g. Bondar et al. 2000.
Today the transport of bed load is almost completely blocked in the impounded river stretches in the upper catchment, and the suspended load in the Danube Delta is reduced to about 30 Million t/yr. Along the upper Danube stretches the suspended load is not as strongly influenced because the majority of the material can pass the dams during floods.
Channel incision has several causes, the most significant being the extensive river regulation since the 18th century, which included river shortening and straightening. Apart from some local stretches where accumulation still occurs (mostly resulting from extensively eroded stretches upstream), most of the Danube has serious riverbed degradation problems due to incision. The annual incision rate based on the low water level is estimated at 1-4 cm per year, e.g. Schmautz et al. 2000. The rate of incision is particularly high downstream from dams in free-flowing stretches, within stretches having enhanced dredging activities and downstream of strongly regulated stretches. Incision is not only a problem in gravel rivers, but also in river basins with fine alluvial sediment.
The article further illustrates the adverse riverbed erosion effects after dredging. Dredging has local and immediate effects (both spatially and temporally) as well as far-reaching and long-lasting impacts. Some effects are irreversible. These effects can be seen in particular when the amount of dredged material exceeds the average natural transport capacity.
The amount of dredged material varies for each country and time period, and is difficult to compare. For some stretches, the amount of dredged material has exceeded the recent (and even the potential) annual bed load transport by several times, causing long-lasting consequences for the sediment balance. For example, within the SK-HU stretch, both countries dredged excessively between 1970 and 1992, e.g. Rákóczi, 2000. During this time, between 60 and 65 million tons of sediment were excavated, an amount which exceeds the sediment transport capacity by many times (bed load is here between 100-250,000 t/yr).

Keywords: sediment balance, sediment extraction, channel incision, hydromorphology.

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FLOOD RISK AND FLOOD HAZARD MAPS - VISUALIZATION OF HYDROLOGICAL RISKS

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Hydrological models are an important basis of flood forecasting and early warning systems. They provide significant data of the hydrological risk. In combination with other modelling techniques, such as hydrodynamic models, they can be used to assess the extent and impacts of hydrological events. The new European Flood Directive (Directive of the European Parliament and of the Council on the assessment and management of flood risks) forces all member states to evaluate flood risk on a catchment scale, compile maps of flood hazard and flood risk for prone areas and inform on a local level about these risks.
Flood hazard and flood risk maps are important tools to communicate flood risk to different target groups. They provide compiled information events to relevant public bodies like water management authorities, municipalities or disaster control staffs, but also the broad public. For almost each section of a river basin run-off and water levels can be defined based on the likelihood of annual reoccurrence, using a combination of hydrological and hydrodynamic models, or based on historical records and mappings. In combination with data of the vulnerability of a region risk maps can be derived.
The project RISKCATCH, funded under the CRUE ERA-NET initiative by the German Federal Ministry of Education and Research and the French Ministry of Ecology and Sustainable Development, addresses the issue of hydrological risks and vulnerability assessment in the focus of the flood risk management process. Flood hazard maps and flood risk maps were compiled by Austrian and German partners at test sites in these two countries regarding existing national and international guidelines and evaluated by the French partner within the so called “experimental graphic semiology”. The experimental graphic semiology is a method to record the eye movement of a person watching a map. It provides information how the test person is parsing and reading the map. A questionnaire asking for negative and positive aspects and complexity of each single map completes the experimental graphic semiology and is necessary to understand the occurring difficulties and problems test persons had interpreting the maps.
The results indicate how this type of maps can be improved to fit the needs of different user groups like spatial and urban planning, water resources and disaster management. Especially colours, forms, size, positioning of the legend and explaining remarks as well as the density of information were in the main focus of the analysis and were approved for each single user group. As an outcome recommendations are developed to water management authorities how to derive maps from hydrological and hydrodynamic model results and provide information about hydrological risks.

Keywords: flood risk, flood hazard, risk management, visualisation, flood risk map, flood hazard map, flood directive.

PROTECTION OF SKI TRAILS IN WINTER-TOURIST CENTRES AGAINST EROSION

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The development of tourism in mountainous regions without planning from the aspect of erosion control, results in the negative consequences. During the last several years, on the territory of Serbia, several new ski centres have been launched: on the mountains Šara, Zlatibor, Divčibare. To create the space for the formation of new ski runs, the forests are excessively felled and the meadows are destroyed. By removing the vegetation, the soil remains unprotected and such changes lead to the development of erosion processes. The consequences of deforestation are especially visible during the summer period.

On the existing ski trails, the soil infiltration capacity is considerably reduced, which causes the increase of runoff. The normal runoff process also destroys the packed snow on the trails. Without adequate erosion control and maintenance, the trails could be ruined in a short period.

For this reason, it is necessary to undertake technical, bioengineering and biological erosion control works in these regions.

Keywords: erosion, ski trails, bioengineering and biological works.

FLOOD HAZARD MAPPING IN BADEN-WÜRTTEMBERG WITH REGARD TO THE EU WATER FRAMEWORK DIRECTIVE

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This paper gives an overview of the current situation of the flood hazard mapping and the planned implementation of the EU-Flood Risk Management Directive (FRMD) in the federal state of Baden-Württemberg.
Flood hazard mapping in Baden-Württemberg is already geared to the catchments and management units asked for in the Article 4 of the FRMD.
According to the FRMD the following working steps have to be borne in mind and implemented:
- Preliminary assessment of flood risk (end of 2011)
- Mapping of flood hazards and risks (end of 2013)
- Development of flood risk management plans (end of 2015)

In course of the survey and the demand analysis for the flood hazard mapping catchments have been identified. A very high potential flood risk is expected in those catchments. Flood hazard maps for the relevant water bodies of the federal state (summing up to about 12,300 km) should be available till 2010. In relation to Article 13 Paragraph 1b of the FRMD the working step preliminary assessment most likely can be dropped besides the arrangements with riparian states and the verbal risk evaluation.
The flood hazard maps have to be supplemented by the following themes to become flood risk maps: the indicative Number of inhabitants potentially affected, type of economic activity of the area potentially affected, pollution prevention and potentially affected protected area, information which the Member States. The country-wide methodology and standards in doing so are intended to be developed within EU-Projects. As an example of risk assessments there are examples of the River Rhine and Danube, those are intended to be used as basis. The not yet included statistical, cartographic and technical requirements of Article 11 of the FRMD have also to be kept in mind.
The description of planned measures as well as rankings is the crucial element of the flood risk management plans (FRMP). The definition of planned measures includes technical flood protection, measures of flood prevention respectively area prevention. Consequently those experiences of the flood protection strategy of the federal state of Baden-Württemberg can be adopted. Still open are the questions of how to consider cost-benefit-aspects or disadvantageous effects on environment, humanity or cultural heritage. For public hearing processes but also for information provision it is intended to stick to the ways used for the hazard mapping, however by extending and intensifying those ways.
For Baden-Württemberg it's intended to build on the experience and results achieved from the flood hazard mapping. Therefore operational procedures have to be described in detail and worked out centrally, if applicable. At first this procedure is more complex however more feasible for the periodic updating afterwards. All work will be done with existing institutions such as: Ministry of the Interior, Ministry of Commerce, Ministry of the Environment and municipal unions, regional unions and the Chamber of Commerce and Industry. Technical assistance is provided by the Landesanstalt Umwelt, Boden und Wasserwirtschaft (LUBW), the Regional District Offices (Regierungspräsidien) and Rural District Offices (Landratsämter). It's quite likely that the risk management plans have to undergo a strategic environmental audit. Additionally the plans might be checked for accordance with the Water Framework Directive.

More information is available:
http://www.hochwasseronline.de
http://www.hochwasser.baden-wuerttemberg.de
http://www.hochwasser.baden-wuerttemberg.de/servlet/is/1253/Floz_Hazard_Maps.pdf
http://www.hochwasser.baden-wuerttemberg.de/servlet/is/1253/HWGK_Leitfaden_ENG.pdf

THE INFLUENCES OF THE EXTREME HYDROLOGICAL REGIME PHASES UPON THE ALLUVIAL TRANSIT IN THE ROMANIAN SECTOR OF THE DANUBE

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The paper provides a comparative analysis between the sediment discharges during the flood periods and the sediment discharges during hydrological droughts over the last two decades in the romanian section of the Danube, including the repartition ratio of this hydrological parametre for the river`s three main branches.
The analysis also makes refferences to the the solid contribution of the Danube`s most important tributaries from the romanian territory during these extreme phases of hydrological regime as well as an evaluation of the type and predominance carried out by the transported sediments.

Keywords: sediment discharge, floods, hydrological drought, the Danube.

VARIABILITY OF BED SEDIMENTS IN CHANNEL NETWORK OF RYE ISLAND (SLOVAKIA)

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Aim of the paper was to evaluate the changes of bed silt state of the Rye Island channel network in the period from 1993 to 2004.
The Rye Island is part of the Danube Lowland, it is area between the two branches of the Danube river - the Danube and the Small Danube. These two branches of the Danube flow separately approximately 100 km and then join each other again near the town Komárno. The average width of Rye Island is 20 km; its area is approximately 2000 km2. Rye Island is the result of sedimentation of the Danube River, with sediments from upstream mountains (Alps) being spread over its territory. Sedimentation of transported materials has created thick layers of gravel, with a tendency to elevate the river bed. The creation of river branches, which flow according to the Danube River water level, is another aspect of the sedimentation process. During previous centuries (up to the 19th century), the river branched into multiple streams and frequently changed course within its own alluvial sediments. At present, the process of river migration has stopped or is being controlled.
Measurements of bed silt thickness in Rye Island channel network were done in 1993 at the channels: Aszód, Gabčíkovo-Topoľníky, Aszód-Čergov, Čergov-Komárno, Čalovo-Holiare-Kosihy. Then in 2004 were done measurements at selected profiles of Aszód, Gabčíkovo-Topoľníky and Komárňanský channel for checking of the silting up variability. According to results of measurements at the three selected channels we can say that at the beginning parts of channels the silt thickness are nearly without changes. In the middle parts we observed luxuriant water vegetation. The silt thickness increased in Komárňanský channel and slightly in Gabčíkovo-Topoľníky, too. In the ending parts of channels Aszod and Gabčíkovo-Topoľníky silts has been increased in the monitored period, in the case of Komárňanský channel there was observed only moderate increase of silts. The silts from middle and ending part of Gabčíkovo-Topoľníky channel included large content of organic mass. Generally, we can say that the channel silting up has not been changed considerably in monitored period.
The observed facts could be useful for channels maintenance, as a base for expectation of silting up process in the channels. Also the knowledge about silt thickness in the channels is important from the view of interaction between channel network and groundwater, especially when this information would be supplemented by characteristics of silt permeability. So the other aim of field measurements was determination of hydraulic conductivity. Their values were calculated by empirical formulas. These characteristics will be used for simulation of interaction between channel network and groundwater at the Rye Island area in the oncoming period.

Keywords: channel network, Rye Island, aggradation, silt thickness, permeability of silts.

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GEO-HYDRO-MORPHOLOGY OF THE UPPER PRUT

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There exists a certain similarity within the processes of the current self-organization and its hydro-morphological parameters in different geographical and geophysical conditions. Correspondingly, the concept “hydro-morphology” should contain more phenomena and be considered in a broader sense. To denote this new interpretation, we suggest introduction of a term “geo-hydro-morphology”. Hence, the analysis of channel formation factors hierarchical system was conducted within the frame of this term, as well as that of major hydro-morphological correlation and manifestations, which allowed for clearer outlining of the rivers’ basic specific character. As regards the river beds overflow capacities and their alluvial environment level of development, the channels can be divided into three groups: structural, structural-alluvial and alluvial. The said groups in its turn are subdivided into classes (e.g., the alluvial river channels include large-alluvial, sand and sub-sand classes). The classes are subdivided into sub-classes, and the study of channel types starts with the latter.

The suggested geo-hydro-morphological classification deepens the notion of the typology. However, the reality presents a wide diversity of the details. This is why it seems very important that the description and the monitoring of river channels and flood-plains condition in different regions be continuously kept. With this purpose, the river evolutions along the current are to be considered, where their characteristic and homogeneous sections would be outlined and described. It is the homogeneous sections that should be the basic object of study. The channel formation is considered hierarchically, i.e., from the grouped sections towards their inner structure.

The rivers (and river systems, as accords with the basin approach) hydro-morphological condition description and analysis are envisaged by the EU Water Framework Directive 2000/60/EC. The evolutions along the river current seem to be the most natural way of description. Actually, it undermines the channel and the flood-plain monitoring, as well as the accumulation of hydro-morphological information.

The geo-hydro-morphological analysis of the channels and the flood-plains development regularities deals with the tasks similar to the above. In particular, it is applied to the study of the Prut river upper current, the latter being the central component of the “Upper Prut Euro-Region” and the river being among the largest ones in the Eastern Carpathians. The current section from the river beginning to the Moldovian border has been put under analysis.

The channel within the whole said section contains boulders, pebble and gravel, i.e., is large-alluvial. The section includes two characteristic plots, namely, the mountain and semi-mountain. The borderline between the plots is somewhat difficult to be delimited because of availability of additional creases and significant peaks beside the mountains. The channel and the flood-plain homogeneous sections are outlined with consideration of the following parameters-attributes: lengthwise inclines of the channel formation and the flood-plain strips; the valley bottom width; the channel dominant elements morphology peculiarities. 16 plots are outlined in the mountain part of the current, as well as the same quantity in its semi-mountain area. The general trend of the channel formation evolution along its current can be described as a transition from the rapids and the falls towards the plots of highly developed alluvial forms and the particles’ lowered coarseness. At the same time, the general evolution is not monotonous, being transgressed by certain deviations that can be subdivided into sub-evolutions that include two or more regularly connected channel plots. Each studied plot is described and classified.

The study also includes the analysis of the history and the major types of anthropogenic influence upon the Upper Prut channel, as well as the questions of the river development referential and anthropogenic premises.

The present study was conducted with no sufficient financial support. It therefore seems important that it was included into international study projects.

RESPONSE OF SOIL EROSION TO LAND USE CHANGE WITH PARTICULAR REFERENCE TO THE LAST 200 YEARS (JULIAN ALPS, WESTERN SLOVENIA)

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The changes in erosion in the Upper Soča Valley (Julian Alps, western Slovenia) during the last two centuries are discussed in the paper. The calculation of the erosion was made by a model in which land use was employed as one of the principal factors. Selected was the empirical Gavrilović equation (Gavrilović, 1962) partly modified by Lazarević (1985). The erosion was calculated for five terms, i.e. for the years 1827, 1896, 1953, 1979 and 1999. On this basis it was possible to establish the changes in erosion process as the consequence of land use change in the last 200 years. The data on land use for the year 1827 were obtained on the basis of Franziscean cadastre. The data were taken from the written part of Franziscean cadastre, separately for each cadastral municipality. The data for the year 1896 are based on the cadaster revision. In order to establish land use changes after the Second World War, we likewise used the data from the land cadastre, aggregated on the level of cadastral municipalities for the years 1953, 1979 and 1999. Because of the uniform and only slightly changed methodology of collecting data employed since the first established stable (Franziscean) cadastre in the first half of the 19th century, the data on land use from the land register is a very suitable source, primarily for establishing changes in land use over longer periods and for larger spatial units (i.e. from several 10 to several 100 km2), in spite of its otherwise lagging behind the actual situation (Petek, 2005). The calculations were done in the form of raster with the basic cell size of 25 x 25 metres, by means of Idrisi program package. The calculations were done on the level of cadastral municipalities.
Between 1827 and 1900, changes in land use in the Slovenian Alps were minimal. Between 1900 and 1953, selective limitation of cultivated fields to only the most favourable land began; overgrowing with grass dominated during this period. Between 1953 and 2000, changes in land use were the greatest, with the prevailing afforestation (Petek, 2005).
The total annual erosion in the study area amounted to 4.76 million m3 in 1827, and it was approximately the same also in 1999. In the meantime erosion increased and reached 5.72 million m3 in 1953, with presumed maximum during 1920's. In 1827, the specific erosion amounted to 133.4 tons/hectare/year, in 1999 it was 135.5 tons/hectare/year, and in the meantime, in 1953, it reached 160.3 tons/hectare/year.
The paper shows that historical sources on land use are very useful for establishing the changes in erosion, if a proper model is employed. Geomorphic response to land use is non-linear: a small change in the percentage of arable land results in relatively big changes in erosion risk and sediment delivery (Van Rompaey et al., 2003).

Keywords: erosion, erosion modelling, Gavrilović equation, land use, land use changes, Alps, Slovenia.

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INTERRILL SOIL EROSION ON FLYSCH SOIL UNDER DIFFERENT LAND USE IN SLOVENE ISTRIA

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"Little research has been done on soil erosion in Slovenia" says the evaluation of the implementation of the United Nations Convention to Combat Desertification in Slovenia (2005). In April 2005 the researchers at the Anton-Melik Geographical Institute of the Scientific Research Centre of the Slovenian Academy of Sciences and Arts and of the Faculty of Civil Engineering, University of Ljubljana began with measurements of interrill soil erosion near the Marezige village in the Dragonja river basin.

Eight 1-m2 erosion plots were set up on locations with different land use types: on bare soil in a young olive grove (2), in an overgrown meadow (2) and in the forest (4). Surface runoff from each of the erosion plots was collected in small reservoirs. As a rule, the samples from the reservoirs were taken weekly. The samples were dried in the laboratory, where the concentration of undissolved particles was determined. A tipping bucket rain gauge was located next to the erosion plots for monitoring of precipitation and intensity of erosive events (Zorn, 2007a).

The results show that few major erosive events are responsible for the greater part of the eroded soil. Interrill soil erosion in the first year (May 2005–April 2006) was estimated at 90.1 t/ha on bare soil with a slope of 5.5°, and 118.2 t/ha in the second year (August 2006–July 2007), despite the lower cumulative rainfall amount (Zorn and Petan, 2007).

The annual denudation rate of 1 cm due to soil erosion was in Slovenia rarely mentioned in the past. Mikoš and Zupanc (2000) stated that on average 5–10 mm of "fertile soil, or even more in severe conditions" are lost in Slovenia every year due to soil erosion. These values were considered high in the past (Komac and Zorn, 2005). However, our measurement data show that these values are rather common (Zorn, 2007b): the bare soil surface in an olive grove is lowered by 9–11 mm per year. It needs to be mentioned that only interrill soil erosion was measured, but not total (rill and interrill) soil erosion. The estimation of lower erosion rates in the past could be assigned to the fact that the measurements were rare; the data were based on empirical equations, which strongly underestimate the actual soil erosion.

The research also highlighted the importance of vegetation in the battle against soil erosion (for example, leafy canopies reduce the rainfall intensity).

Keywords: pedogeography, pedology, geomorphic processes, interrill soil erosion, flysch, Dragonja river basin, Istria, Slovenia.

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Topic 6: DEVELOPMENTS IN HYDROLOGY

SPATIAL INTERPOLATION OF HYDROLOGIC SERIES BY ARTIFICIAL NEURAL NETWORK

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The paper presents performance results of modelling procedure for generating synthetic flows at one month time scale. A sequentially adaptive Radial Basis Function network as a type of Artificial Neural Networks was applied for the purpose. Sequential adaptation of parameters and structure were achieved using the extended Kalman filter. A criterion for network growth was obtained from the Kalman's filter consistency test. A selection of river profiles for flow simulations was made among small and medium area basins within observation system of Republic Hydro-meteorological Service of Serbia. In addition to mean monthly flows at observation stations, mean monthly air temperature and monthly sum of precipitation were used as variable input data. Basin area was indirectly employed as basin physiographic characteristic, while mean basin altitude was used in the testing-training set decision making step. The vegetation indicator was percentage of forested area. The sets of testing and training basins were decided upon input data ranges of variables. There were fifteen artificial neural network training basins. There were three variants of networks applied, depending on input data sets and number of network training cycles. For eight river basins from the testing set, used as ungauged basins, the analysis of the attained accuracy of the synthetic runoff modulus series compared to the observed ones, was measured by root mean standard error and shown as graph for two best and two worst simulation results. In addition, simulation results are shown for a test basin in an earlier research (Blagojevic, Trajkovic (2006)). It is clear that some improvements of simulation have been made.
In order to further improve achieved simulation results accuracy, recommendations for future work have been made regarding input data check, combination of input variables and basin characteristics, and performance of two tier simulation.

Keywords: Artificial Neural Network, Monthly flows, Ungauged basins.

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HYDROLOGICAL AND HYDROTECHNIC STUDY PROVIDING AN OVERALL SOLUTION AND CALCULATIONS FOR THE GREATER AREA OF LOCAL DETAILED PLAN ZAPOGE 1 (SLOVENIA)

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The purpose of this study was to analyse flood safety of a future residential settlement planned in the area of the village of Zapoge, which is covered by the local detailed plan Zapoge 1, under planning zone ŠS 14/7. In this area there are no visible traces of surface flow, because the rain water infiltrates in a nearby sinkhole, at the south end of the village of Zapoge. Sometimes, during heavy rain, the water flows on the surface and floods the grasslands nearby. Records show that this happened at least in 1990 and 2005.
First, the catchment area of the valley was defined, as well as the course of the runoff. This was made using the Digital Relief Model. Afterwards, surface runoff was modelled using HEC, covering each part of the catchment area. Prior to modelling, the probability calculus for station Brnik – Airport was ordered at the Environmental Agency of the Republic of Slovenia. On the basis of rainfall probability calculus and the model the amount of surface runoff with several recurrence periods was calculated. In the field, infiltration in ten sites of different soil types was also measured. For the purpose of defining flood safety the longitudinal profile and critical transversal profile were recorded using levelling measurements and GPS. Based on the results we proposed measures to assure flood safety of the future settlement.

RIVER ICE INSPECTION AND ICE COVER ESTIMATION BY WEBCAMERAS

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Webcameras enables inspection of river sections anytime from anywhere. Manual and analogue photo processing of ice on Danube @ Baja, Hu. roots back 35 years. Processing webcamera collected visual data over the past few years initiated further development of earlier civil engineering based pattern recognition, camera calibration and ice cover rate estimation, all described for educational and professional purposes in details to follow. Camera calibration and processing ice data take advantage of planar surface of investigation. Simple ideas on arhiving and postprocessing for simulation are also considered. Both short historical retrospect and descriptive basic linear algebra relations are presented. The review of a patented new calibration idea and pattern recognition to explore further is illustrated in demonstration on pictures taken on Danube's river section Baja, Hungary.

Keywords: webcamera, digital photogrammetry, camera calibration, river ice, cover rate, velocimetry, simulation.

EDUCATE!: AN INTERNATIONAL E-LEARNING POSTGRADUATE COURSE IN WATER RESOURCES AND ENVIRONMENTAL MANAGEMENT

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E-Learning has been attracting, over the past decades, a lot of interest from different stakeholders within the education and training sectors. It appears however that a new level of seriousness in understanding and exploiting its particular strengths is required. The aim of this work is to present and discuss the EDUCATE! project and postgraduate course in Water Resources and Environmental Management, a multi-institution, e-learning programme. The current work attempts to suggest a roadmap for collaboration in Higher Education, within the context of e-learning in the South Eastern Europe and the Balkan Region (Makropoulos et al, 2008).

The rapid development of environmental education in Europe has largely bypassed the countries in South East Europe and the Western Balkans despite the fact that the region has been subjected to unprecedented pressures over the years. Enormous effort to remedy the situation is needed but the capacity of the region to undertake this work is limited by the lack of trained professionals with the knowledge and transnational perspective required. The Educate! project will attempt to reverse the flow of trained professionals leaving the region and increase the capacity to deal with issues of integrated water resources management, rather than relying exclusively on external expertise. The EDUCATE! consortium, formed between five Engineering Schools coming from four leading national academic institutions, aims at shaping future policy makers from highly trained individuals. The overall objective of the EDUCATE! postgraduate course is to assist the regional transnational cooperation on Water Resources and Environmental Management and to contribute in addressing cross-boundary environmental problems in the Balkans. In a broader aspect the project aims to contribute to the social and regional cohesion, forming the basis for long-term collaboration and acting as a bonding mechanism not only within the region, but also between the region and the members of the EU. The main innovative element of the postgraduate course relates to its e-learning component. The course is delivered to the students through a set of pilot easy-to-use, flexible e-learning support tools, integrated in a Moodle web-based platform provided under an open source licence. The design of an e-learning course requires an evaluation phase as early as possible in the process (Laurillard, 2002). The EDUCATE! postgraduate course is currently run for its first year as *a pilot*, funded by the INTERREG III CADSES EU Programme. During the course design phase a series of decisions were taken in terms of objectives, activities and modes of delivery. These decisions need to be tested, both in terms of mode of delivery and in terms of learning. It is suggested that the question that needs answering in this context is whether the specific design of the learning activities facilitates the achievement of the learning objectives (Makropoulos et al., 2008). Teaching staff are actively involved in a constant re-assessment process in order to make necessary changes and adaptations. Most importantly, students are taking an active part in shaping the course and customising content and delivery modes.

Keywords: e-learning, environmental management, computer-based education, water resources

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RELIABLE OBSERVATION METHODS OF DRIFTING FLOES

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The importance of scientific work in the field of flowing ice based on extrame icefloods. At the investigated reach of Danube the most dangerous floods were almost all icy. This used to be so for two main reasons, out of which one is a hydro-meteorological, the other is a morphological factor. River training works on the reach have been completed, only maintenance and small corrections are being done. In spite of the process of global warming, that can be concluded analyzing the past few decades data, an unfortunate constellation of hydro-meteorological factors can anytime cause serious frosts, and, consequently, ice floods. In our study we statistically analyzed the past hundred years' data series of the reach in question. The results proved the existence of a 35-years long, almost iceless period, that we investigated the reasons for. Because of the above-mentioned rare occurence of ice phenomena, the observation and study of these processes also deteriorated. It is a big luck that Hungarian experts have dealt a lot with past ice phenomena up to 1970. Starting out from literal data and ideas, our investigations and new observations can be massively based. The newest computer technology features are now used for ice observations near town Baja. A webcamera was installed for a properly tall place on the bank of Danube from where the river can be observed. A place 40-50 m above the river is a sufficient altitude to eliminate the error of perspective view. During icy periods of the river many movies were made about the floes. These movies could be investigated by PIV (Partical Image Velocimetry) method and even discharge data could be derived out of them. Our goal was to find an exact method for determining ice coverage too. Therefore new ideas were studied to solve this task as well. With the help of linear algebra and methodes used in computer games seem to be a solution for postprocessing ice simulation. Since 2001 useful experiences were gained in computer-aided ice observation. In our presentation we would like to give an overall impression about current issues of Ice observation in Hungary. Our results were good enough to continue and develop the measuring system. By the end of march 2008 five section of the southern Hungarian Danube reach will be observed such a way.

FLOOD WARNING LEVEL FORECASTING FOR UNGAUGED CATCHMENTS BY MEANS OF A COMBINED API-STORAGE CONCEPT

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Flood forecasting with sparse data availability is still a great challenge to hydrologists. But preevent information about the probability of high floods occurrence increases the prevention potential and thus the remaining risk due to flood damages. For preventive measures the knowledge of the expected dimension of the flood peak is of major importance for security and warning services. In this paper contribution the authors want to introduce the concept of the Antecedent Precipitation Index (API) as a possible variable to estimate runoff warning classes. To consider time and state dependant rainfall losses a spatially distributed linear storage concept was applied to intercept the actual rainfall.
The traditional concept of the API refers to precipitation on daily basis. It describes the declining impact of past precipitation in time (Linsley et al., 1958). The API can be interpreted as a kind of runoff disposition in the catchment. With a higher temporal resolution of available precipitation data also the API has to be adapted to a higher hourly resolution as the runoff disposition changes with every precipitation element.
The aim of the study was (a) to define API warning classes which correspond to runoff warning classes at a certain runoff gauge and (b) apply the method to ungauged basins. Runoff losses were considered by a linear storage reservoir. The depletion of the reservoir, which corresponds to factors like basin size, hydrogeology or soil moisture redistribution, was described by a retention factor. Only the precipitation excess of the storage contributes to the API computation. The storage parameters like maximum capacity and retention constant as well as the API coefficient were optimized until the best statistical accordance between the API function and the observed hydrograph was achieved (Holzmann & Lehmann, 2007). As the evaluation criteria we used the correlation coefficient.
The calibration method was applied to several flood events at observed gauges within the district of Lower Austria and lead to a set of optimized parameters. Subsequently a 15 years time series of the API by using the storage model was created and the annual maxima derived. By using the Gumbel distribution the computed 1, 5 and 30 years extremes were deduced and compared to the 1, 5 and 30 years flood gained by extreme value statistics of observed data. The calculated flood events had the tendency to underestimate the smaller flood frequencies where the extreme flood classes could be reliably performed. The key parameters for the gauged basins were spatially interpolated by means of geostatistical Kriging. This enabled the applicability of the introduced techniques for ungauged small basins in lower Austria.

Keywords: API, flood forecasting, ungauged catchments, warning classes.

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WATERNET: THE NASA WATER CYCLE SOLUTIONS NETWORK - DANUBIAN REGIONAL APPLICATIONS

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WaterNet is a new international network of researchers, stakeholders, and end-users of remote sensing tools that will benefit the water resources management community. This paper provides an overview and it discusses the concept of solutions networks focusing on the WaterNet. It invites Danubian research and applications teams to join our WaterNet network. The NASA Water cycle Solutions Network's goal is to improve and optimize the sustained ability of water cycle researchers, stakeholders, organizations and networks to interact, identify, harness, and extend NASA research results to augment decision support tools and meet national needs. Our team will develop WaterNet by engaging relevant NASA water cycle research resources and community-of-practice organizations, to develop what we term an "actionable database" that can be used to communicate and connect NASA Water cycle research Results (NWRs) towards the improvement of water-related Decision Support Tools (DSTs). Recognizing that the European Commission and European Space Agency have also developed many related Water Research products (EWRs), we seek to learn about these and network with the EU teams to include their information in the WaterNet actionable data base. An actionable database includes enough sufficient knowledge about its nodes and their heritage so that connections between these nodes are identifiable and robust. Recognizing the many existing highly valuable water-related science and application networks in the US and EU, we will focus the balance of our efforts on enabling their interoperability in a solutions network context. We will initially focus on identification, collection, and analysis of the two end points, these being the NWRs and EWRs research products and water related DSTs. We will then develop strategies to connect these two end points via innovative communication strategies, improved user access to NASA and EU - Danubian resources, improved water cycle research community appreciation for user requirements, improved policymaker, management and stakeholder knowledge of research and application products, and improved identification of pathways for progress. Finally, we will develop relevant benchmarking and metrics, to understand the network's characteristics, to optimize its performance, and to establish sustainability.

Established partnerships represent a cross-section of individual and networked NWRs and DSTs from government, private, and academic domains, that will enable us to quickly complete an operational solutions network, entrain more partner nodes and networks, and move WaterNet toward self-sustainability. EU projects like AWARE, and the flood and drought forecasting research efforts, and GMES projects are potential projects that may directly benefit from this WaterNet networking.

Specific goals and objectives, methods of communication, and invitation to join the WaterNet will be discussed. Examples of NASA products from the MODIS, TERRA AQUA, and other satellites and Land Surface Model results over the Danubian countries will be presented that show potential value added to water resource management in the region. Examples of snow water equivalent, soil moisture, surface temperature, runoff estimates will be shown from the Global Land Data Assimilation System (GLDAS) and its Land Surface Models (LSM).

Keywords: networking, land surface models, remote sensing, hydrologic modelling, mesoscale modeling.

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MODEL OF RUNOFF DETERMINATION ON HYDROLOGICALY UNEXPLORED BASINS

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Run-off, in addition to precipitation and evapotranspiration, is the basic element of the water balance and phase of hydrological cycle influenced by numerous factors. Run-off genesis was performed on the basis of an analysis of the total run-off process. The study shows total run-off process structure, the degree of possible influence of heterogeneous geological terrains on water run-off in natural conditions and the way of determination of the total run-off through appropriate models for determination of evapotranspiration and precipitation analysis. At spatial analysis of precipitation the method is applied which, besides other, includes orographic and dynamic effects. Three-dimensional dynamic analysis was performed, by the application of adequate non-hydrostatic meso model that gives better results in comparison to classical interpolation methods. One of the first steps at this kind of analysis is bringing up to date an adequate data base from domain analysis on the basis of grid system. Input data in the study were obtained by cartometric and physical measurements. For calculation of spatial evapotranspiration numerical model was used developed on modular approach for heterogeneous geological conditions (Nikolić, 2004). The model contains modules of energetic, dynamic and plant physiology influence, with parameterization of geological characteristics of terrain influences. The influence of geological characteristics of terrain is being parameterized on the way that demands hydro-geological approach to terrain research methodology. The effects of aerodynamic resistance, as well as surface resistance of plant categories, are being parameterized on the specific way. Surface resistance of plant categories simulates control of water vapor flow from plant leaves through available parameters in practice. Aerodynamic resistance is calculated in the function of wind speed and coarse level of the active area. Modularly determined parameters are integrated through basic equation of the model that includes influence of all relevant factors on the process of evapotranspiration: the most significant energetic and aerodynamic factors, the influence of plant cover and geological characteristics of the terrain. The model uses basic equation on the basis of combined approach, with starting data that represent standard measurements within the framework of competent institutions. At hydrologicaly unexplored basins measurements of water level are lacking, as well as measurements of flow, and run-off cannot be determined directly. By determination of precipitation and evapotranspiration with sufficient accuracy, on the basis of tested models, the run-off on hydrologicaly unexplored basin is determined indirectly, on the basis of water balance equation. This is significant for solving numerous practical problems: the analysis of water balance, planning and control of water resources, solving water-supply problem, irrigation and drainage of the terrain, projection of hydro-construction objects, construction of mini hydroelectric power stations and numerous other applications in hydrological, meteorological and hydro-geological practice as well as environment protection. The basic goal of this study is raising necessity of multi-disciplinary approach in solving this problem, as the only possible way of correct perception of this natural process.

Keywords: evapotranspiration, hydrological cycle, active area, energy balance, water balance, heterogeneous geological conditions.

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AWARE PROJECT

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Snowmelt in the mountain environment fills the rivers and recharges the aquifers that millions people depend on for their water needs (drinking, energy, production in agriculture and industry). However, climate change and other factors make the water resources balance from snowmelt very fragile and inconstant. Many natural events (such as the recent droughts observed in Alpine catchments and downstream rivers) clearly revealed that innovative technology to predict medium term flows is necessary for an effective sustainable water resources management.

AWARE is a research project that aims at providing innovative tools for monitoring and predicting water availability and distribution in those drainage basins where snowmelt is a major component of the annual water balance, such as the Alpine catchments. AWARE is funded with the contribution of the European Commission - Directorate General for Enterprise and Industry - under the Sixth Framework Programme. The duration of the project is 3 years starting from July 2005.

AWARE is considering relevant catchments representative of various geographic conditions (climate, geology, geomorphology, hydrography) in the mountain environment. Case study basins are distributed inside the Alpine area, including Austria, Italy, Switzerland and Slovenia. The AWARE approach of developing and testing several models applied and tailored to local conditions, makes the Project a good candidate also in other mountainous European regions, such as the Scandinavian area and the Pyrenees.

AWARE will develop appropriate models to represent snow-pack dynamics and snowmelt runoff based on the combined use of satellite Earth Observation data and in-situ hydrological and meteorological measurements. Models will be implemented in a geoservice, a geoapplication requested by a standard web interface, allowing users to access remote information and processes regarding catchments of their interest/responsibility..p@irea.cnr.it

One of the main goals of AWARE is to bridge the gap between available data about the state of water resources and information requested by different stakeholders involved in the local water resources management. Models produced within the project will be designed to solve specific problems of different users, such as hydropower companies, irrigation consortia, municipal water supplies and to assist stakeholders responsible of water policy, such as regional, basin and municipal authorities.

HYDROLOGICAL AND SEASONAL CONTROLS OF NITRATE MOBILIZATION FROM A FORESTED CATCHMENT

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Understanding of interactions between hydrological and biogeochemical responses of catchments on rainfall events which is usually unclear from periodic measurements and requires tracing of the temporal dynamics of the processes. Smaller streams reflect strong connections between hydrological processes of the rainfall runoff formation and biogeochemical processes in the catchment, consequently, the responsiveness of the streamwater chemistry to changed hydrological states is very high. In accordance with the analysis of hydrological factors it is therefore possible to obtain an insight into the changeable biogeochemical conditions which are reflected on the changed flux of nutrients with rainfall runoff from the catchment.

In the contribution, we present results of the measurements which have been carried out in year 2006 in the scope of the project “Arrangement of the water supply for the Slovenian coastal region” on a forested watershed of the Padež stream in hilly area of Brkini. From the hydrogeological point of view, the Padež watershed has a uniform structure characterized by low permeability of erodible flysch layers and a consequent well developed, dense and highly incised stream channel network. In the climatic sense, the Brkini hilly area is a transitional area between the mediterranean and continental climate. Detailed hydrological monitoring which included measurements of rainfall, meteorological conditions (air temperature, solar radiation) and discharges in the Padež stream and its tributary, the Suhorka stream, has been supplemented by periodical continuous measurements of streamwater chemistry (water temperature, pH, conductivity, dissolved oxygen concentration, ORP, nitrate concentration) in different seasons.

Acquired cognition about the responsiveness of the streamwater nitrate concentration to changed hydrological conditions recognized through streamwater electrical conductivity measurements are important from the viewpoint of understanding the seasonal mobility of nutrients and mobility of nutrients imposed by given rainfall event. Determination of the quantity of the nutrient flux shall answer the question what is the role of natural background of the nutrient fluxes form the forested catchments in the sense of broader ecological impacts.

Keywords: watershed hydrology, high-frequency measurements, forest biogeochemistry, streamwater nitrate, electrical conductivity.

THE GLINŠČICA STREAM EXPERIMENTAL WATERSHED

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For the purpose of monitoring the impacts of the urban environment on urban streams, the monitoring system has been established on the Glinscica stream experimental watershed. The Glinscica stream watershed area is situated in the central part of Slovenia and reaches into the eastern part of the urban area of the capital city of Ljubljana. The precipitation watershed area of the Glinscica comprises 16.7 km2. The position of the runoff within the urban area is determined by the removal of rainfall water by way of a sewage system therefore the orographic barrier does not coincide with the Glinscica drainage area. The total drainage area of the Glinscica up to its outlet into the Gradascica river is larger and comprises 19.3 km2 of the watershed area. New, sophisticated measuring equipment was introduced, which enabled tracing of seasonal and short-term changes of in-stream hydraulic and water chemistry changes. The equipment included a one-dimensional ultrasonic Doppler instrument, 2D/3D handheld Doppler velocimeter, Flo-tracer dilution flowmeter, water quality multiprobe and three rain gauge stations. The one-dimensional Doppler instrument is placed at the bottom of streams and records water level (limnigraph), water velocity and temperature. The water quality multiprobe, designed for in-situ and flow-through applications, measures parameters simultaneously. The multiple parameters include: nitrate, ammonium, temperature, conductivity, depth, dissolved oxygen, total dissolved solids (TDS), oxidation reduction potential (ORP) and pH. 19 sampling points were chosen for the monitoring of spatial and temporal variations of the water quality in the Glinscica stream and its tributary, the Przanec creek. The results of the monitoring raised some new questions about the role of the stream hydromorphological alterations as a consequence of past channel regulations, interactions between the urban environment and surrounding areas and the effects of these interactions on ecohydrological state of the Glinscica stream. The research was a part of the URBEM (Urban River Basin Enhancement Methods) EU 5th framework project for implementation of the Water Framework Directive (Directive, 2000/60/EC) in the urban river environment.

MODELING OF SMALL URBAN-LANDSCAPE RIVER BASIN GEOSYSTEMS

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Negative consequences of society/economy impact on hydro-environment are particularly appreciable for non-large river basins situated at territories of large cities, including their suburbia, which are qualified now as urbanized landscapes of the highest level. That's why new theoretic-applied bases and procedure for geo-informative mathematical modeling of state for small river basin geosystems of urbanized landscapes were substantiated, elaborated and tested.

Notions on small urban-landscape river basin geosystem (SULBG), set of its simulation subsystems and geosystem state level by its stability and reliability were introduced. Principal simulation modes, criteria and models for all classified for this SULBG's state level components were fixed and parameterized including the ways of such modes improvement. So, stability (with its two types – phase and parametric stability) is regarded as geosystem capacity to save owns properties, structure and typical peculiarities under anthropogenic and natural impacts due to the self-regulation.

Phase stability is simulated as that which represents the measure of river basin geosystem self-regulation capacity. This stability is divided into subtypes taking into account: the degree of 'residual' ability for self-regulation (phase-anthropogenic stability), the degree of preservation for hydro-functioning relations (phase-ethological stability) and principal character of river basin geosystem structural-functional transformation (phase-general-functional stability).

Parametric stability is simulated as the degree of polyvariant conformity of SULBG's state level parameters to reference parameters established according to 'normality' of geosystem nature properties etc. This stability is model differentiated on varieties, taking into consideration: the degree of mentioned conformity for principal structure-forming processes (parametric-processing stability), the degree of geosystem capacity to renew its nature properties due to availability of renewal factors such as 'green' city zone, territories with environmental status etc (parametric-renewal stability), the adequate degree of complex hydro-environmental parameters of basic geosystem river for reference parameters as integral reflection of state level to the whole 'compact' SULBG (parametric-integral stability by water-flow and water-quality criteria). At that, models and categorical-classified scheme of SULBG's water-quality stability were modified with adaptability of substantiated approaches for development of general principles of surface waters' quality categorical assessment.

River basin geosystem reliability is interpreted as the degree of its capacity to fulfill or intensify required environmental-positive natural-social-economic functions or to eliminate such negative functions. The classification of these functions was proposed.

Elaborated procedure and approaches were tested as a whole with satisfactory results using created modern geo-information basis for SULBG of Kyiv rivers. Recommendations were elaborated for model estimation of small urban-landscape river basin geosystem state, identification of reasons of such level deterioration and measures for its improvement. The results can be used in regional schemes and designs of nature management and city environmental programs for small river basins environmental rehabilitation.

Keywords: small river basin, urban-landscape geosystem, modeling of state level, stability and reliability, city environmental program.

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MEASURING AND MODELLING FOREST TRANSPIRATION

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The experimental part of the study was performed in the floodplain forest growing along the bank of Dyje River close to Pohansko (about 10 km east of the town of Břeclav, southernmost Moravia, 155 m a. s. l.). An approximately 2 to 3 m deep layer of heavy soils of quaternary origin lies on an approximately 8 m deep layer of sandy gravel of tertiary origin in this area. The experimental stand containing sample trees was about 50 to 100 m from the river-bank. The underground water table was within the heavy soil layer on most days in the analysed growing season; water rose above the soil surface during spring floods about four times a year; precipitation was lower than potential evapotranspiration during summer until late September.
Sap flow was measured by the trunk heat balance (THB) method with direct electric heating of xylem tissues, using instrumentation made by EMS Brno Inc. Three electrodes delimiting the measured trunk section and a battery of three thermocouples were applied. Two measuring points were installed at breast height on opposite sides of each of ten sample trees. Data were measured each minute and stored as means over 15 minute intervals.
Two transpiration models were tested, one with plant control, and another without. The principle of the model with plant control was that the physical mechanism of transpiration is evaporation that is actively controlled by plants. The supposed mechanism is: part of the heat (heat equivalent of the energy absorbed from solar radiation), which would cause overheating of the plant above 25°C, is dissipated by evaporation. The model has five physical parameters, which are in principle measurable. The model without plant control is based on the assumption that transpiration dissipates a constant fraction of the heat from the heat equivalent of absorbed solar radiation (about 45%). The model needs only one measurable physical parameter.
Both models were tested by comparing their results with actual measured transpiration (via sap flow) in the floodplain forest growing along the bank of the Dyje River close to Pohansko. The results of the two models were almost identical. We discuss their physical differences, evaluate their goals and weak points, and suggest a programme for further testing the physical mechanism of transpiration.

Keywords: plant transpiration, SAP flow, floodplain forest.

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THE EXPERIMENTAL WATERSHEDS IN SLOVENIA

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Experimental watersheds are critical to the advancement of hydrological science. By setting up three experimental watersheds, Slovenia also obtained its grounds for further development of the science and discipline. In the Dragonja experimental watershed the studies are focused on the afforestation of the watershed in a mediterranean climate, on the Reka river the water balance in a partly karstic area is examined, and on the case of the Glinščica stream the implications of the urban environment are studied. We have obtained valuable experience and tested new measuring equipment in all three experimental watersheds.

The Dragonja river basin is situated on the border between Slovenia and Croatia. Due to political and social circumstances and poorly managed agriculture in the past, the catchment area has been depopulated in the past decades, leaving the forests to develop in the abandoned agricultural fields. The changes in land use changed the hydrology of the catchment a great deal. The intensive natural reforestation in the last decades, which has caused a decrease in minimal and maximal flows. At the same time no noticeable climate (precipitation and temperature) changes have been perceived. Precise measurements in the last few years were the basis for cooperative scientific work between the Vrije Universiteit from Amsterdam and the University of Ljubljana, which resulted in several PhD Theses, Master Theses and scientific articles. At the same time the experimental watershed provided support to the teaching and studying process.

The Reka River is the widest known sinking stream of a classical karst area, and it has been studied since antiquity. The river sinks into the Škocijan Cave system, which was proclaimed by UNESCO as a World Heritage Site in 1986. Then the groundwater stream flows to the karst springs of the Timav, and drains into the Adriatic Sea in the Trieste Bay. The river has a drainage area of 422 square kilometres and a mean discharge of 8,26 cubic meters per second. In the seventies, the Reka River was one of most polluted rivers in Slovenia. During floods in 1999 and 2000, experimental measurements of velocity, water stage, suspended sediment transport, chemical parameters and toxicity tests were conducted.

In urban areas the concept of the watershed becomes more complex and difficult to define because the natural topography has been disturbed; the water may be drained through storm drains and in some cases it may be diverted by drains into other basins. In the area of Ljubljana watercourses Ljubljanica, Gradaščica and the Glinščica are regulated in sterile channel cross sections with high concrete banks which separate the water bodies from surrounding urban areas. The precipitation watershed area of the Glinščica comprises 17.4 km2.The Glinščica watershed study site is equipped with weather stations, rainfall stations, two water stations with Doppler velocity meters and sample points for water quality measurement by multipurpose probe. The multipurpose probe measures dissolved oxygene and nitrates concentration, pH, specific conductivity, depth, total dissolved solids and temperature.

Keywords: experimental watershed, measurements, hydrology, afforestation, karstic area, urban area, Slovenia.

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HYDROLOGIC AND HYDRAULIC ANALYSIS OF LESS STUDIED WATERSHEDS

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Increasing flooding frequencies of settlements, roads, agricultural lands, and other areas, which often result in high economic losses and threaten human lives, require modelling of high water level hydrographs for less studied watersheds. Accuracy and reliability of the results is dependent on: precipitation data, physical, geographic and other characteristics of the watershed, geometry of river valleys and waterways, and selected method for analysis of precipitation to drainage relation, in other words on defining of overall hydrograph. Processing of physical and geographic characteristics of watershed and preparation of spatial data related to geometry of river valleys and waterways are simplified by using digital elevation models and GIS tools. Calculation of hydrographs is performed using mathematical modelling software HEC-HMS 3.1.0. (Hydrologic Engineering Center - Hydrologic Modelling System) which stands among the most applicable software packages in the world dedicated to modelling of relations between precipitation and drainage based on precipitation data and drainage surfaces characteristics. After hydrographs are defined, the next step is to calculate water quantities and levels in waterways based on the calculated inflow from the watershed area. Calculation of water flow in natural streams in modelled as unsteady flow using mathematical modelling software HEC-RAS 4.0 (Hydrologic Engineering Center's River Analysis System) produced by US Army Corps of Engineers – Hydrologic Engineering Centar. Once the mathematical model of water flow is completed, including defining of input parameters: hydrographs and geometry of waterbed and inundation area, next step was to calibrate model using recorded frequent floods and data from single water gauge station, from which statistically processed data on water levels and flow rates were obtained. Calculations were processed for different values of roughness coefficient for surface runoff and roughness coefficient of waterbed and inundation area until satisfactory values are reached, including approximate flood lines and water level for 5-year recurrence interval on existing water gauge station. Obtained coefficients were used for calculations of water levels for higher order of recurrences.

Keywords: drainage, hydrograph, mathematical models.

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RECENT TECHNOLOGY FOR WATER LEVEL MEASUREMENT

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Accurate discharge estimation is crucial for an efficient river basin management and especially for flood forecasting and issuing warnings related to possible extreme flood events. The traditional way of estimating the discharge in hydrological practice is to measure the water stage and to convert the recorded water stage values into discharge by using the single-valued rating curve. New equipment for measurement of pressure is used for measurement of water level on the Sava River. During flood event in autumn 2007 new equipment survived in the extreme field conditions and provides excellent results.

CHAIR OF HYDROLOGY AND HYDRAULIC ENGINEERING

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Teaching and research staff of the Chair of Hydrology and Hydraulic Engineering perform research, measurements and consultant work, professional training, modelling and teaching in the following fields: hydrology, flood protection, flood control, water management, water resources, river hydraulics, river training, torrential hydraulics, torrent control, watershed management, soil erosion, soil and water conservation, hydraulic structures, water power plants, and environmental management.

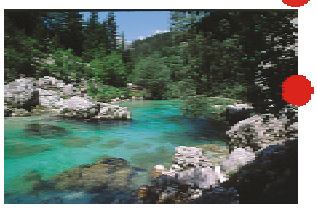
ENVIRONMENTAL AGENCY
OF THE REPUBLIC OF SLOVENIA

MISSION

Preserving natural resources, biodiversity and sustainable development;

Observing, analysing and forecasting natural phenomena and processes in the environment;

Reducing impact of natural hazards;



Ensuring legal protection and professional assistance to participants in environmental encroachment procedures;

Guiding change of national and personal values system in relation to the environment as well as influencing the value criteria for environmental encroachments;

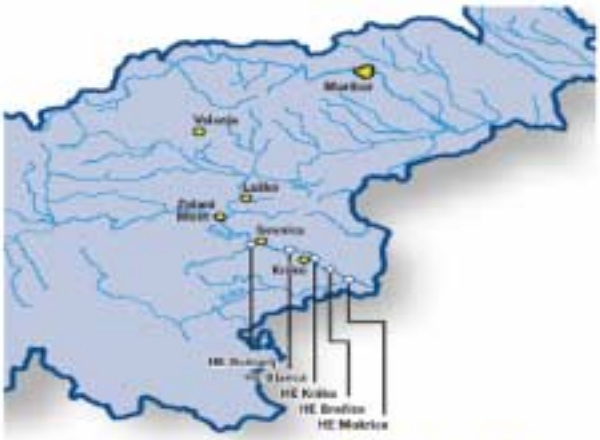
Ensuring high-quality environmental data for all target groups;

Raising the awareness of people and institutions about the environment and environmental issues.

HIDROELEKTRARNE NA SPODNJI SAVI d.o.o.

Cesta prvih borcev 18, 8250 BREŽICE

Družba HIDROELEKTRARNE NA SPODNJI SAVI d.o.o. Brežice je bila ustanovljena z namenom izgradnje verige petih novih hidroelektrarn in proizvodnje električne energije na spodnjem delu reke Save od HE Vrhovo do državne meje. Hidroelektrarne Boštanj, Blanca, Krško, Brežice in Mokrice bodo več kot podvojile proizvodnjo električne energije na reki Savi. Električna energija novih elektrarn, ki bodo zgrajene postopno do leta 2015, bo predstavljala 21 odstotkov proizvodnje slovenskih hidroelektrarn in bo predvidoma pokrivala šest odstotkov skupne porabe električne energije v državi.



Veriga petih HE na spodnji Savi

HE Krško

HE Boštanj

KARST RESEARCH INSTITUTE

TURIZEM KRAS
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POSTOJNA CAVE

The Postojna Cave system is the largest known cave system in Slovenia. There are longer caves in the world, but a visit to a cave such as Postojna deserves full attention due to the diversity of shapes, expansive cave areas, stalactite and stalagmite formations and water characteristics. What is especially noteworthy is that most of these various shapes and formations can be seen by every visitor, meaning tourists and not just cavers with special caving equipment. Well kept paths for tourists comprise the greater part of Postojna Cave, making it a "horizontal" cave.