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Abstract number 2 – CHARACTERIZATION OF GROUNDWATER IN THE MORSOTT-EL AOUNET BASIN NORTHEASTERN ALGERIA: HYDROCHEMICAL AND ENVIRONMENTAL ISOTOPES APPROACHES

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Groundwater analysis of Plio-Quaternary aquifer shows the importance of gypso-saliferous facies in the area of Morsott-El Aouinet (North-East of Algeria). These facies are represented by Triassic outcrops on the surface and a marly-saliferous bed rock. In this paper the groundwater hydrochemistries are studied through well sampling from study area. Hydrochemical end members are identified and the sources of water salinization are defined. The salinity of water is very high, ranging from 1154 to 23800 $\mu\text{S cm}^{-1}$ decreasing from South towards North with groundwater flows. From the hydrochemical evaluation of the analytic results, two different water types could be identified: - A fresh groundwater end-member: Ca-HCO₃ water type with a low salinity values. - A saline water end-member: predominantly Na-Cl water type with high salinity concentrations. In order to determine the contribution of the different parameters to the salinity of groundwater, the correlation coefficients of chlorides in respect of Ca, Mg, Na, K, SO₄, and Sr were calculated and the results indicate the direct contribution of these ions to the salinity of Morsott-Laouinet groundwater aquifer. The ionic speciation and mineral dissolution/precipitation was calculated by Wateqc package software. The increase in salinity is related to the dissolution and/or precipitation processes during the water-rock interaction and to the cationic exchange between sodium and similar elements. The isotopic analysis of some groundwater samples shows a similarity with the meteoric waters reflect their short residence time and a lowest evaporation phenomenon of infiltrated groundwater.

Abstract number 4 – EFFECT OF WATERLOGGING ON TRANSPIRATION OF DATE PALM: CASE STUDY OF THE MODERN TUNISIAN OASES

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Estimating crop transpiration in response to groundwater dynamic and irrigation practice is crucial for efficient management of scarce water resources in arid and semi-arid regions. Based on field and laboratory measurements of soil and groundwater physical properties, this study estimated date palm water use (transpiration) in modern Tunisian oases in response to variations of the water table level, irrigation water management, leaf area index, rooting depth and soil permeability. HYDRUS 1D model was used to simulate the impact of a perched water table on vadose zone hydrology processes and date palm water use for three typical parcels in the Segdoud oasis in the southwest of Tunisia. The results of this study suggest that changes of the water table level may have a strong influence on the transpiration of date palm. A rising water table from 1.76-2.30 m to 0.19-0.60 m causes an increase in water stored in the root zone resulting in decreases of oxygen availability and of actual transpiration from 1654 to 372 mm/year. The influence of irrigation depth on the date palm water use is not significant in parcels where the water table depth is below 0.9 m. In that case, the ratio between the actual and potential transpiration (relative transpiration) increases linearly with the decrease of the water table level. Under deep water table condition, an increase of the irrigation depth gives an increase of the water stored in the root zone and an augmentation of the actual transpiration. These results suggest that to ensure an efficient irrigation water management in the oasis, no irrigation would be required in autumn and winter months for water table below 0.9 m. To avoid water stress inside parcels with deep water table, the irrigation interval should not exceed eight days in spring and summer months. From the simulation results, it is apparent that the impact of the leaf area index depends on the water table level. Under shallow water

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table condition an increase of the leaf area index has no effect on the relative transpiration because the actual and potential transpiration increase in the same magnitude. Under deep water table condition, an increase of the leaf area index gives a slight decrease of the relative transpiration because the potential transpiration increases more than the actual transpiration. The impact of the rooting depth is found to be dependent on the position of roots compared to the water table level. If roots are deeper than the water table, an increase of the rooting depth causes a decrease of the relative transpiration. If not, the relative transpiration increases with the elongation of roots. Finally, it was shown that increasing the soil permeability in the range 10-100 cm/day induces a strong increase of the relative transpiration.

Abstract number 5 – IMPACT OF ANTHROPOGENIC PRESSURES ON SELECTED CHARACTERISTICS OF A WETLAND AT TS'AKHOLO, LESOTHO

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Generally, there is sparse information on the impact of anthropogenic pressures on the wetlands of Lesotho. Thus, the objective of this study was to assess the impacts of anthropogenic activities on the physicochemical characteristics of Ts'akholo wetland and to compare Ts'akholo wetland's physicochemical and morphological characteristics with other land uses surrounding the wetland such as pasture/grazing land and the cropped land. The three demarcated land use types (LUTs) were demarcated: wetland, grazing/pastureland and cropped land. The analyzed physicochemical properties include the pH, organic carbon, available phosphorus (avP), total Nitrogen (TN), CEC, K, particle size analysis, hydraulic conductivity, bulk density, silt: clay ratio and SOM/(silt + clay) ratio (SSCR). The determined morphological characteristics used were the soil colour, structure, texture, consistency, roots, mottles, and the presence of stones and quartz abundance. An eighty three year (1923-2006) rainfall distribution was used to assess the contribution of rainfall to the condition of Ts'akholo wetland. Results showed that there is high spatial variation between the three LUTs in terms of the morphological and physicochemical properties. Organic carbon (OC) contents were found to be of the order pasture/grazing>wetland>cropped lands. When compared with undisturbed wetlands (OC=12%), the OC were low. Generally, the TN, avP, exchangeable K and CEC were very low when compared with undisturbed wetlands in the area. The pH reaction in the wetland was alkaline (pH> 8.5) and dominated by high exchangeable Na, while that in the cropped and grazed lands were almost neutral. Results further showed that the SSCR were low suggesting high impact of anthropogenic pressure on the three LUTs. Rainfall amount has declined successively over the years. Most of the indicator weed species typifying wetlands have been replaced by invasive grass species. It can be concluded that largely, there has been a very high anthropogenic impact on these wetland when compared to an undisturbed wetland occurring in the area.

Abstract number 9 – ECOLOGICAL ASSESSMENT OF AQUATIC ORGANISMS THROUGH FOOD CHAIN IN RIVER BASIN

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Since the traditional river basin assessment has not been employed from the ecological viewpoint, the sound river basin management was not completed. Waterside has been evaluated through economical or ecological aspects, individually, although obviously it has strong relationship with human and social activities. In this paper, introducing the concepts of food chain and aquatic organism existence for

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ecological system, the river basin simulation model based on physical dynamics of discharge and toxic-chemical is proposed. Firstly, CASM (Comprehensive Aquatic System Model) is introduced to simulated the food chain among fishes under the structure of ecological pyramid. Since the distribution of zooplankton and phytoplankton in the river different from the lake where the original CASM was employed, the modified methodology is developed as CASM-River. The distributed runoff model, HydroBEAM (Hydrological River Basin Environment Assessment Model) developed by Kojiri provides the water quantity and quality at the arbitrary points in the basin. Secondly, to estimate the accumulation processes for toxic-chemicals in the fish body, PBPK (Physiologically Based Pharmacokinetic Model) is introduced. Nonylphenol, which is one of the serious endocrine disrupting materials released from factories and houses, is considered for impact assessment. The parameters are defined with the experiment data and empirical data. The leslie matrix is applied to classify the feasible expected life span according to the age. Both models are linked with biomass balance equation. Consequently, the relationship of food absorption and body accumulation can be expressed in physical-based equations. Finally, the Kamo River in Kyoto, Japan, is applied for verification. The present situations on several aqua organisms such as chironomid, Sludgeworm, Cambaroides japonicas, Dark chub, Crucian, Carp, Bass and others are simulated to find the preferable habitats. Moreover, introducing GCM outputs modified with the regional climate model around Japan and assuming the economical change of Japan, the future ecological sustainability is analyzed comparing both cases of Nonylphenol exposure and non-exposure. The continuous exposure of toxic-chemical brings big damage for ecosystem after 20 to 30 year accumulation. The ecological risk shows the risky situations in the downstream metropolitan area although not big change is not obtained in the upper area with less population and industry.

Abstract number 16 – BENTHIC AND HYPORHEIC COMMUNITY COMPOSITION: RESPONSE TO NATURAL AND ANTHROPOGENIC DISTURBANCE

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The hyporheic zone, or transitional interface between groundwater and surface water, is an integral part of the lotic ecosystem which provides a unique, thermally stable and highly oxygenated habitat for a diverse biological community (hyporheos). Despite including a number of cryptic and endemic species, the hyporheic community receives relatively little research attention and is rarely included in freshwater monitoring programmes. This study assesses the composition and distribution of the hyporheos in relation to environmental parameters including water chemistry and flow. Eighty-five species, including one previously undescribed amphipod, were recorded at three depths below the streambed from the ephemeral and perennial sections of a lowland river in southern England over a two-year period. Community composition was found to be associated with depth rather than site location, suggesting three distinctive communities despite significant differences in water quality and flow permanence along the watercourse. The results do not suggest any spatial or temporal variance in the distribution of the hyporheos. However, a number of normally benthic taxa, such as the amphipod *Gammarus pulex* (L.) and Trichopteran larvae *Agapetus fuscipes* (Curtis), were found to migrate into the hyporheic zone following periods of low flow and poor water quality, suggesting that some benthic species utilise the hyporheic zone as a refuge during adverse conditions. The results of this study indicate that benthic and hyporheic communities respond differently to changes in environmental parameters, suggesting that traditional monitoring may be an insufficient measure of lotic status. A greater understanding of the response of the hyporheos to anthropogenic disturbance is essential for the conservation of this unique community and the improvement of lotic monitoring programmes.

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Abstract number 19 – COMPARISON OF MEASURES FOR REDUCTION OF THERMAL STRATIFICATION EFFECTS ON AQUATIC ANIMAL IN LATIAN DAM

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Objective: Thermal stratification in dam reservoirs is associated with serious issues such as eutrophication, reduction of water quality for domestic and recreation use and algae growth in the upper layer of the reservoir which leads to reduction of Oxygen concentration and thus mortality of aquatic animal. This phenomenon was investigated for the case of Latyan Dam reservoir, in the present paper. On the basis of water quality modeling in the reservoir, most appropriate method to for lake dam were proposed. **Materials & Methods:** For modeling water quality in the reservoir, two-dimensional CE-Qual-W2 software was used. In this regard, the Oxygen concentration at different levels of the reservoirs for different seasons was predicted. On the basis of hierarchical analysis, using AHP software, the most appropriate method for reduction of the effects of thermal stratification and nutrition oriented repository in Latyan dam reservoir was proposed. **Results & Conclusion:** The reservoir modeling results showed an annual stratification period starting in early June and lasting up to late November. Dissolved Oxygen in the deep reservoir varied between 1 to 12 mg per liter. But this parameter drastically reduced to anaerobic level near the reservoir bed, especially in the summer. This is a warning condition and is unfavorable for growth of the aquatic animal. On the basis of hierarchical analysis, lake aeration in the summer time as well as prevention of pollutants at the source in the basin were found to be the most appropriate methods for water quality management.

Abstract number 21 – INFILTRATION OF SURFACE WATER FROM THE DIJLE-RIVER DURING PERIODS OF HIGH WATER LEVEL NEAR SHALLOW DRINKING WATER WELLS. AN EXAMPLE OF A TIME-SERIES ANALYSIS OF HIGH-FREQUENT WATER LEVEL MEASUREMENTS IN KORBEEK-DIJLE (CENTRAL BELGIUM)

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The fourteen VMW-drinking water wells of Korbeek-Dijle 'Noord' (Central Belgium) are situated in an alluvial plain on a short distance (60-280 m) of the river 'Dijle'. The production wells have a depth of 15 to 20 m below the surface and extract groundwater from the coarse pleistocene alluvial sediments. These coarse sediments are covered by fine-grained heterogeneous alluvial sediments of the Holocene. The wells are situated in an area that is part of the Natura2000 network. Under normal conditions the Dijle drains the shallow aquifer and has no influence on the groundwater quality. Earlier studies of the water levels in the alluvial plain have shown that only during periods of high surface water levels, infiltration of river water towards the groundwater occurs. This infiltration of surface water could influence the quality of the groundwater, used for the production of drinking water. The aim of this study was to analyse the impact of the wells on the groundwater level and to analyse the infiltration of the Dijle-river to the shallow groundwater during high water periods. Water levels were intensively measured in 8 piezometers from august 2005 until februari 2006. A statistical time-series analysis was performed to analyse the factors that influence the groundwater fluctuations. The impact on the groundwater level of several simultaneous impulses, in this case daily rainfall and evaporation, daily pumping rates and the hourly river level of the Dijle at 'Korbeek-Dijle' was modelled with the software-program Menyanthes (von Asmuth et al., 2008). The water level models clearly show that the fluctuations of the Dijle river have no impact on the nearby groundwater level in the shallow aquifer and in the covering sediments in the alluvial plain. Quality analysis of the pumped water confirms this conclusion. The impact of the Dijle river is only detected in the river bank water level. The Dijle irrigates to the alluvial plain only

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during periods of very high water level and only in a time period of several hours. As a second important result the models show the distinct impact on the groundwater level of rainfall and evaporation on the one side and of pumping on the other side. In this way the analysis yields important information on the cone of depression around the pumping wells. The conclusions of this study are important for further exploitation of the drinking water wells and for environmental management on the well site.

***Abstract number 24* – CONSEQUENCES OF A POOR CONCEPTUAL MODEL WHEN PREDICTING THE RESPONSE OF THE RIPARIAN WATER TABLE POSITION TO STREAM RESTORATION, WESTERN MONTANA USA**

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A 1 km section of channelized river was chosen for restoration in the Jocko River basin of western Montana. The Jocko River is a gravel bedded stream with an average discharge of 1.6 m³/s and a maximum peak flow of 3 m³/s. The stated restoration goals were to enhance channel conditions to improve fish habitat and restore the riparian plant community by raising the water table in the riparian area adjacent to the incised channel. The design conceptual model proposed that raising the stream bed by 1.5 m and remeandering the channel would accomplish project goals. The study site area was instrumented with 11 staff gauges, and over 50 monitoring and domestic wells; stream discharge, bed grain size, vertical hydraulic conductivities, vertical hydraulic gradients, and flux rates were determined both pre and post restoration. Results showed only minor changes in the water table position (+0.15 m to 0.55 m), little change in stream bed hydraulic properties, yet deviations in streambed vertical hydraulic gradients (+/-0.12). Success of the restoration hinged on applying a conceptual model that include the hydrogeologic conditions of an unconstrained river floodplain system and correctly identifying how a section of pre restoration losing stream channel would respond to the channel filling and remeandering.

***Abstract number 25* – PLANT SPECIES COMPOSITION AND HYDROLOGY/EROSION RELATIONSHIPS ON U.S. RANGELAND**

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Hydrology and erosion studies on range and forestland in the U.S. have shown that amount and types of vegetation (life and growth form, and species effects) and ecological status affect infiltration, runoff, and erosion. Rainfall simulation experiments were conducted on short, mixed, and tallgrass prairie and sagebrush steppe shrub community types in the United States. The original study conducted experiments at 26 different site locations throughout the U.S. and subsequent simulation studies have evaluated impacts of wildfire and shrub invasion. There were several objectives to these studies: 1) gain information about ecological status (rangeland health), hydrology, and soil loss relationships, and 2) try and develop a rangeland hydrology and erosion model for U.S. rangelands. Multivariate analyses (non-metric multidimensional scaling) were conducted using plant species composition and environmental factors (soil, site, and management data). Several different strategies were used starting with the complete suite of plant community types and then segregation by community type. This paper presents a summarized view of vegetation, soils, hydrology, and erosion relationships of diverse western rangelands, and utilizes the data to assess the validity of the various assumptions/generalizations for rangelands. The data set emphasizes the difficulty in understanding hydrologic responses on semiarid

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rangelands, where the relationships between plant/soil characteristics and infiltration/erosion is not well established. A myriad group of factors determine infiltration and erosion potentials and is dependent on rangeland type, site conditions, the discrete plant species. Our analyses affirmed the inappropriateness and risk of using generalized assumptions about rangeland hydrologic response. We emphasize the need to change the current modeling paradigm of erosion models in the U.S. Universal algorithms to represent the response of all rangeland types will not provide sufficient accuracy for prediction or assessment of management. Utilizing plant and growth forms of vegetation provides for more accurate predictive equations to enhance model performance and management of rangelands.

Abstract number 26 – UTILISATION DE LA MÉTHODE EPIK POUR LA CARACTÉRISATION DE LA VULNÉRABILITÉ À LA POLLUTION DES NAPPES KARSTIQUES. APPLICATION À LA NAPPE DU SAHEL DE SAFI, MAROC

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Utilisation de la méthode EPIK pour la caractérisation de la vulnérabilité à la pollution des nappes Karstiques. Application à la nappe du Sahel de Safi, Maroc Khalid NADIFI et Mohamed Karim Behachmi, UH2M, FSTM, Maroc Mots clés: Maroc, Sahel, Nappe Karstique, SIG, Vulnérabilité, Périmètres de protection. RÉSUMÉ: Les cartes de vulnérabilité aux pollutions constituent une base d'information essentielle pour la gestion des ressources en eau, pour l'évaluation des risques de pollution des nappes et la mise en place de mesures destinées à la protection des ressources en eau en général et des captages d'eau potable en particulier, dans le cadre des dispositions de la loi sur l'eau (Loi 10/95). Une nouvelle méthodologie est proposée, pour le cas de la nappe du Sahel de Safi utilisée principalement pour l'Alimentation en eau potable, pour la caractérisation de la vulnérabilité et de la sensibilité à la pollution des nappes karstiques. L'approche adoptée consiste dans l'application de la méthode EPIK, et la comparaison des résultats à ceux de la méthode DRASTIC. Deux grandes zones de vulnérabilité rattachées à la typologie d'aquifère (Plioquaternaire et Calcaires de l'Hauterivien) et aux caractéristiques de la zone non saturée. L'application de la méthodologie développée, a nécessité la mise en place d'un Système d'Information Géographique, synthétisant une masse de données (géologiques, hydrogéologiques, Hydrochimiques, géophysiques, Utilisation des ressources en eau et Occupation des sols etc.). L'ensemble des investigations et analyses de la vulnérabilité, de la sensibilité réalisées ont permis de définir les risques de pollution de la nappe et des captages actuels et potentiels aussi bien en ce qui concerne les pollutions ponctuelles qu'en ce qui concerne les pollutions diffuses, particulièrement par les nitrates ainsi que le risque d'augmentation de la minéralisation dans la zone de l'étude (dus aux activités agricoles ou à l'avancée du biseau salé). Un plan d'action global est proposé pour la prévention et la lutte contre cette forme de pollution pour et la protection des captages dessinés à l'Alimentation en eau potable.

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***Abstract number 27* – IS SUSTAINABLE SUPERFICIAL AQUIFER PRODUCTION POSSIBLE IN AREAS WITH VULNERABLE PHREATOPHYTIC VEGETATION?: A TEST CASE IN MEDITERRANEAN SOUTHWEST AUSTRALIA.**

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The consequences of excessive groundwater abstraction on groundwater dependent vegetation have been observed throughout Australia. Current bore field operation is largely responsive to consumptive demand and often in conflict with peak environmental needs for groundwater in summer, resulting in drought stress and sometimes death of phreatophytic vegetation. Vegetation decline and mortality associated with the increasing demand for public and private groundwater supply, coupled with a drying climate regime, have resulted in the need to mitigate the environmental impacts of existing bore fields. In Western Australia, the single largest water supply to the city of Perth is the Gnangara Groundwater Mound located within and to the north of the metropolitan area on the Swan Coastal Plain. Much of the Mound is overlain with phreatophytic Banksia woodland that is susceptible to prolonged separation from the unconfined aquifer during the hot, dry Mediterranean summer. This has led to constraints being placed on the operation of existing bore fields as a precautionary measure to mitigate the impacts on Banksia woodlands. Whilst the precautionary response was valid, the loss of production from existing bore fields due to environmental risk and regulation represented a significant economic loss to the water providers and industry. This study sought to determine if modification of bore field operation strategies to be sympathetic to, rather than in competition with environmental demand, would allow for opportunistic resource utilisation from existing bore fields. The strategy was to alter the timing of abstraction as well as the magnitude and rate of drawdown to avoid times of peak environmental demand. It was hypothesised that operation of bore fields during winter and early spring would significantly reduce the risk to phreatophytic Banksia woodland by avoiding separation from the aquifer when alternative water sources are depleted. If it could be demonstrated that resource use from a 'high risk' area was possible without degradation of dependent vegetation then there is potential to recover at least 5GL/year from existing bore fields. Hydrological and plant water status parameters were monitored over two winters at research sites with an initial depth to groundwater of less than 5m. During winter and spring, groundwater abstraction at a reduced capacity resulted in a 0.75m drawdown. Operation of the bores did not adversely impact the water status of phreatophytic Banksia at the study sites relative to control sites. Analysis of plant water source partitioning indicated that plants exposed to the winter drawdown were sustained by unsaturated zone soil moisture storage replenished by winter rainfall. When pumping ceased, the water table rose rapidly and plants utilised more groundwater during late spring and summer as the soil water store became depleted. Using the outcomes of this research, a decision support framework was developed to assist in the operation of bore fields in environmentally sensitive areas.

***Abstract number 28* – DEVELOPMENT OF A PROCESS-ORIENTED CONCEPTUAL GROUNDWATER MODULE FOR SIMULATION OF HYDROLOGICAL PROCESSES IN MESO-SCALE CATCHMENTS WITH SHALLOW AQUIFERS**

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Groundwater plays a decisive role for the hydrology of catchments which are situated in lowlands, flood plains or pans. Therefore, a number of hydrologic models - numeric, analytic or conceptual - deals with the simulation of groundwater levels and groundwater flow. Often modelling systems use several coupled models to describe the processes in the groundwater, or groundwater levels are only computed in subcatchment scale. This study should introduce a modelling concept for the simulation of groundwater levels within single hydrologic entities and the water fluxes between several adjacent entities. The scope of this conceptual spatially distributed groundwater model is a process-oriented simulation of hydrological processes in meso-scale catchments with shallow aquifers. The integration of the interaction between ground-water and surface water and the description of the processes in and close to lakes or reservoirs are of particular interest. The method presented in the study was applied in the spatially distributed hydrological model J2K and topologically linked hydrologic response units as modelling entities. At first a simple one-to-one routing scheme was implemented. Additionally a new improved multi-flow routing scheme (one-to-many) and the simulation of backwater effects are envisaged for implementation. The underlying equation for the description of the flow processes is largely similar to the Darcy-equation, whereby some calibration parameters were added. The reliability of the model will be tested with a numerical finite element groundwater model under steady state and transient conditions, observed water table levels in boreholes and lakes and observed river discharge. As test site, the catchment of the Lower Gera River (approx. 540 km²), which is situated in the Thuringian Basin, was selected for this study. The catchment is defined by the gauges of Ringleben 1 and 2 as catchment outlets, and by the gauge of Erfurt-Möbisburg as catchment inlet. Characteristic elements of the catchment are a wide shallow aquifer consisting of gravel and sand, heavily modified and artificial waterbodies and a cascade of quarry ponds. Due to this complicated and sophisticated layout of the modelling area the subcatchment of the Gramme Creek (approx. 320 km²), a small tributary of the Gera River, was chosen for calibration of the model. A well observed groundwater monitoring network can be used for the calibration and the validation of the model. The modelling concept is expected to provide an adequate reproduction of the groundwater levels and a realistic estimation of the groundwater fluxes in meso-scale catchments with shallow aquifers.

***Abstract number 30* – CONTROLS AND PATTERNS OF NUTRIENT FLUXES IN LOW STREAM ORDER AGRICULTURAL CATCHMENTS**

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A large range of human activities have increased the nitrogen fluxes of reactive nitrogen to such an extent, that it has reached the planet carrying capacity, or the planet boundary. This increase has affected not only the nitrogen cycle but also the carbon and phosphorous ones, both on land and in the ocean. Modern agriculture is one of the most prominent human activity which increased nitrogen fluxes in the last 50 years could find positive relationships between percentage of agricultural land cover in catchments and nitrate fluxes at their outlets. The positive relationship between agricultural landcover and nitrate, and more generally between N input and output hold for large or medium size catchments, i.e 100 km² and above). Yet, in smaller drainage basins (stream order 1-2; less than 10 km²), large variations of fluxes were measured despite similar land cover. These variations decrease as the size of the catchment increases; average fluxes values being measured in larger stream orders. Two main non antagonistic hypotheses can be formulated to explain the change of the variability pattern of nutrient fluxes along stream networks: i) instream biogeochemical processes can recycle and or remove more nutrient per surface unit than larger streams, entailing larger spatio temporal variations of fluxes than larger streams; ii) The importance of spatial arrangement of landscape features including riparian zones, hedgerows, ditches..., affects nutrient fluxes' signal in small catchments, while in larger catchments, signal-to-noise ratio is low, hampering to decipher subtle land cover or land use changes. In this paper we use a 4 years of continuous discharge and water quality monitoring in 12 small stream order 1 and 2 catchments ranging from 15 to 240 ha in Brittany, northwestern France (Lat 48.29 to 48.33N and long 1.32. to 1.38W) to analyze the variability of responses of comparable small drainage basins in terms of patterns of nutrients concentrations with discharge, the stoichiometry of nutrient fluxes, the relationship between rates of N fluxes and landscape features, N and P concentration patterns during flood events and nyctemeral nutrient fluxes patterns during low flow periods. Our results underline the need to include small catchment scale in stream water quality monitoring schemes in order to i) understand the relationship between land use and land cover and water quality, and ii) forecast water quality change under land use and landscape change.

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Abstract number 31 – ECOLOGICALLY RELEVANT STREAMFLOW CHARACTERISTICS ACROSS THE UNITED STATES

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A conventional assumption is that anthropogenically altered streamflow metrics that have ecological interpretability are necessarily useful for assessments. This assumption has led to a proliferation in the literature of proposed streamflow metrics with little regard for their ecological relevance or statistical limitations. Furthermore, although the redundancy of some metrics is acknowledged, it is typically addressed by excluding individual metrics that are redundant at undisturbed sites, which assumes that sets of redundant metrics are in all other respects equal. In this study, we evaluate a broad range of streamflow characteristics for their predictability and ecological relevance by using the following four steps: 1) quantification of streamflow metrics at undisturbed/natural basins, 2) development of statistical or mechanistic models to estimate natural streamflow metrics that are applied to hydrologically altered basins, 3) quantification of streamflow alteration by comparison of observed to expected ratios of streamflow metrics, and 4) association of the severity and type of streamflow alteration with measures of biological integrity. Using the above framework, we assessed the usefulness of 858 streamflow metrics for regional and national assessments of perennial streams. Metrics were computed at 1,035 relatively undisturbed stream sites and at ~250 altered sites across the conterminous U.S. where biological assessments had also been conducted. We evaluated 1) which metrics can be accurately and precisely estimated, 2) which metrics were most strongly associated with biological integrity of fish and macroinvertebrate communities, 3) the validity of removing the redundant streamflow characteristics, and 4) which basin-scale attributes, such as number of dams and freshwater withdrawals, are associated with altered streamflow metrics. We identified 226 streamflow metrics that can be estimated accurately and precisely. From these metrics, roughly 90 of them were strongly associated with poor biological integrity, and they can be categorized into the following classes: high streamflows in spring, low streamflows in winter, and skews. Poor biological integrity was more strongly associated with diminished (an altered streamflow metric being less than the estimated natural one) than inflated streamflow metrics, suggesting a pervasive effect of water withdrawals. Sets of metrics that were redundant at reference sites had widely varying importance to biological integrity at impacted sites, indicating that ecologically relevant streamflow characteristics can be mistakenly overlooked if discarded based on redundancy analyses at undisturbed sites. Finally, we were able to identify several key anthropogenically influenced basin attributes that are main drivers of the changes, such as storage intensity, in streamflow metrics.

Abstract number 36 – DEVELOPMENT OF EARLY WARNING SYSTEM FOR SOIL QUALITY CHANGES IN TROPICAL ECOSYSTEMS

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Using a range of environmental data describing climate, soil, biotic and contemporary land use conditions the research seeks to develop a model of soil quality which has sufficient sensitivity to provide a warning of potential rapid decline in soil quality. The study will require field data together with regionally recorded climatic and soil data and will seek to utilise established models such as DSSAT, CENTURY, IPCC-Soil Carbon Tool, Soil Par and Soil Water Characteristics. The major goal

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is developing an early warning tool that shall be used to monitor changes in soil quality as a result of climate and land use change. The methods include inventorization of soil quality indicators in five selected ecosystems as they change from tropical rainforest (benchmark), to savannah, wetland, arable or perennial farming systems. The change in ecosystem is based on changes in soil carbon stocks as the land cover and land use changes from native ecosystem/soil type. Ten (10) years regionally recorded (day-to-day, month-to-month and year-to-year) weather data shall be analysed and observed changes relative to the class limits correlated with changes in land use, land cover, soil carbon and soil type. Climatic indicators used include rainfall, temperature, relative humidity, solar radiation, and pan evaporation. To establish soil quality at any particular time (t), the five groups of indicators to be integrated are visual, climatic, physical, chemical and biological. For each group, at least four easy-to-measure parameters are selected for quantification. The soil quality indicators will be analysed in the laboratory using routine (soil quality) methods of SQI-USDA. The parameters will be monitored for two tropical seasons (wet and dry). The results so collected will be incorporated into models and simulated for -50, -25, 0, 5, 25, 50, 75 and 100 years (i.e. one lifespan); to observe changes and quantify which parameter(s) contributes most. Based on published class limits and simulations output, new tropical soil quality indices/equations shall be established. Using these minimum and maximum tolerable limits, critical values/standards to be known as Early Warning System will be set up. The model would be a valuable tool in sustainable land management in Nigeria and beyond. A computer program can then emanate there-from that will (function as dashboard of car to) warn of impending dangerous change in soil quality.

Abstract number 42 – INSPECTION AND STUDY OF WATER TRANSFER EFFECTS FROM SABZKOOH RIVER TO CHOGHAKHOR EARTH DAM, SOUTH WEST PART OF IRAN

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Sabzkooch River and Choghakhor earth dam are located in Chaharmahal and Bakhtiari province, southern west part of Iran. The main target of the water transfer project in this area is to provide water supplies for industrial and agricultural activities by water transfer from Sabzkooch river, which is one of the Karoon river branches in Zagros zone, to Choghakhor existing earth dam. This project include a diversion structure, a 10.4 long tunnel and increasing the height of dam in few meter. In this study the effects of project on surface and ground water are inspected. The conclusions show that the execution of this project cause the decreasing river flow and change its morphology, increasing the pollutants concentration due to fish farms in down stream, drainaging groundwater from Kalar karstic anticline which is between Sabzkooch river and Choghakhor dam lake, thermal stratification and the eutrophication of reservoir and destruction of ecological characteristics of this international pond. At the end, some proposes are given to correct and decrease the environmental effects of this project.

Abstract number 43 – IMPACTS OF HYDRAULIC REDISTRIBUTION AND GROUNDWATER TABLE DYNAMICS ON EVAPOTRANSPIRATION

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Evapotranspiration (ET) plays an important role in the water and energy budgets. While there are many factors affecting ET, this study focuses on assessing the impacts of hydraulic redistribution and groundwater table dynamics on ET. We have these processes tightly coupled into a hydrologically based Three-Layer Variability Infiltration Capacity (VIC-3L) land surface model and investigate their roles in the evapotranspiration process under both dry and wet conditions. The coupled model is tested against observations. Impacts of the distribution of plant roots, groundwater table depths, heterogeneities of soil

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properties on ET are also investigated through a series of sensitivity analyses. Results and new insights will be presented and discussed.

Abstract number 44 – HYDROLOGICAL MODELLING AND UNCERTAINTY ANALYSIS TO UNDERSTAND WATER BALANCE OF A WETLAND SYSTEM UNDER SUBARCTIC CLIMATE

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The subarctic wetlands span almost one-sixth of the Canadian wetlands and have been recognized as an important ecotone between the arctic tundra and boreal forest. Recently, the investigation and conservation of the subarctic wetlands have been recognized as an attractive route because of their unique hydrological features and vulnerability to climate changes. The hydrology of the subarctic wetlands is spatially and temporally complex on account of the shallow ponds and topographical attributes, understanding their hydrological characteristics has been of major concerns for the purposes of modelling and predicting how the water cycle may vary under future climate. To gain insight of the interaction between hydrology and atmosphere of the second largest wetland in Canada - the Hudson Bay Lowlands, extensive field investigations were conducted during 2006 and 2008 in the Deer River watershed near Churchill, Manitoba, Canada. Climatic conditions and hydrologic features were monitored and characterized to advance the understanding of the wetland systems. Following up the field investigation, distributed hydrological modelling tools were employed to simulate the water cycle particularly the interactions between wetland hydrology and climate in subarctic regions. Statistical design of experiment methodology was adopted to examine the sensitivity of the key input parameters and the uncertainties as well as their associated impacts on modelling. By analyzing the results from the factorial design and central composite design, the contribution of each parameter was evaluated. The results indicated that the interaction between fast storage and precipitation factor had the greatest positive impact on modelling accuracy. Both the field and modelling work revealed the distinguishable hydrological features of the sub-arctic wetlands. For example, the peaks of the spring streamflows were to unexpectedly some extent high because the shallow frost table were extensive with low temperature and significantly impeded the infiltration of snowmelt eventually contributing to surface runoff; most of the small and moderate summer rainfall events were not able to produce much runoff partially due to highly porous soil, shallow permafrost, and intensive evapotranspiration; the numerous ponds/lakes stretching over the middle and lower reach of the watershed became connected during and after rainfall and behaved as buffers and notably prolonged the concentration time. The findings helped build a scientific basis for advancing the knowledge of the hydrologic cycle and impacts of climatic changes on sub-arctic wetlands.

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Abstract number 45 – THERMOGRAPH ANALYSIS FOR ESTIMATING VERTICAL HYDRAULIC CONDUCTIVITY AND NEAR STREAMBED FLUXES: COCKBURN RIVER, NSW, AUSTRALIA

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In literature, most of the results on the dynamic nature of streambed conductance are based on controlled laboratory experimentation. Because of the nature of laboratory environments, results of experimentation may not necessarily capture all nuances of hydrologic regime, including flood events. In this study, field based data was used to study the dynamic nature of vertical hydraulic conductivity at two sites in the Cockburn River, in NSW-Australia-. Near streambed fluxes were estimated using the USGS heat transport model, VS2DHI. For modelling purposes, the entire period of observation, extending from July 2008 to January 2010 was split into ten segments. To a certain extent, each segment is considered to be a representative of physical, chemical and biological environmental conditions that prevailed within the streambed during the observation period. For instance, a segment of the hydrograph, which represents the two flood events that occurred in late 2008, illustrates the hydrologic regime prior to the flood events and the effect of flood events on the temporal development of de-clogging processes. During this period, at the pool site, near the Kootingal Bridge the vertical hydraulic conductivity (VHC) varied from 10^{-3} to $8 \cdot 10^{-5}$ m/s and the corresponding fluxes ranged from $1.6 \cdot 10^{-5}$ to $4 \cdot 10^{-4}$. In contrast, in an armoured zone, near the Ballantines Bridge, the VHC varied from $8 \cdot 10^{-5}$ to $2 \cdot 10^{-3}$, with stream leakage ranged from $9 \cdot 10^{-5}$ to $2 \cdot 10^{-4}$. At both locations, a maximum VHC was simulated after flood events, probably induced by increase in stream temperature and break up of the clogging layer by the increase in stream velocity. This suggests the low flow hydrologic regime creates a favourable environment for the formation of a clogging layer. The disintegration of the clogging layer takes place during high runoff and flood events.

Abstract number 46 – EFFECT OF EXCESSIVE GROUNDWATER DISCHARGE ON KAFTAR LAKE

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The objective of the present study is to investigate the interaction between Namdan Aquifer Basin and Kaftar Lake in Namdan Plain, southwest of Iran. This research assists the local watershed planners in assessing the status of the water resources and adverse effects of groundwater exploitation on the water resources systems. The study region is located on the northeast of Shiraz near the Zagros Mountains. Due to the combined effects of rapid agricultural development and droughts the stress on the Namdan Aquifer has been dramatically increased over the last decade. Groundwater is pumped to the surface by more than 2083 wells which discharge the aquifer over 381.51 MCM per year while the region used to be natural grassland with several wetlands. The wetlands have been gradually drained out due to excessive groundwater discharge. Kaftar(also called Shadkam) Lake is the most important surface water resource in this basin. It has been also the subject of interest from environmental aspects and is considered as an environmentally protected area. It is a habitat for migratory birds. Kaftar Lake occupies 4700 ha (12.6 km length and 6.5 km width) and is a shallow, semi permanent freshwater lake. Lake water has been also used for irrigation via a canal which is attached to the lake. The groundwater map of the Namdan Aquifer basin shows that the groundwater flow converges to the lake. It suggests that the interactions of two groundwater/surface water systems are essential for study of each system. The quantitative study of the interaction of Kaftar Lake and Namdan aquifer can provide an effective tool for

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water resources planner and environmentalists to evaluate the adverse effects of agricultural development in this region. The required data including the time series of piezometric data, pumping test data, the geometry and the water level variations of the lake and other required data were collected and used for modeling groundwater surface water interactions using MODFLOW. The model was validated using some test data and the results was presented and discussed in some detail. Results shows that the excessive use of groundwater can dramatically reduce the recharge to Kaftar Lake. This eventually may lead to drying out of the Lake which is an environmental disaster. Moreover, the use of lake water as a resource for irrigation can adversely effect on groundwater basin. The model can be also help for evaluation of remedial measures such as artificial recharge.

***Abstract number 47* – MODELLING GROUNDWATER FLOW AND AQUIFER HETEROGENEITY IN URBANISED ENVIRONMENT WITH STRONG RIVER INTERACTIONS**

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Heavy industries, such as chemical and metallurgical plants, are often located in very urbanized areas, close to navigable rivers. This has resulted in the existence of numerous heavily polluted brownfields located in alluvial plains, often presenting a major risk of groundwater deterioration and of contaminant dispersion in the environment, particularly through groundwater discharge into surface water. Here, the objective is to describe and illustrate a methodology to asses, as accurately as possible, the spatial distribution, magnitude and dynamics of groundwater fluxes, relying on the development and calibration of a numerical groundwater flow model. It is based, on the one hand on long term monitoring of groundwater and surface water interactions, on the other hand, on a dual-scale groundwater flow modelling using a combined zonation (regional scale) –pilot point (local scale) parameterization of aquifer heterogeneity. The methodology is illustrated on a case study corresponding to a brownfield located near the Meuse River, in the region of Liège, in Belgium. A numerical groundwater flow and solute transport model is developed with MODFLOW and MT3DMS, using data on groundwater – river interactions obtained in the field. The model calibration provides a very detailed image of aquifer heterogeneity for the studied site which is shown to be reliable using independent field observations. The numerical model is finally used to evaluate the influence of aquifer heterogeneity and groundwater – river dynamics on groundwater and solute contaminant fluxes in realistic hydrologic conditions. From the perspective of monitoring contaminant concentrations in time and space, such results indicate an efficient monitoring programme should be based on a detailed continuous monitoring of groundwater flow conditions in order to capture the dynamics of the contaminant plume in such a dynamic groundwater system.

***Abstract number 51* – GROUNDWATER-SURFACE WATER INTERACTIONS AT THE LAJA WATERSHED IN THE CENTRAL VALLEY OF CHILE**

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Watersheds at the Central Valley of Chile present very well define groundwater-surface water interactions. However, those interactions are not well understood and transfers of water are normally considered as water losses in the case of a river that feed the groundwater system or water recuperations in the case of a river that gain groundwater, missing the connection between groundwater and surface water systems. This document present a discussion about groundwater-surface interactions that we had identified at the Laja Watershed and how those interaction fit with the general trend of the Chilean Central Valley. The Laja valley is formed by a series of deposits associated to the activity of the Antuco Volcano that took place in the superior Pleistocene and early Holocene. The deposits are concentrated along the valley until the sector of Tucapel where they opened conforming a fan-shaped deposit, which is locally named as Arenales del Laja (Laja's sands). The deposits of the Laja Valley are associated to an aquifer that is recharged by infiltration of rain water and Laja riverbed. During the summer of the year 2008, a study was done to evaluate potential infiltration of the upper part of the Laja River. The study was base on a regional geological analysis, field surveys and the elaboration of a water balance model, which considered the losses of the river by infiltration and evaporation. From that study it was possible to estimate that infiltration from the Upper valley of the Laja River to the groundwater system varies from 4 to 10 m³/s. At the lower part of the Laja Watershed, the Claro River is formed in the union of the Laja Sands and the Coastal Mountains. The summer streamflow at the Claro River has an abnormal behavior. Chilean summer corresponds to a dry season (between September to March), for that reason, a typical Chilean river located at the eastern side of the Coastal Mountain have a pronounce recession, in contrast, the Claro River has a almost constant summer flow, which indicated that the river is feed by the sandy fan groundwater system associate to the Laja river. In spite that the amount of the flow associated to groundwater surface interaction is several times smaller than the average superficial flow, these interactions are very important for the analysis of water availability in dry years, especially if we consider the impact of climate variability in Chilean Hydrology.

***Abstract number 52* – ECOLOGICAL ASPECTS OF THE INTERACTION OF RIVER AND GROUNDWATER IN THE LOWER AMUR**

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Based on bank filtration the Northern water intake facility of the Khabarovsk City has been under operation for over 70 years. In natural conditions groundwaters of alluvial deposits usually have increased concentrations of iron (32 mg/l) and manganese (7.5 mg/l). Due to many years of intake facility operation a zone of iron-free groundwater has been formed. Chemical composition of

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groundwater in the wells satisfies drinking water requirements except for sometimes increased manganese content (up to 0.3 mg/l). A longitudinal observation analysis showed that in the aquifer mineral and organo-mineral compounds of bonded iron transform into its dissolved form due to intensive groundwater flow and inflow of surface waters. In October 2009 and February, May and July 2010 water quality in the Amur River and three water wells was analyzed. A microbiological indication method was used to study penetration of organic matter from the Amur River into groundwater. Iron and manganese concentrations were measured with an ICP-MS method. Biomonitoring revealed organic substances of Amur origin in the wells in autumn. The highest number of ammonifying and iron-manganese bacteria was registered in the well that situated at the beginning of the infiltration row relative to the direction of the Amur surface water flow. In winter and after snow melting in May the number of indicator groups of bacteria was less. High-quality water during the whole observation period was registered in the well at the end of the infiltration row. Seasonal changes of iron concentrations in the well at the beginning of the infiltration row corresponded to iron concentrations in the Amur. From October till May iron content in the Amur River gradually decreased from 3.15 mg/l to 0.81 mg/l, and in the well it decreased from 1.93 mg/l to 0.35 mg/l. In the wells more distant from the river iron concentrations were lower. Manganese concentrations in the wells (0.83-0.96 mg/l) in autumn significantly exceeded those in the Amur River (0.12 mg/l). In February manganese content in well water (0.27 mg/l) was nearly the same as in the Amur (0.26 mg/l). The undertaken studies showed that due to river bank filtration in flood time greater amounts of organic matter of different origin get into groundwater that feeds the city intake facility. Organic matter combined with oxygen that comes with river water affects the activity of iron-manganese bacteria, which cause the transformation of dissolved ion forms of iron and manganese into their non-dissolved compounds.

Abstract number 53 – MICROBIOLOGICAL INDICATION AS A SENSITIVE TOOL TO STUDY OF GROUNDWATER TREATMENT PROCESSES IN SITU: THE AMUR RIVER BASIN

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At the present time for the water supply of the Khabarovsk city (Far East of Russia) the groundwater intake at the Tungus site is being built. Groundwater in this site has good quality, but contains high concentrations of Fe (12.3–28 mg/l) and Mn (0.38–1.86 mg/l). For water treatment is being used the technology SUBTERRA, and as its part the groundwater aeration for activation of biogeochemical processes. Abnormal factors of groundwater in the Amur River basin (low mineralization, hardness, temperature, high concentrations of dissolved CO₂, Fe, Mn) have significant impact on formation speed of Fe and Mn oxidation zones. During the first 10 months after beginning of aeration of production wells at the Tungus site, the number of indication group of iron-manganese bacteria (IMB) and its oxidizing ability gradually increased. Because of low temperature (5–6 °C) and high concentration of CO₂ in groundwater, the growth of IMB and the formation of biogeochemical zones were more slowly than in Europe. After the well technological operating mode change, there was a disruption of biogeochemical zone stability: the number and activity of bacteria-indicators were decreased, and as a consequence, the concentration of Mn was increased to 7 mg/l (above the natural background). It can occur due to microbiological Mn reduction with oxygen deficiency when IMB uses manganese oxides as an alternative electron acceptor. The research shows the dependence of number and activity of IMB on structure of water-bearing rock, dynamics of aquifer aeration, and redox potential. It shows that bacteria's ability to grow in the attached state on soil particles as biofilms has an influence on biological demanganisation processes. Under identical conditions of aeration and operating modes of two wells, the speed of IMB growth was defined by the structure of water-bearing rock. Independently of technological process stages (pumping out or infiltration) the highest number of IMB was at the level of

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operation aquifer where is formed the biogeochemical barrier round the aeration zone. Experiments show that the usage of Na₂CO₃ (to increase water hardness) and other chemicals for microbiological processes activation inhibit the growth of IMB, so the optimal reagent for stimulation of their activity is air oxygen only. Thus, microbiological indication is a sensitive tool to study the specificity of Fe and Mn oxidation processes in groundwater in situ of different regions. Microorganisms-indicators help to control physical and chemical conditions, and to operate of water treatment technological process in situ.

***Abstract number 55* – TRANSPORT AND BACTERIAL INTERACTIONS OF THREE BACTERIAL STRAINS IN SATURATED COLUMN EXPERIMENTS**

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The impact of bacteria-solid and bacteria-bacteria interactions on the transport of *Klebsiella oxytoca*, *Burkholderia cepacia* G4PR1, and *Pseudomonas* sp. #5 was investigated in saturated sand column experiments (L=114 mm; ϕ =33 mm) under constant water velocities (~5 cm/h). Bacterial strains were injected into the columns as pulses either individually, simultaneously, or successively. A one-dimensional mathematical model for advective-dispersive transport and for irreversible and reversible bacterial sorption was used to analyze the bacterial breakthrough curves. Different sorption parameters were obtained for each strain in each of the three experimental setups. In the presence of other bacteria, sorption parameters for *B. cepacia* G4PR1 remained similar to results from individual experiments, indicating the presence of other bacteria generally had a lesser influence on its migration than for the other bacteria. *K. oxytoca* is more competitive for the sorption sites when simultaneously injected with the other bacteria. *Ps. sp. #5* generally yielded the greatest detachment rates and the least affinity to attach to the sand, indicative of its mobility in groundwater systems. The results of this study clearly indicate both bacteria-solid and bacteria-bacteria interactions influence the migration of bacteria. A more complete understanding of such interactions is necessary to determine potential migration in groundwater systems.

***Abstract number 59* – PLANNING OF THE AGRICULTURAL LAND USE AND WATER MANAGEMENT SYSTEM FOR PRESERVATION OF ECOSYSTEM IN THE RURAL AREA**

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The objective of study is to clarify the affect of water use condition in the crop fields on the surrounding ecosystem for planning of the agricultural land use and water management for preservation of ecosystem in the rural area. The field observation is conducted in the Tachiura reservoir command area, which located in Fukuoka Prefecture, south-west Japan. The kinds and number of the animals and plants are investigated in the normal paddy field, paddy field where is cut down the agricultural chemicals, ponded

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fallow field, upland fields, and green house. In the ponded fallow field, the most various animals and plants are observed, comparing with other fields. The high-level consumers, including little egret and snake, are observed. The food pyramids are obtained using the investigations. The ecosystem is higher level, in order of the ponded fallow field, paddy field where is cut down the agricultural chemicals, normal paddy field, upland field, and green house. Using this result, to preserve the ecosystem, the agricultural and land use plans are made. First, the agricultural land use formation rearrangement is effective. Second, the new type of the irrigation canal for preservation ecosystem is designed, considering the movement of the small animals. Finally, the new water management system in the paddy fields by farmers is planned, considering both of the spawning season and paddy growth season.

***Abstract number 62* – POLICY AND SCIENCE NEEDS FOR THE PROTECTION OF GROUNDWATER DEPENDENT ECOSYSTEMS**

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The Australian national water reforms require integrated management of connected surface and groundwater resources and protection of water-dependent ecosystems. Identification of groundwater dependent ecosystems (GDEs) and understanding of their water requirements is emerging as a challenging area requiring multidisciplinary science/policy integration. This paper reports the findings of a 12-month review of the science and policy of environmental provision from groundwater in Australian water planning. There are a variety of policy approaches across Australian jurisdictions regarding protection of GDEs. Parallels and contrasts are drawn to illustrate the diversity of policies which reflect the national driver of water reform but have developed in a range of biophysical environments, socio-economic settings, planning frameworks and data availability constraints. The applicability of these policies is discussed, the underpinning assumptions and conceptual framework examined, and limitations and common knowledge gaps identified. Strategies to overcome knowledge gaps and ecological and hydrological time lags are explored. In particular, the applicability of concepts and practices of environmental flow provision in surface water are discussed. Although the considerable body of literature and experience in surface water environmental flows offers useful insights, the concept of the flow regime may not be directly translatable into groundwater environments because of the dominance of unidirectional flow in surface water and the likely greater complexity and uncertainty of the response function between components of the groundwater regime and ecosystem values. Supply of water to selected groundwater-dependent assets is likely to be inadequate for support to vital microbially-mediated ecosystem services, such as nutrient processing and contaminant degradation, which are dependent on patterns in hydrological connectivity. Protection of groundwater-dependent environmental values in Australia will be assisted by the joint engagement of policy makers, managers and scientists in the development of policy frameworks which allow for precautionary environmental provision but, crucially, require supporting evidence from medium to long-term monitoring programs. Key research directions with links to the policy application are identified. Recommendations are made for policy approaches in specific settings and for better national integration of policies to facilitate progress in environmental provision for groundwater. This provision will depend on integration of the work of hydrogeologists and ecologists working at multiple spatial scales and in close cooperation with policy makers, planners and managers.

***Abstract number 63* – RUNOFF CHARACTERISTICS BETWEEN SURFACE AND GROUND WATER IN THE SMALL RIVER**

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The extraordinary rainfall occurred in the small river basin (called Asano River) of Kanazawa city, Ishikawa prefecture, middle part of Japan, July 2008. The center of the city was affected by severe damages by the big flood due to the extraordinary rainfall. The hourly rainfall intensity ranges more than 100 mm/hour. This study aims to make clear the runoff characteristics between surface and groundwater in the extraordinary strong rainfall event. Usually runoff characteristics analyzed on the low flow and middle scale flood runoff events. But the characteristics between surface runoff and ground water runoff is not clear. So we get the hydrological data of the extraordinary storm. Using these hydrological data, I analyzed the characteristics between surface water and ground water on the extraordinary storm by the runoff model. Finally, the interesting result is acquired by use of runoff model.

***Abstract number 64* – SUITABILITY OF MICROMET MODEL FOR HYDROLOGICAL SIMULATIONS**

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MicroMet is a quasi physically based meteorological distributed model developed by Liston and Elder, 2006. MicroMet model is integrated into the physically based distributed model, GEOTop [Rigon et al., 2006]. GEOTop model includes solution of Richards equation (Richards, 1931) in three dimensions for evolution of soil water content and pressure, coupled with one dimensional simulation of soil heat transport. The spatial distribution of atmospheric forcings are given to the GEOTop model in two ways: either GEOTop physics, as described in Rigon et al., 2006 and Brtoldi and Rigon, 2004, or by MicroMet model. Since MicroMet is a quasi physically based model, it is important to check its suitability for hydrological simulations with physically based distributed models such as GEOTop using comprehensive datasets. In this study, the GEOTop model is applied to the Little Washita basin [611km²], Oklahoma, USA using the comprehensive datasets that were collected during the Southern Great Plain Hydrology Experiments-1997 (SGP97) and SGP99 over the basin. First, the GEOTop model was calibrated and validated for SGP97 and SGP99 experiments, respectively using atmospheric forcings as described in Rigon et al., 2006 and Brtoldi and Rigon, 2004 from 45 meteorological stations distributed within and around the basin on an hourly time step. These meteorological forcings are: precipitation, relative humidity, air temperature, downward solar radiation, wind speed, wind direction and air pressure. For both experiments, the GEOTop model is well reproducing heat fluxes: Sensible heat, latent heat, net radiation and ground heat. The diurnal cycles of soil moistures and soil temperatures are well reproduced by the model. Discharges at the basin outlet were well simulated by the GEOTop. After calibrating and validating the GEOTop model, all the physical parameters e.g. soil properties, flow parameters and land use properties are kept fixed, except the displacement heights of land use objects which were slightly modified, and the GEOTop model was run once at the basin scale using the same meteorological data but the meteorological forcings were distributed using MicroMet model. Fortunately, the GEOTop model was well reproducing the heat fluxes, discharges, soil moisture profiles and soil temperature profiles without further calibration. The GEOTop model results obtained using the spatial distribution of meteorological forcings as described in Rigon et al., 2006 and Brtoldi and Rigon, 2004 are very similar to the results obtained using MicroMet model for the spatial distribution of the atmospheric forcings. This indicates the suitability of MicroMet model in hydrological simulations.

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Abstract number 66 – THE FLUVIAL AND THE LAKE SHOREZONE FUNCTIONALITY INDICES: A NEW MACROSCOPIC APPROACH TO RIVER AND LAKE FUNCTIONALITY

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While most of earlier indices were characterized by a particular analysis, for example to the water itself (chemical analyses) or the biotic environment (biological extended index), the Fluvial and the Lake Shorezone Functionality indices look at the overall status of the fluvial and lacustral environments. Both biotic and abiotic factors are used to evaluate the buffering capacity of riparian vegetation, the complexity and artificiality of the shoreline, the anthropogenic use of the surrounding territory, and the way the inputs from the watershed enter the water body. These factors are used to assign a different functionality level, for each homogeneous stretch, ranging from excellent to poor (divided into 5 categories as suggested from the WFD 2000/60/CE). Morphological, structural and biotic parameters are evaluated in the field with an ecological point of view. These semeiotic indices are easily surveyed, evaluate the state of the environment, and assist in the identification of the causes of deterioration, zooming out from the waterbody itself to also include all the surrounding territory and watershed topography. These reports give specific indications on what actions are needed to improve the functionality of the water body and can therefore be used to plan, monitor and evaluate restoration efforts. Similarly, different scenarios can be modeled in a specific area to foresee the impacts that public or private work may have on the waterbody. The data can be entered into a GIS system, in order to carry out further spatial analysis and easily display the results in maps. For these reasons, these indices represent an important and powerful tool that can be used for sustainable planning and management. Today, the Fluvial Functionality Index (created in 2000) is used in Italy and supported by the Italian institutes and agencies, while the most recent Lake Shorezone Functionality Index (created in 2009) is used within the Eulakes and Silmas European projects in Italy, Austria, Slovenia, Poland and Hungary. The following paper introduces the Fluvial and the Lake Shorezone Functionality Indices, presenting practical examples of their use.

Abstract number 67 – SETTLING RATES OF FREE-LIVING AND PARTICLE-ATTACHED BACTERIA AND ENTEROCOCCUS IN THE HUDSON RIVER (NEW YORK), U.S.A.

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Settling rates of free-living and particle-attached bacteria and Enterococcus has been studied in two estuarines using SETCOL experiments. In addition, a time series of both locations supports characterization of sampling water and microbial variabilities. We statistically quantified and compared settling rates in the samples, including total suspended matter (TSS), to outline potential differences between locations and within one location under rain and no rain condition. Settling rates of free-living bacteria and Enterococcus were buoyant, while particle-attached bacteria and Enterococcus settling rates were statistically- indistinguishable between locations but were higher under rainfall than no rainfall condition. We related particle- attached Enterococcus to TSS, which positive correlated with each other, and statistically combined E.coli obtained in the literature showing similar linear regressions. Minor variations are a result of a higher number of settling rates obtained under TSS < 20 mg l-1 compared to the E.coli data matrix. ANOVA suggests that there was a significance difference in the settling rates of particle-attached Enterococcus under no rain (0.005 m h-1) and under rain conditions (0.037 m h-1) for TSS < 50 mg l-1; if so, it will significantly improve our understanding of the role of particle-association

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in combination with TSS under no rain and rain conditions, with having consequences for variable inputs into sewage indicator models in rivers.

***Abstract number 69* – THE ANALYZE OF SURFACE AND GROUND WATER EXCHANGE IN TWO DIFFERENT RIVER WATERSHEDS**

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Water regime of Albanian rivers is a Mediterranean typical one, about 85-90% of the annual flow belongs to the wet period and only 10-15% to the dry period. In this paper the water regime of the Semani dhe Vjosa River is analyzed. These are two boundary rivers but with a total different hydro geological and not only, characteristics. Vjosa river watershed is mainly composed of massif calcareous rocks that are streaky and karstified. A totally different view is in the other river, in Seman where the impermeable rocks dominate. This is the main factor determining this watershed in terms of water resources, a poor one. Even the distribution of the precipitation is quite different. In the Vjosa River the amount of the precipitation varies from 1500 mm to 2500 mm per year. In Semani River the total amount of precipitation is only 1100 mm per year. Since the flow of the wet period is mainly a result of the precipitation, having as its main characteristic the floods, the minimum discharge occurs during the dry period. So the flow during the dry period represents the so called base flow that is the contribution of the groundwater. In this point of view the flow of the dry period is also an indicator of the underground water resource, having a hydraulic relation with the surface water. During the dry period the watershed gives what it received and has cumulated during the wet period. The effect of this regulator is much more sensitive in the case of a karstic watershed as Vjosa is. Elaborating the records for a multi annual period, the recession curves are analysed for all the hydrometric stations in the both river basins and the parameters of these curves are evaluated. Among the entire information there are selected only those years with e considerable amount of precipitation during the wet period and with a non influenced regime during the dry period that means there were no rain during the dry period. These results are analyzed and compared between the two different watersheds reflecting the differences on water exchange of surface and ground water. Another conclusion is the assessment of groundwater resources through these recession curves for these two rivers.

***Abstract number 70* – EFFECTS OF WEATHER VARIABILITY ON PESTICIDE LEACHING**

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Pesticide leaching to groundwater is dependent on adsorption and degradation rates when pesticides are degraded in both adsorbed and aqueous phase. Pesticides which are not available for micro-organisms when they are adsorbed, can not be degraded in adsorbed phase. For a solute that can only be degraded in aqueous phase, the residence time in solution determines the leached fraction to groundwater. The residence time in soil is dependent on the water flux, which is determined by the weather and climate of the location where the pesticide is applied. Adsorption is not important for the leached fraction, but it does determine the velocity of the solute plume and is needed to predict the arrival time of the plume at a certain level. In a nonuniform soil the effective retardation factor varies when the solute plume propagates through the medium. Effective retardation factors can be calculated with spatial and temporal moments. Estimations of an effective retardation factor have been made for heterogeneous aquifers. For vertical transport in a horizontally layered soil another approach is needed to estimate an effective retardation factor. The objective of this study is to show the sensitivity of leaching of a degradable solute to climate, degradation and adsorption. Furthermore we show how the mean displacement of the plume

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in a layered soil is dependent on adsorption, degradation and dispersion. Solute transport in a layered soil is simulated for three different climates with the pesticide transport model PEARL. Adsorption and degradation rates are varied. The mean leached fraction is mostly dependent on climate and degradation rates. The coefficient of variation of leached fraction decreases with increasing adsorption. The decrease is stronger if a solute degrades in aqueous phase only than if it degrades in adsorbed and aqueous phase. Seasonality increases the CV in leached fraction in a dry climate. In a layered soil with degradation in aqueous phase only, the first spatial moment is not linear with precipitation surplus, like it is when a solute is also degraded in adsorbed phase. The effective retardation factor based on spatial moments gives different results than the effective retardation factor based on temporal moments. Both are lower than the arithmetic mean of the retardation factors of the separate layers.

Abstract number 72 – AN OVERALL TOXICITY SCREENING OF WATERS USED FOR FIELD IRRIGATION AND LIVESTOCK WATERING IN THE VENETO REGION, USING PSEUDOKIRCHNERIELLA SUBCAPITATA AND DAPHNIA MAGNA AS TEST ORGANISMS

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Using the 96 hours growth inhibition test on the green alga *Pseudokirchneriella subcapitata* and the 48 hours immobilisation test on the microcrustacean *Daphnia magna*, surface waters used for field irrigation and ground waters used for livestock watering were respectively screened for toxicity. This was done in order to generate a priority list of water samples to be further checked by chemical analysis for various contaminants. Fifty livestock watering sources and fifty field irrigation sources were monitored. From each site four samples (one in each season) were collected. Irrigation samples were filtered and then diluted in algal medium before testing. Livestock watering samples were filtered, their salinity and pH adjusted to those of *D. magna* medium, and then tested without dilution. The large majority of irrigation samples tested positive, particularly those collected during the summer season, where some samples showed more than 50% algal growth inhibition even at the highest dilution (1:8). Effects of ground water samples on *D. magna* were moderate, and the majority of samples tested negative. Positive samples generally caused not more than 10% immobilisation and were considered only as suspected toxic, some samples caused 15-45% immobilisation while only a few samples, collected during the summer season, caused 45-60% immobilisation. Altogether the tests showed to be sensible enough for the prioritisation of the water samples and confirmed that both surface and ground waters are more contaminated during the spring/summer seasons, probably due to the massive use of fertilizers and pesticides on crops during the spring-summer period. The results indicate also that in the Veneto region the contamination of surface waters is a serious problem while that of ground waters is only a moderate problem and regards essentially those waters coming from aquifers that are closer to the surface.

Abstract number 74 – ECO-HYDROLOGY OF CANADIAN PRAIRIE WETLANDS AND MANAGEMENT IMPLICATIONS: SYNTHESIS OF A 40-YEAR STUDY

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Eco-hydrology can be broadly defined as the interaction between living organisms and physical components of the hydrologic cycle. Eco-hydrological understanding of aquatic environments has far reaching implications for protection, restoration, and management of these environments. We will

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present a unique case study of the northern prairie wetland ecosystem in Canada, where long-term monitoring and focused experiments over the past 40 years have generated a body of fundamental scientific knowledge that is beginning to guide policy development for wetland protection and restoration. The key findings are: 1) long-term monitoring of basic hydrological and ecological variables is necessary to assess the response of wetlands to natural and anthropogenic stresses; 2) effective management of wetlands requires the consideration of wetland complexes, as opposed to individual wetlands, and the hydrological linkage between wetlands and surrounding uplands; and 3) biodiversity of prairie wetlands depends on the diversity in water regimes (e.g. ephemeral, seasonal, permanent) within a wetland complex, in other words, hydro-diversity.

***Abstract number 75* – THE ROLE OF GROUNDWATER IN THE DEGRADATION AND RESTORATION OF RAISED BOG ECOSYSTEMS**

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Peat bogs are traditionally considered to be relatively isolated hydrological systems with no direct linkage to a source aquifer. The isolation of a raised bog ecosystem from regional groundwater flow is primarily a consequence of its mode of development, where natural drainage is impeded by topography and geomorphology. As groundwater inflows become insignificant in the water balance of an individual bog, groundwater is no longer a source of nutrients to the ecosystems dependent ecology and the bog becomes wholly fed by meteoric water. Recent research on Clara Bog, Ireland, indicates a more complicated relationship between the bog body and regional groundwater system. Though the bog has been damaged in the past through peat cutting and drainage, it still contains botanical assemblages of unique conservational value, and in this regard it is considered Ireland's premier example of a near intact raised bog. However, in recent years (< 20 years) the western tract of the bog has subsided significantly, by up to 1.0 m in local areas, and as far as 600 m from the bog margin towards its centre. Consolidation of the peat substrate is thereby altering the hydrological conditions on the bog surface which are, in turn, affecting its ecology. Typical of most raised bogs, peat overlies low permeability lacustrine clay, impeding downward movement of water. However, there are areas under the bog where this clay barrier is naturally absent, allowing the peat to rest directly on an underlying aquifer, a regional body of relatively permeable till subsoil. Coincident with the subsidence of the peat has been a localised drop in regional groundwater table, between 0.4 and 1.0 m. It is noteworthy that both peat consolidation and groundwater level decrease have occurred in areas where lacustrine clay is absent. A network of drains associated with peat cutting has developed adjacent and peripheral to the bog margins during this time and hydrogeological and hydrochemical investigations reveal that where the levels of the drains are below the regional groundwater table, groundwater discharge occurs. This external drainage has created an enhanced hydraulic connection between the high bog and regional groundwater flow, resulting in vertical drainage from basal peat in the high bog, and ultimately bog subsidence. The inference is that maintenance of regional groundwater levels can be a critical support condition in the conservation of raised bog wetlands. The implication for the design and implementation of measures for restoration of partly cutaway raised bogs is that shallow drain blocking may not be sufficient to arrest differential settlement and the long term decline in the bog surface. Under the EU Water Framework Directive (WFD), raised bogs in themselves are not considered to be Groundwater Dependent Terrestrial Ecosystems. However, the current study indicates that groundwater may provide a critical 'support' function to the sustainability of a raised bog. The conservation and restoration of Clara bog is therefore intimately related to an understanding of the hydrogeological processes at work, the significance of which has important implications for the status of raised peat bogs under the WFD.

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Abstract number 76 – DYNAMICS OF EVAPOTRANSPIRATION IN SHALLOW WATER TABLE SETTINGS REMOTELY SENSED BY LANDSAT TM IMAGES

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Evapotranspiration (ET), being one of the core elements of ecohydrological processes, is a key factor relating both water and heat balance. It is still a great challenge to couple of groundwater into ecohydrological processes especially at watershed scale. This paper focuses on integration remotely sensed ET with the observed water table for investigating the role of groundwater for plant water use under draught conditions in Guishui River Watershed (GRW), northwest Beijing. The Surface Energy Balance Algorithm for Land (SEBAL) methodology is used to derive ET from four Landsat TM images from April 5 to May 16, 2000. The 5-day phreatic observation is interpolated into 30×30m grid. A spatio-temporal analysis is implemented with GIS tools. The spatial pattern and temporal variation is investigated with a focuses on the changing water table and land cover type. The results indicate that groundwater and leaf area index (LAI) dynamics relate well with ET rates.

Abstract number 79 – CHANGE OF STREAM FLOW PATTERN DUE TO EMERGENT LEAFY VEGETATIONS WITHIN A STRAIGHT CHANNEL

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Vegetations intruded rivers would arouse increment of flow resistance and water stage, and then reduction of flow velocity. They also affect on formation of river topography. Vegetation effects on flow field are generally studied with field investigation and/or hydraulic model experiments. The present study is to investigate the flow pattern changes due to partially and fully emergent leafy trees. The projection area and height of the vegetations, degree of submerged fractions, and arranged spacing of vegetation were related to the flow characteristics, including water depth, flow velocity, and the Froude numbers. The analyzed results were used to establish a module accounting flow resistance due to vegetation for a two-dimensional numerical model. The model vegetations were made with plastic trees with dense canopy, and a series of experiments were performed with changing vegetation densities. To verify the accuracy of the numerical model, a series of hydraulic experiments were performed. They were done in a 40 cm wide flume with 8 cm and 10 cm high miniature plastic trees. The plastic trees were aligned in a straight line, and the spacing and total numbers were changed. The experiments could be mainly classified two groups, submerged and emergent vegetations. The surface water velocity fields were measured with a particle image velocimetry technique. The study showed that the flow velocity could be remarkably reduced within and near the model trees. And it showed that the vegetation density was one of the most important factors on the flow pattern changes. Finally, a vegetation resistance module for a two-dimensional numerical model was developed. The module was based on the hydraulic model experiments. Two approaches for vegetation resistance were investigated, including drag approach and roughness coefficient approach. Considering the physical viewpoint, for trees drag approach seems to be more appropriate and for bushes and shrubs the roughness coefficient does. In the present study, the developed vegetation resistance module used the drag approach, since its application target was woody plants.

***Abstract number 80* – MECHANISM OF VEGETATION RESISTANCE FOR A TWO-DIMENSIONAL NUMERICAL MODEL**

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The present study is to develop a vegetation resistance module due to trees and implement it to a plane two-dimensional computational model. To improve the accuracy of the numerical model, a series of hydraulic experiments were performed. They were done in a 40 cm wide flume with 8 cm high miniature plastic trees. The experiments could be mainly classified two groups, submerged and emergent vegetations. To understand the flow patterns, plane distributions of water depths and surface water velocity fields were measured. The surface water velocity field was measured with a particle image velocimetry technique. The developed vegetation resistance module due to trees was introduced in KU-RLMS-flow (Kyungsoong University-River and Lake Modeling System) model which is a two-dimensional unsteady river and lake model using finite difference scheme and orthogonal curvilinear coordinate system. The developed model was applied to two cases in an artificial channel with and without vegetations. Through two-dimensional flow modeling, the suitability of approach using the drag coefficient for flow resistance due to vegetation growth was evaluated. It means that the drag coefficient lumps all the effects of vegetations on flow pattern. The model was verified with experimental data with vegetation. The effect of vegetation penetration ratio on flow field was analyzed to evaluate the applicability of the numerical model. The calculated results showed that velocity distribution was changed significantly but water stage did slightly. It was established that the numerical model could represent the vegetation effect on flow field through the modification of the drag coefficient.

***Abstract number 81* – EVALUATING CHEMICAL AND BIOLOGICAL INDICATORS FOR THE ASSESSMENT OF INNOVATIVE STREAM REHABILITATION IN WATER STRESSED ENVIRONMENT**

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Treated waste water in arid and semi-arid regions becomes an important component of the water balance. It serves as an attractive substitute to conventional water for irrigation, and its uses expected to increase as demand grows and water resources are declining. Israel serves as a unique example where presently more than 75% of the total domestic sewage is reused for irrigation. The increasing demand for water resulted also in excess pumping and the dry out of many stream ecosystems. It is now suggested that the loss of wetlands and stream ecosystems (with its services) could be regained by waste water reuse. A unique case study is now underway in the Yarqon stream (Israel). Stream rehabilitation initiatives in the Yarqon stream are combined from two main actions including: using high quality treated waste water for stream rehabilitation (used in a contaminated section), and using a circulation system to artificially triple the flow in order to improve the in-stream conditions (used in an unpolluted section). It is expected that variation of flow with different water qualities will have a significant impact on the stream ecosystem. Our general hypothesis is that there will be a lag time between the improvement of water quality and the observation of stream ecosystem recovery, thus rehabilitation will be detected initially by stream nutrient concentrations, than by enhancement of nutrient retention, and finally by biota indicators. In this work, we will present our monitoring program and preliminary results from the rehabilitation of the Yarqon stream. A combination of chemical and biological indices for

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stream rehabilitation will provide hierarchical information on stream ecosystem rehabilitation by waste water and will reveal the interplay between microbial and other biological components of the riparian ecosystem. Incorporating the information on nutrient dynamics with biological indicators will enable the formulation of a recommended scheme for assessing rehabilitation of streams under water stressed environments.

Abstract number 83 – MODULE HYDROLOGY (HYDMOD): THE SWISS METHOD FOR ASSESSING AND CLASSIFYING THE STATE OF THE RIVERS' FLOW REGIME

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Module Hydrology (HYDMOD): the Swiss method for assessing and classifying the natural state of the rivers' flow regime The Module Hydrology (HYDMOD) is an assessment method for the description, evaluation and classification of the impacts on the flow regime due to measures related to water resources management (in Switzerland basically from hydropower operations and urban water management activities like e.g. drainage and sewerage systems). HYDMOD is embedded in the so-called Modular-Stepwise-Procedure, i.e. a conceptual framework for the assessment of the ecological status of rivers (<http://www.modul-stufen-konzept.ch/e/index-e.htm>). It aims at assisting the cantons in implementing the Swiss Federal Water Conservation Act, in particular in the management and achievement of the ecological objectives. This framework consists of a number of Swiss-wide standardized methods (the modules), covering the domains of hydro-morphology, biology and chemical/eco-toxicological aspects. HYDMOD's target is the flow regime and is located at the interface between hydrology and aquatic ecology. The method's point of departure is the identification of man-made interventions and measures that may alter the flow regime. For the analyzed watershed an inventory of such measures has to be established. To that end, a typology of interventions is proposed, including significance criteria in order to factor out minor interventions that are not significantly affecting the river. The impacts, i.e. the alterations of the flow regime are assessed on the basis of nine indicators, covering hydro-ecologically relevant aspects from the low-, medium and high flow regime plus phenomena like hydro-peaking and flushings. Based on these indicators the flow regime alterations are quantified and translated in classification scheme with 5 classes. Hydro-ecological considerations have been crucial in the selection of the nine indicators and the definition of the class-boundaries. HYDMOD has been developed and published as a draft in 2008 (http://www.modul-stufen-konzept.ch/e/hydro_startseite_e.htm). Based on a testing phase during the last two years, the method is actually being revised considering the feedbacks collected from the test applications. The HYDMOD revision will be ready by the end of 2010 and the publication of the definite method is foreseen for early 2011.

Abstract number 84 – CHANGES IN REACH-SCALE TRANSIENT STORAGE AND BENTHIC HABITAT DUE TO MACROPHYTE COVERAGE IN GROUNDWATER DOMINATED LOWLAND STREAMS, CANTERBURY, NEW ZEALAND

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In 2009, NIWA began work in the Lake Ellesmere Tributary Research Area (LETRA), focusing on stream ecohydrology in Canterbury lowland streams. Dominant features of these lowland, groundwater-fed streams are dense beds of submerged and emergent macrophytes. The objective of this study was to

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examine the effects of macrophyte growth and density on flow, solute transport and benthic habitat in natural streams. We selected four sites in three streams located in or near the Lake Ellesmere catchment. Over the growing season we took channel and hydraulic measurements, conducted conservative tracer (salt) releases, and measured macrophyte growth and coverage. We also sampled sedimentation and benthic macroinvertebrates inside and outside of multiple plant beds within each reach. Salt releases were used to relate reach-scale macrophyte coverage to solute dispersal and storage. Macrophyte coverage varied widely across our streams, with maximum plant coverage ranging from 25% to 100% of the reach. Benthic macroinvertebrate communities were more abundant and diverse outside of macrophyte beds compared to areas inside macrophytes. Benthic habitat inside the plant beds was composed mostly of fine sediment and organic matter, while benthic habitat outside of the beds was composed mostly of gravel. Over the study period stream water discharge across all streams slowly declined to baseflow; however, water depth and wetted width increased. The results of our salt releases showed that at intermediate macrophyte development, when flowing channels were still visible in the stream, transient storage models fit our data well and could be used to estimate the zone of storage within the channel. At very low levels of plant coverage these models estimate almost no storage, as solutes were carried quickly out of the site via advective flow. Interestingly, at sites and dates with very high levels of plant coverage, when no discernable flowing channels could be seen, the transient storage models again predict no storage. At high levels of macrophyte coverage solutes move slowly through the stream primarily via advection, but also with high longitudinal diffusion. These interactions of macrophytes with water flow have important ramifications for the management of flood risk, habitat quality, stream biodiversity and nutrient export in lowland streams.

***Abstract number 87* – A STUDY OF ARTIFICIAL NEURAL NETWORKS FOR AN EVALUATION OF RIVERINE BIODIVERSITY**

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Due to the rapidly increasing human population and land use demands, the use of environmental resources has exceeded the naturalization rate that might result in a degeneracy of ecological structure and a decrease of species diversities and thus will reduce environmental resources. The hydrological indices play a key role in ecological sustainability, and have been generally used in watershed analyses over the last decades. The developed Taiwan Eco-hydrologic Indicator System (TEIS) was constructed based on the structure of Indicators of Hydrologic Alteration. In this study, discharge data and fish sampling data are collected. The discharge data are selected from thirty-four gauging stations with flow recording length longer than twenty years. The fisheries data consist of species composition of each sample with the retention of time and location specificity. The ecological data were historical data, and each sample set recorded the annual fish species data under investigation. The total number of sample sets is one hundred and fifty. This study proposes a combination of the Self-Organizing Feature Map and the Radial Basis Function Neural Networks into the Self-Organizing Radial Basis Function Neural Networks (SORBFNN) for estimating the fish biodiversity, and the moving average method applied to TEIS statistics is implemented to reflect the effects of antecedent flow conditions for fish biodiversity. The results indicate the ANN not only can categorize the stream flow data but also estimate the biodiversity precisely based on the MA(4) TEIS data.

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***Abstract number 89* – A MACROINVERTEBRATE INDEX TO ASSESS STREAM BED STABILITY**

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In the framework of global climate change, sediment dynamics and flow regime in catchments respond to altered local climates, e.g. via precipitation regime or catchment vegetation. However, habitat conditions in rivers are also influenced more directly by anthropogenic activities, e.g. gravel mining. Changes in channel dynamics and flood occurrence affect lotic ecosystems of which benthic invertebrate communities are a key constituent. Ecological studies often require measurement of habitat variables such as stream bed stability but direct measurement can be laborious and biological assessment has the advantage of indicating habitat conditions over longer time scales (e.g. life cycle) than discrete direct measurements. Biotic indices based on community composition and calculated from sensitivity scores assigned to individual taxa, are commonly used as indicators for ecological integrity of fluvial ecosystems. Macroinvertebrate indices can assess water quality but invertebrate community composition also responds to other environmental factors including stream bed disturbance. This study presents a biotic community index that assesses stream bed stability in stony riffles. This Macroinvertebrate Index of Bed Stability is calibrated on transport and entrainment of in situ marked tracer stones in 46 North Island, New Zealand streams which represented a wide range of substrate stability. Scores were investigated for 67 common invertebrate taxa using Indicator Species Analysis based on taxa abundance at varying levels of substrate stability. The resulting site score, weighted by taxa abundance, improved a predictive model of bed stability, generated with model trees, when added to the pool of habitat variables and explained 69% of the variation in bed stability. The presented macroinvertebrate index of bed stability may provide background information to improve interpretation of water quality assessment based on biological criteria. It may also be used to monitor the impacts of anthropogenic physical disturbance, e.g. when river beds are modified for flood control or for gravel extraction. In studies of invertebrate ecology it can be used to account for the habitat parameter stream bed stability and make direct measurement redundant.

***Abstract number 90* – BIO-INDICATORS OF GROUNDWATER-SURFACE WATER CONNECTIVITY**

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The consequences of abstraction from aquifers that are hydraulically connected to streams are generally considered only in terms of stream flow depletion. However, the ecological impacts on the hyporheic and groundwater ecosystems linked to these streams are largely unknown. The subsurface (stygo)fauna communities have long been acknowledged to be intrinsically adapted to their environment both in terms of their specialised morphology, physiologies, habitat requirements and long life cycles. Links between groundwater flow regime, geochemical conditions and the abundance, diversity and composition of the stygo)fauna community should, therefore, be anticipated and utilised. These linkages

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were investigated along a 1 km reach of Maules Creek, in a semi-arid environment, NW New South Wales, Australia. Maules Creek is a small, essentially, ephemeral, tributary of the Namoi River. Vertical streambed profiles of hydrochemistry and stygofauna were collected at five different locations along the creek. The results demonstrated a heterogeneous and complex ecosystem with relatively consistent downstream gradients, in terms of overall animal and species numbers from the upstream sites to the downstream sites. These gradients are directly reflected in the changes in water chemistry. Generally the streambed pore waters became more reduced in a downstream direction and with depth, with a clear inverse correlation between stygofauna numbers and diversity and pore water concentrations of Fe²⁺ and Mn²⁺. The invertebrate ecosystem functioning seems to break down at the point when the system becomes truly anoxic. This relationship between water chemistry and fauna distribution seems to correlate to the overall stream/groundwater exchange patterns. This study highlights the direct correlation between water management, water chemistry and ecosystem functioning between groundwater and surface water in hydraulically connected systems. The study also indicates that stygofauna can be used as biological tracers of groundwater discharges and recharge and has major implications for the management of both surface ecosystems and groundwater ecosystems.

***Abstract number 91* – RESEARCH OF ISOTOPE HYDROLOGY MODEL BASED ON ITÔ DIFFERENTIAL EQUATION**

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The implementation of the project on “water diversion from the Yangtze River to Taihu Lake” has effectively raised water supply and improved the water quality of Taipu River and water environment of river network around. However, it is not exactly known how deep it influence. Stochastic differential equation is an effective tool to solve complex problems about nonlinearity and uncertainty, and its research and application to isotope hydrology are still at the initial stage at home and abroad. Supposing that the isotope concentration c_t in the river vary as the geometric Brownian motion, a non-stationary stochastic process can be introduced. In this process, initial concentration c_0 and the synthetic attenuation coefficient α are taken as two indefinite constants. Subsequently, isotope hydrology Itô model of river is built based on the Fick’s law. Analytical expression of velocity in tidal rivers is put forward respectively; their expected value and variance function-expression are also deduced. Then parameters c_0 and α are obtained by GM (1, 1) model after a series of data pre-processing on the basis of data analysis. Results show that the model’s error is small and precision is high, which indicate that the grey model is practical and effective. Furthermore, based on the water balance and mass conservation of isotopes D and ¹⁸O, isotope Itô model is used to compute the transmit time of Taipu River drainage to the upper Huangpu River reply the sudden accidents of water contamination. It is used firstly in typical plain tidal river network and results show reasonable.

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Abstract number 92 – REGIONAL SCALE FLOW AND TRANSPORT MODELLING FOR THE MANAGEMENT OF GROUNDWATER AND SURFACE WATER BODIES IN THE FRAMEWORK OF THE EU WATER DIRECTIVE

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The Water Framework Directive requires from EU member states to manage water resources at the scale of surface water and groundwater bodies in a sustainable way, without altering the different functions provided by the system in natural conditions. Efficient management also requires qualitative tools to assess the evolution of water quality regarding the activities performed in the area of interest. In this context, the objective is to discuss the needs in terms of groundwater flow and transport modelling as a support to the Water Framework Directive and to present a methodological and numerical approach that fits with these requirements. Different variably-saturated models have been implemented for selected case studies ranging between 500 and 1700 km² in the Walloon Region of Belgium. The implementation of such models is challenging because of the scale and the processes that have to be simulated. However, when calibrated and used adequately, they are able to deliver most information required, such as the estimation and evolution with time of groundwater reserves, the calculation of different indicators on groundwater replenishment and exploitation, the base flow to rivers and surface water bodies, under different stress conditions such as pumping, rainfall and climate change. They are also used for the evaluation of regional groundwater quality status and for contaminant trend assessment (e.g. nitrate) under different alternative management scenarios and mitigation measures that could be implemented in the future. This study illustrates perfectly the efficiency and usefulness of regional scale groundwater flow and transport modelling as a tool for the management of groundwater bodies.

Abstract number 93 – RESPONSES OF DIFFERENT REED SPECIES TO MORPHOLOGICAL BANK CONDITIONS ALONG THE MARSH EDGES

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Modelling interactions between hydrology and ecology in North Sea estuaries supports the implementation of the European Habitat Directive and the Water Framework Directive. It also allows for considering projections of climate change scenarios in order to identify sensitive marsh sections that may be subject to significant habitat alterations. Reed species such as *Schoenoplectus tabernaemontani*, *Bolboschoenus maritimus* and *Phragmites australis* form the natural vegetation of estuarine river banks in Germany. They act as ecosystem engineers providing habitats for other organisms and trapping sediments for bank protection. The distribution of these species is affected by hydrology and

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hydrodynamics. Therefore the distribution of the three named reed species can be modelled using these variables. Until now, just the different elevations in relation to the water level are known for the mentioned reed species and are a suitable parameter for modelling. Other local parameters such as tidal range, wave impact, and current velocity, which are shaped the morphology of the river banks, have not been taken into account. For an effective planning, incorporating these parameters in the models might enhance the model accuracy. Thus, our research question is what responses reed species show to different morphological bank conditions along the marsh edge. We focus on the marsh edge without vertical vegetation zones, because it is most strongly affected by hydrodynamics. By means of GIS analysis we stratified the marsh edge into different relief types such as slip-off slope and undercut slope of the main stream as well as sections of anabranches. These strata represent different levels of hydrodynamic impact. We surveyed the presence of the reed species in these relief types along the marsh edge on different elevations in relation to the water level, and found that: A) *P. australis* is scarcely present on undercut slopes but if so, it settles on higher elevations than the other two species. B) On anabranches, *S. tabernaemontani* and *B. maritimus* grow on higher elevations than *P. australis*. These results suggest that in sections of low hydrodynamic impact *P. australis* dominates over the other two species in all observed elevations. In contrast to *P. australis*, *S. tabernaemontani* and *B. maritimus* are able to settle on river banks that are exposed to higher hydrodynamics.

***Abstract number 94* – FERTILIZATION MANAGEMENT IN ZONES VULNERABLE TO NITRATE: A NEW PERSPECTIVE BASED ON G.I.S. MAPPING OF RESIDUAL NITROGEN AVAILABILITY**

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Nitrogen losses from agricultural sources have been recognised as one of the most serious threats in industrialised and emerging countries, determining ecosystem eutrophication and groundwater nitrate contamination. This issue has recently become a priority within the European Community Framework Directive for water protection (WFD) which has established a list of measures and limitations to be applied in areas declared “vulnerable to nitrate from agricultural sources”. An example is the Ferrara Province (Northern Italy), an intensively cultivated area affected by serious nitrate pollution since decades. The land is fertile and allows the cultivation of some different crops especially winter cereals, maize and energy plants which cover more than 65% of the land. Ferrara province is a flat area located on Po lowlands covering an area of 2.623 km². It is characterized by a flat topography and is fertilized by more than 91% with synthetic fertilizers, mainly urea. The minimal run-off and an homogeneous inorganic nitrogen load allow to simplify the hydrological and nitrogen balance: excess nitrogen tend to move vertically trough the unsaturated zone, becoming one of the most important causes of groundwater contamination. To minimize these losses a monitoring program was started in 2010, the aim was to estimate readily available nitrogen before and after maize and wheat cropping cycles. Four soils types were selected as the most representative (Silty loam, Silty clay, Peat and Sand) of the Ferrara Province. In each sampling period, 5 georeferenced cores (1 m long and 2,5 cm int. diam.) were sampled in 5 plots under corn-wheat and wheat-corn rotations, for a total of (5 cores x 5 plots x 4 soils x 2 rotations). Cores were split into 2 halves (0-50 and 50-10), extracted in 1 N KCL on a rotary shaker (60 rpm for 45’), centrifuged (3500 rpm for 10’). Filtered (Whatman G/FF) samples were analysed colometrically for urea, NH₄⁺, NO₂⁻ and NO₃⁻ using a double bean Jasco 550C spectrophotometer and a Tecnicon Autoanalyser II. Results were processed using Geographical Information System applications to obtain of the residual mineral nitrogen availability for each considered crop and rotation. This information can be transferred to agrotechnicians and farmers to calculate accurately the amount of fertilizer to be added in the next cropping season. The proposed procedure highlight the possibility to estimate accurately nitrogen needs in specific vulnerable zones and proceed with fertilisation by avoiding to generate excess and risk of nitrate leaching to groundwater.

Abstract number 95 – SIMULATING FLOW PATHWAYS IN IRISH CATCHMENTS USING A LUMPED AND SEMI-DISTRIBUTED MODELLING APPROACH

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In Irish catchments underlain by bedrock aquifers, the hydrograph can be conceptually split into a summation of four different pathways: overland flow, interflow, shallow groundwater flow and deep groundwater flow. The paper includes two case studies in which the Nedbør-Afstrømnings model (NAM) was applied to simulate the flows of each pathway. NAM was applied first as a lumped model. The catchments were then divided into subcatchments and NAM used to model these in series. The different pathway flows were investigated using hydrograph separation techniques, recession curve analysis and both analytical and graphical techniques, in order to constrain the simulated flows to within reasonable limits. Overland flow and interflow were primarily constrained using methods described in the UK Flood Estimation Handbook (FEH) and the American National Engineering Handbook, together with runoff coefficients obtained from an Irish methodology for linking runoff and recharge to groundwater vulnerability. Shallow and deep groundwater flows were primarily constrained using recession curve analysis by itself, in conjunction with a modified version of the Lyne and Hollick one-parameter algorithm, and through the use of throughput calculations using the equations of Darcy and Dupuit-Forchheimer. Deep groundwater flow was also investigated further through the use of wavelet analysis of the hydrograph. These constraining procedures produced feasible limits for flows, for use in calibrating the NAM model. Following this, a high Nash-Sutcliffe coefficient was obtained between the simulated and observed hydrograph for both high and low flows. Future research will include modelling of contaminant transport and attenuation along the same flow pathways.

Abstract number 96 – SURFACE AND SUBSURFACE WATER CONTINUOUS MONITORING TO QUANTIFY NITRATE LEAKING TO GROUNDWATER FROM MAIZE PLOTS

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Nitrogen from agricultural sources has become one of the most serious causes of ecosystem eutrophication and groundwater contamination worldwide. An example is the Po River plain (Northern Italy), an intensively populated, industrialized and farmed region, severely affected by nitrate pollution. While urban sources has been recently reduced by the introduction of more efficient treatment processes, agricultural contribution both as manure and as synthetic fertilizers remains high. The focus of this study was to quantify nitrogen losses to groundwater in the Po River Delta area (Ferrara Province, Emilia Romagna Region), characterised by silty-loamy soils and extensive maize cultivation, fertilized with urea. Replicated maize plots, amended with synthetic urea at 300 kg N/ha, were monitored to follow nitrogen transformations, runoff and leaching to groundwater. The experiment started in 2008, when the site was equipped with a meteorological station and probes at different soil depths for continuous water content and temperature measurement. Soil water and groundwater were sampled, every two months, via suction lysimeters and piezometers to obtain snapshots of nitrate along the vertical profile, using bromide as conservative tracer. From 2009 to 2010 continuous monitoring of level, temperature, electrical conductivity (EC) was applied in a piezometer located in the cultivated plot and in a nearby canal, 500 m upgradient. In accordance, surface water was sampled with the same

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bimonthly frequency from the canal. Results revealed that the canal was connected with the unconfined aquifer, but the connection was limited by impermeable muddy sediments forming the canal bed, hindering water fluxes. In fact, only when the canal stage rose above 4.4 m a.s.l. (from this height the river bank is formed by silty sand sediments) a head input was conveyed to the unconfined aquifer. Fluctuations below this threshold were never registered in the piezometers. Compared with bromide snapshots, temperature was proved to be a better tracer than EC, since the latter was affected by cation exchange and salts precipitation/dissolution processes. These processes highly hampered the chance to track nitrate export from maize plots by EC continuous logging, as confirmed by the poor correlation coefficient between nitrate concentration and EC ($R^2=0.45$). Results highlight the importance of a continuous monitoring to fully understand connections between surface and groundwater in alluvial environments and the need to integrate it with detailed estimates of biogeochemical processes when quantifying nitrogen export from agricultural soils to groundwater.

***Abstract number 97* – CHANGES OF PLANT DIVERSITY IN RIVERINE GRASSLAND AFTER EXTREME HYDROLOGIC EVENTS ON THE ELBE FLOODPLAIN**

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Grasslands dominate the floodplains along the river Elbe. In a monitoring project, vegetation data of a riparian grassland site were collected in three different periods over thirteen years. The effects of two extreme hydrologic events, the summer flood of 2002 and the extreme low water of 2003 on plant diversity, were analysed. The study site near Dessau on the in the active floodplain of the Middle Elbe area shows typical, extensively managed grassland communities. 36 sampling plots of a size of 100 m² each were established based on a stratified random sampling design. The plots were classified into three classes according to their hydrology: flooded depressions with amphibian vegetation ($n = 15$), wet ($n = 7$) and moist grassland ($n = 14$). Vegetation in these plots was recorded twice a year using the classical Braun-Blanquet scale. The sampling periods were 1998 and 1999, 2003 to 2006 and 2009 to 2010. For the description of plant diversity, species richness, the Shannon-Wiener index and Simpson's dominance index were calculated. Between 1999 and 2003, species richness and Shannon diversity declined in all classes while Simpson's dominance increased. In the following years until 2009, species richness increased and reached even higher levels than before 2002 in wet and moist grassland. In these classes Shannon diversity and Simpson dominance reached values similar to those of 1998 and 1999. For the vegetation of the flooded depressions, these indices did not recover. The observed extreme hydrologic events had a clear effect on species composition of the study site. While areas on higher elevations that are less frequently flooded gained species after few years, Shannon diversity reflecting the evenness of species' cover values in the assemblage needed a few more years to reach the level before 2002. The shift of cover values towards a stronger dominance of certain species after 2002 is reflected by the Simpson dominance index. Diversity and dominance were most strongly affected in the vegetation of flooded depressions. Due to the higher disturbance regime, even after seven years, species composition remained less balanced and more dominated by single species as compared to 1998 or 1999. However, it remains uncertain if the flood event of 2002 or the drought of 2003 or both led to the observed changes in vegetation. A yearly monitoring (KLIWAS project) of these sites at least until 2013 may provide further understanding of the effect of extreme hydrologic events.

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***Abstract number 98* – RELATIONSHIPS BETWEEN EARTHWORM ABUNDANCE AND PREFERENTIAL FLOW PATHS**

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Infiltration variability in the topsoil strongly determines the distribution of precipitation water to surface runoff, soil moisture storage and percolation towards groundwater. Preferential infiltration often takes place along macropores of biological origin, such as earthworm burrows and root channels, leading to a large variability in infiltration. Previous research showed that earthworm presence was the main cause of preferential flow in the Weiherbach catchment (Baden-Württemberg, Germany). This resulted in the BIOPORE project, which is aimed to link spatiotemporal earthworm distribution models with a preferential flow model to obtain an integrated eco-hydrological model. There are three different earthworm types which have different burrowing patterns. These result in varying infiltration patterns: from rapid deep vertical infiltration to a stronger diffuse distribution of water and solutes in the upper soil layers. Thus the spatial distribution of different ecological earthworm types can help us to understand the spatial variability in preferential infiltration patterns. However varying numbers and sizes of macropores may be hydrologically active under different conditions. Therefore in this study the relationships between the abundance of different earthworm species, the resulting macropore numbers and sizes in different soil depths and their effectivity under high intensity rainfall are studied. This will lead to information for quantifying the spatial distribution of potential preferential flow paths using earthworm distribution models.

***Abstract number 99* – AN INTEGRATED MODEL STUDY ON THE ROLE OF LATERAL CONNECTIONS AND PROCESS INTERACTIONS IN RETENTION OF MATTER IN STREAMS**

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The quantity and quality of water transferred to the coastal zone is determined within the river basin. Events and heterogeneity play an important role in the retention of matter in river ecosystems, the so called "hot moments" and "hot spots" (McClain et al. 2003), times or places with higher activity. Lateral connections of subsystems are also very important for retention of matter in river ecosystems and their resilience (Fisher et al. 1998). Therefore, multidisciplinary research and integrated modeling of groundwater, hydraulics, biogeochemistry and ecological processes is required. This merging of different disciplinary models and process formulations forms a methodological challenge. We are developing a STREAM-RIVER-Ecosystem package (STRIVE), that enables the construction of integrated river ecosystems to capture cascade effects and feed back mechanisms, that lead to the ecosystems

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characteristic functioning. This is performed within the FEMME software environment (Soetaert et al. 2002). Subsystems of different complexity can be linked to study the dynamic behavior of water, dissolved and/or particulate matter, culminating in retention. The core modules are: - Stream/river geometry module - Hydraulic module, from constant up to fully dynamic 1D Saint-Venant equations - Modules for transport and reaction formulations of dissolved and particular matter - Hyporheic zone module, based upon the diagenetic model of Soetaert et al. (1996) - 2D-margin model for horizontal groundwater flows - Growth and nutrient uptake model for macrophytes - Output formulation modules tailored for the specific questions (residence times, retention,...). We will illustrate the role of (dynamic) forcing of upstream discharge and water quality on the retention of matter for increasing linkage of subsystems and transformation processes.

***Abstract number 100* – EFFECTS OF MICRO-TOPOGRAPHY ON RUNOFF GENERATION AND RESIDENCE TIMES IN A RIPARIAN WETLAND**

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The interaction between stream discharge and the riparian zone during high flow events is still poorly understood. Chemical data supports the existence of defined flow paths controlling the exchange between riparian zone and streams. After rainfall events, waters rich in DOC, resembling the chemical composition of uppermost soil pore waters, is rapidly mobilized and mixes with waters from deeper layers and groundwater in various proportions. Monitoring and modeling of the spatial and temporal dynamics and influence of the different flow pathways on runoff generation and water quality is therefore very difficult. Chemical and hydrometric data taken for a minerotrophic fen located in North-Eastern Bavaria show that water quality and runoff generation during intensive rainfall events is controlled by a complex interaction between surface flow and groundwater. Processes controlling runoff generation and water quality seem to predominantly occur within the riparian zone. The signature of runoff during intensive storm flow events often shows a similar chemical composition like the water stored in the riparian zone. In this study, the hypothesis is tested that micro-topographical structures which are typical for this types of wetlands, induce heterogeneous sub-surface flow patterns. Furthermore, they allow a complex interplay of storage and rapid mobilization of surface near pore waters. Thus, the influence of these subsurface-flow patterns on the biogeochemical process settings of the wetland is investigated. Herby, a process based surface/sub-surface flow model is used which is capable of representing the interaction between precipitation, riparian zone and stream. Microtopographical structures are generated using a geostatistical approach and are integrated into the hydrological model. Along the flow paths, different biogeochemical processes are modeled, using field and literature data as estimates for concentrations, rates, and switching points between processes. Processes were implemented as rate expressions in PhreeqC and are controlled by availability of substrates. The different flow paths with individual characteristic residence times allow for turnover of organic matter and electron acceptors, depending on rate and flow. Following field observations, we included aerobic respiration, denitrification, iron reduction, sulfate reduction, and organic matter degradation, leading also to ammonium release. All processes are resolved in high spatiotemporal resolution and cause different chemical characteristics of the waters mobilized during high flow events. Complementary to the simulations, we show field data of different soil pore water profiles. The measured data supports our hypothesis that mainly rapidly mobilized waters from the near surface layers are reflected in the stream water chemistry. Nevertheless, there is an overlay with waters mixing in from deeper waters, as nitrate, sulfate, and e.g. chloride show different mixing behavior during high flow events. This supports our model hypothesis that different flow paths with different residence times contribute to the overall runoff, depending on the event and pre-event conditions.

Abstract number 102 – THE FUTURE GROUNDWATER RECHARGE: EVAPOTRANSPIRATION RESPONSE OF NATURAL VEGETATION TO CLIMATE CHANGE

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In The Netherlands, climate change is likely to cause longer periods of drought, wetter winters and high intensity rain showers. These changes will affect the water balance, freshwater availability and the spatial distribution and type of vegetation. Vegetation characteristics that determine evapotranspiration, like vegetation coverage, biomass and water use efficiency, may alter due to climate change and may subsequently affect groundwater recharge. Future groundwater recharge can only be assessed if we understand how vegetation responds to changing climatic conditions. We hypothesize that prolonged periods of drought will lead to a larger cover fraction of non-rooting plants (mosses and lichens) and bare soil. This vegetation feedback will reduce the effects of meteorological drought on groundwater recharge by reducing transpiration. Our simulations show that groundwater recharge may even increase in the future climate due to this vegetation response. Groundwater models frequently use crop factors or static predefined vegetation characteristics to estimate groundwater recharge. Crop factors, however, are representative for the current climate only, and do not distinguish between soil evaporation, transpiration and interception evaporation. As these components may respond differently to changing weather conditions, crop factors cannot be used to evaluate climate change effects. In an initial analysis, we show that assessing climate change effects on evaporation, transpiration and interception separately, leads to a significantly higher predicted future groundwater recharge than by using traditional crop factors. We pursue a modeling approach to simulate dynamically the response of vegetation to climate change and the impact on groundwater recharge. Hereto, we will first disentangle transpiration and interception for different plant species. Special attention will be paid to the interception evaporation of mosses which may occupy large areas in coastal and inland sand dunes. Secondly, field experiments will be used to relate water stress to cover fractions of different plant functional types. Thirdly, we will assess the significance of vegetation patchiness on soil moisture contents, as the vegetation structure or patchiness may cause radial unsaturated flow from barren surfaces to rooting plants. Fourthly, we will analyze climate change effects on soil organic matter contents. Finally, this will lead to a robust, dynamic model that takes account of climate change effects on vegetation and soil physical characteristics, required to estimate future groundwater recharge.

Abstract number 104 – HISTORIES OF LOCAL V. REGIONAL HYDROLOGY AS RECORDED BY TREE RING ISOTOPES AND DENDROCHRONOLOGY

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Links between physical riverine processes and vegetation in the riparian corridor are well appreciated, but the details of vegetation response to physical boundary conditions, such as relative elevation of a riparian floodplain above the riverbed and the corresponding access to various water sources through rooting depth are not well constrained. Tree growth for two contrasting riparian tree species along the Rhône River, France, was investigated in the context of variable water sources, which vary seasonally and by topographic position in the floodplain. Core samples were extracted from *Fraxinus excelsior* (common ash) and *Populus nigra* (black poplar) to determine the relative contributions of three endmember water sources – precipitation, surface water, and groundwater. Selected rings were sampled for alpha-cellulose to determine the $\delta^{18}O$ ratio by stable isotope mass spectrometry. Samples of river water and ground water were also analysed to determine their chemical profile. These chemical profiles were compared with dendrochronology with and without removing regional climate signals. They were also considered alongside surface water flow data and groundwater data from piezometers. The results provide new insights into the long-term impacts of changes in physical boundary conditions (e.g., altering hydrology below dams) and of riparian restoration aimed at re-flooding floodplains.

***Abstract number 105* – COMPARING APPROACHES FOR SETTING ENVIRONMENTAL QUALITY CRITERIA FOR GROUNDWATER PROTECTION**

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Environmental quality criteria for groundwater have to date been largely based on guidelines for surface water protection, drinking water standards, or the analytical detection limits of some pollutants, with little consideration of the inherent value and protection of groundwater ecosystems per se and their unique biota. Importantly, risk-based approaches, such as species sensitivity distributions, that are widely advocated and used for setting surface water criteria have not been used for setting criteria for groundwater ecosystems, largely because of the lack of toxicity data specifically for groundwater biota. Using toxicity data derived for groundwater invertebrates and microbial assemblages from aquifers in eastern Australia, we derive environmental quality criteria for three common groundwater contaminants using a risk-based approach. We compare the degree of protection offered by the various approaches for criteria setting discussed above, compare our criteria for groundwater against existing criteria used in Australia and Europe, and consider future directions for groundwater ecosystem protection in light of the paucity of relevant toxicity data now and into the future.

***Abstract number 107* – THE LOW FRIULI PLAIN CONFINED AQUIFERS: 2D AND 3D RECONSTRUCTION**

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In these years the Friuli Venezia Giulia Region has funded researches aimed at the characterization of the Low Friuli Plain (LFP) subsoil and aquifers system. The DiGEO has been engaged by the Hydraulic Survey to coordinate an integrated study finalized to the LFP confined aquifer geometries reconstruction

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and to provide guide-lines for water rational exploitation (Agreement D.G.R. n. 1827 dd. 27.07.2007). The Friuli Plain (FP) is formed by a succession of clastic alluvial deposits (Plio-Quaternary), overlaying Miocene molasses, Paleogene turbidites and the carbonate platform basement. It is characterized by the presence of a resurgence transition belt, at which the gravely northern area (HFP), hosting mainly unconfined aquifers, changes over to a clayey-sandy alternated system, hosting multi-layered confined ones (LFP). In order to define underground aquifer relations and patterns, more than 1800 stratigraphic columns have been collected from different public departments water well databases. Well logs have been georeferenced, missing elevations calculated on regional DEM (40x40m), possible correspondences controlled and datasets updated. To better correlate spatial data a unique implemented lithostratigraphy legend has been created; it is composed of: Lithological Entries (relating lithology and granulometric features; permeability linked different values are also attributed) and Description Notes (including accessory precious informations as, for example, fractured, carsified, shell or plants rich intervals turned out to be usefull in depositional setting definition and wells spatial correlation). Wells data have been iteratively analyzed and hydrostratigraphy sequences have been interpreted according to the conceptual model relating to layered shallow and deep confined aquifers; where present, A-B-C-D-E-F-G-H-I-L-M aquifers' top and bottom, other than interposed aquitards, have been picked. Top and bottom maps have been elaborated initially through triangulation, then from grids calculated by different algorithm methods (kriging, inverse distance, ecc), other countouring parameters and poligon filterings. Thicknesses were calculated. Obtained maps have been compared and matched with geological cartography, geophysic data, geothermal maps and deep wells. Hydraulically connected areas have been identified in cross correlating sections; permeability domains, different texture features and heteropic interdigitated layers have been highlighted. Extent outlines of main hydro-stratigraphic units have been reconstructed; top surfaces and thicknesses values have been mapped. All these studies were usefull for reconstructing the availability groundwater resources and to evaluate the sustainable exploitation of the resources itself.

Abstract number 108 – DYNAMIC MODELLING OF AQUATIC MACROPHYTES IN A LARGE ALLUVIAL STREAM AND ECOHYDROLOGICAL PERSPECTIVE

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Ecohydrology is a growing field of science that aims to quantify the interplay between water as a nutrient carrier and bio-assimilation processes (Zalewski 2001). Its basic assumption relies on the fact that water pollution can be processed efficiently by biota along the water pathways by regulating abiotic and biotic controlling factors at key locations. The most important feature to design the so called “dual regulation” is the non linear time response of biota to controlling factors. Biota refer either to aquatic vegetation or micro-organisms. We here develop a method to analyze and model the response dynamic of biota to abiotic factors evolution at a reach scale. In a first step a natural growing function is fitted to observed biotic data. Then residues to this model are processed in a second step with a “memory analysis technique” that helps to identify key abiotic factors. In a third step, a dynamic model is build by combining the natural growth functionl with its abiotic controlling factors. Model is then run at a daily time step. Data come from a reach of the river Dordogne. Reach was 250 m long and 100 m wide. Vegetation species and abundance, water level, velocity and temperature were sampled during five years several times a year. Most abundant taxonomic groups of aquatic macrophytes in our samplings were phanerogams and algae. The good model fitting over years with observed data confirms the mixing methodology of biotic and abiotic factors can serve the dynamic process analysis. An equivalent N uptake function is then processes considering the macrophyte biomass. Memory analysis results indicate

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that Phanerogam are mainly linked to water temperature and water depth variations that occurred in the past 10 days but also depend on a seasonal time scale. Algae variations are closely linked to the antecedent day(s) variations in flow velocity. First conclusions are drawn on the methodology and a discussion is open on controlling factors of the nitrogen uptake that would be regulated to increase the yearly overall natural N uptake at the reach scale.

***Abstract number 109* – RIPARIAN GROUNDWATER DYNAMICS OF TEMPERATURE AND OXYGEN IN A RESTORED RIVER CORRIDOR AT A LOSING SWISS PERI-ALPINE RIVER**

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Infiltration of river water is a key process for hyporheic and groundwater ecology due to the continuous input of oxygen and nutrients driving numerous ecosystem processes. The oxygen consumption in the hyporheic zone and groundwater depends on biological activity and thermal variations as well as on travel times of infiltrated river water. However, bank filtration is a transient process resulting in time dependent travel times and oxygen concentrations. To assess the complex dynamics of river water infiltration in the hyporheic zone and in riparian groundwater a spatially and temporally high resolution monitoring is needed. We measured time series of oxygen, temperature and water level at a restored river corridor (Thur River; NE Switzerland) to understand the temporal and spatial variability of oxygen dynamics. High-resolution temperature profiles (5 mm depth intervals) were acquired by wrapped fiber-optic cables using distributed temperature sensing providing detailed insights into heat transport in the hyporheic and riparian zone. To quantify time dependent travel times in the hyporheic zone and riparian groundwater, diurnal oscillations of temperature time-series were analyzed by extracting phase angles and amplitudes using dynamic harmonic regression. To determine flow velocities we applied an analytical solution for 1D heat transport to the travel time and amplitude data. By means of dilution tests in partial penetrating wells the flow velocities were verified. For the evaluation of oxygen data, information about the temperature distribution and the quantity of exchange fluxes is necessary. Low river discharge and relatively high surface water temperatures account for diurnal oxygen oscillations in riparian groundwater close to the river. We observed strongest oxygen fluctuations and shortest travel times during high river discharge events. In general, oxygen profiles of riparian groundwater showed highest oxygen concentrations in the shallow groundwater and lowest in the deeper part of the aquifer correlating positively with travel times in deeper riparian groundwater. Our results demonstrated that travel times and oxygen concentrations are variable over depth and time in riparian groundwater adjacent to a losing peri-alpine river. The oxygen fluctuations can be attributed to hydrologic conditions and the quantity of exchange fluxes between river and hyporheic groundwater.

***Abstract number 110* – HYDROLOGICAL UNCERTAINTY IN ENVIRONMENTAL FLOW METHODOLOGIES BASED ON HISTORIC RECORDS**

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The estimation of environmental flows, in countries with data limitations, is currently an important issue. Hydrological methodologies, based on historic data and usually superceded by more recent approaches, are however the basis of present methods (hydraulic, habitat-based, holistic, etc.) used for environmental flow estimations. On these lines, this article reports on the uncertainty associated with environmental flow estimations due to the quantity and quality of the hydroclimatic information

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available, and the hydrological methods used. For this purpose, 10 different hydrological methodologies (7 internationally and 3 locally proposed), are applied, using discharge data of 47 stream gauge stations in Colombia, in basins with different physical and climatic conditions. The analysis includes structural uncertainty due to the application of the different methodologies; uncertainty due to the hydrological method considered for building the flow duration curve (FDC), in the methodologies that are based on it; and also uncertainty associated to the record length and the use of the flow rating curve. Results show that there are huge differences in the environmental flow estimations using the different methodologies. This is because of the different criteria, intrinsic to each methodology, showing that there is no optimum methodology applicable in all situations and contexts. With respect to the FDC, the results show that the use of a median FDC, estimated from annual FDC, is preferable over the use of a unique (traditional) FDC, estimated for the entire record period, because it captures better the inter-annual discharge variability (very important in Colombia as it is influenced by the ENSO macroclimatic phenomena), and allows the estimation of confidence intervals and the association of the FDCs to return periods. In relation to the record length, although the environmental flow estimations are quite sensible for four out of the 10 methodologies investigated, the estimations using at least 10 years of data are well comparable with those obtained using the total record length available (in most cases more than 25 years). This suggests that the use of a median FDC and data of at least 10 years could produce reasonable environmental flow estimations, especially in cases with data availability limitations.

Abstract number 111 – RELATIONSHIP BETWEEN FARM MANAGEMENT AND SURFACE WATER QUALITY IN AGRICULTURAL REGIONS OF THE NETHERLANDS

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The agricultural sector in the Netherlands is intensive and causes nitrogen losses to the environment leading to exceedance of target values for nitrogen in groundwater and surface water (Zwart et al., 2008). The National Monitoring Program for the effectiveness of the Dutch Minerals Policy (LMM) was set up to study the effect of management regulations on water quality at farms. In sandy regions there is a clear relationship between farm management and nitrogen concentrations in upper groundwater (ao Boumans et al., 2005). In sandy regions tile drainwater and surface water is monitored next to groundwater since 2004. We expect that additionally there is a strong relationship between farm management and surface water quality, via upper groundwater and tile drainwater. This leaching might influence surface water bodies as well and may threaten their quality status. In this paper we focus on total nitrogen concentrations on farms which are artificially drained by tile drains and ditches. Unfortunately we have no data on surface runoff effects. For this study we use LMM data on the quality of the upper meter of groundwater, tile drain water and ditch water, collected during winter on more than 60 farms in the sandy region. Groundwater samples are collected equally distributed over the whole farm. Samples of tile drain water and ditch water are collected at the drained parts of the farm. Three types of ditches are distinguished depending on the source of the ditch (only the farm area or farm and other areas) and if the ditch crosses or borders the farm. Total nitrogen concentrations are averaged per farm per water type and ditch type for the whole measuring period (2004 – 2009). There are strong relationships between the different water types at farm level. Nitrogen seems to be transported from upper groundwater through tile drains into the ditches. All correlations between long-term farm averages of groundwater nitrogen concentrations with nitrogen concentrations of all types of ditches are significant ($p < 0.0001$) and positive ($R^2 = 0.5 - 0.7$). Also the nitrogen concentration in tile drain water is significantly ($p < 0.0001$) and positively ($R^2 = 0.6 - 0.9$) related to the nitrogen concentration of the ditches. The same holds for

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the correlation between upper groundwater and tile drain water ($p < 0.0001$, $R^2 = 0.6$). In conclusion our results show that the total nitrogen concentration of groundwater and tile drain water influences the nitrogen concentration of ditchwater. An increase in nitrogen levels in groundwater will always lead to an increase in nitrogen levels in ditchwater, and by that might influence surface water bodies as well. Boumans, L. J. M., D. Fraters, G. van Drecht, 2005. Nitrate leaching in agriculture to upper groundwater in the sandy regions of the Netherlands during the 1992-1995 period. *Environmental Monitoring and Assessment*, 102 (1-3): 225-241. Zwart, M.H., A.E.J. Hooijboer, B. Fraters, M. Kotte, R.N.M. Duin, C.H.G. Daatselaar, C.S.M. Olsthoorn, J.N. Bosma, 2008. Agricultural practice and water quality in the Netherlands in the 1992-2006 period. RIVM report 680716003, RIVM, Bilthoven, The Netherlands.

***Abstract number 112* – IMPACT OF 90 YEARS OF DRAINAGE ON THE HYDROLOGY AND SUBSURFACE BIOGEOCHEMISTRY OF A NORTHERN PEATLAND**

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Climate in the northern temperate and boreal zone will undergo significant changes in the 21st century and in some areas become drier and warmer. We investigated the impact of a century of drainage on hydrogeological and biogeochemical process patterns in the Mer Bleue Bog, Ontario, Canada. Depending on watershed area, either a bog system was maintained or trees invaded. Changed evapotranspiration and hydraulic characteristics, driven by increased decomposition of the soils, lead to distinct changes in hydrogeologic flow paths with recharging conditions in bog and discharging in treed areas, arguing that stability point exist for ecohydrological response. Altered vegetation and flow patterns corresponded to biogeochemical process patterns; under forest DOC concentration was increased, sulphate reduction dominated against methane production, syntrophic anaerobic microbial processes appeared to be partly disconnected according to thermodynamic analyses, and methane production was strongly reduced. A laboratory based analysis of these patterns demonstrated that humic substance enrichment may lead to suppression of methane production in such soils. In summary, a century of dry conditions triggered the development of two very different hydrological and biogeochemical systems with a different potential to produce and emit methane.

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***Abstract number 113* – CALIBRATION AND UNCERTAINTY ESTIMATION OF THE DAISY MODEL FOR WATER BALANCE IN OAK AND NORWAY SPRUCE STANDS IN DENMARK**

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A number of studies show that by different reason a contraction of agricultural area in the European Union is coming in next decades, where conversion of abandoned cropland to forest is expected in many areas. In Denmark, afforestation is included as a measured to reduce nitrogen and phosphorus discharges from diffuse sources in the current National Action Plan for the Aquatic Environment. In addition, the objectives of afforestation of the Danish countryside have changed from seeing afforestation as an alternative to agriculture on marginal agricultural land to seeing afforestation as a means for securing ecological diversity and recreational purposes. However, there is strong evidence to suggest that afforestation of abandoned cropland have a direct impact in the water balance affecting mainly the evapotranspiration and canopy interception rates and in consequence the water yield of an area. The development of computer simulation models has provided methods to explain how changing land use affects the hydrological fluxes. The aim of this study was to investigate the changes in the water balance with time following afforestation of former arable soils in a sandy loam in Denmark using the DAISY model and its performance was evaluated by considering uncertainty in model inputs using Generalised Likelihood Uncertainty Estimation (GLUE) methodology. The simulations used data from an afforestation area established 15 km west from Copenhagen, Denmark. From 1967 onwards, tree seedlings were successively planted on arable land. Three stands of common oak (*Quercus robur* L.) (planted 1993, 1979, and 1970) and three stands of Norway spruce (*Picea abies* (Karst.) L.) (planted 1997, 1988, and 1969) were selected to represent chronosequences ranging from 4 to 32 years since afforestation. Climatic data, throughfall measurements and soil water content measured using TDR equipment within fixed depth intervals of 0–0.2 m and 0–0.9 m, collected between 2001 and 2005 were used to calibrate the DAISY model. The simulated water recharge decreased with increased stand age, which was mainly due to increased interception evaporation with age. Results show that the GLUE estimates obtained (uncertainty bands 5% and 95%) agreed satisfactorily with measured monthly soil water contents at 0-20 cm and 0-90 cm. These results show that the Daisy model is applicable for predicting soil water content in afforestation studies in Denmark.

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***Abstract number 114* – APPLICATION OF AN INTEGRATED FRAMEWORK FOR PREDICTING NITROGEN LOSSES IN A COSTAL WATERSHED IN SOUTH-EAST SWEDEN**

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Drained agricultural land has been recognized as a major source of pollution to water bodies. Intensive use of fertilizers and manure to increase food production can enhance the risk of nitrogen (N) contaminating surface waters and groundwater, stimulating eutrophication. Nitrate-nitrogen (NO₃-N) contaminated drainage waters have been reported to be a main non-point source of pollution for surface waters. In coastal areas of southern Sweden, which are more prone to N leaching, N transport in lowland rivers has resulted in serious coastal eutrophication problems. This ongoing eutrophication has led to widespread hypoxia and large permanently reducing bottom areas in marine coastal ecosystems in southern Sweden. In developing management practices that alleviate the undesirable consequences of NO₃-N losses to aquatic ecosystems, a better understanding of the processes that regulate N dynamics in drained areas is needed. The development of computer simulation models has provided methods to describe the mechanisms of nutrient retention and release in these drained areas. In this study NO₃-N loading from a 734 ha coastal watershed draining into the Baltic Sea off south-east Sweden was simulated using a modelling approach in which the nitrogen model DRAINMOD-N II and a temperature-dependent NO₃-N removal equation were incorporated into the Arc Hydro-DRAINMOD framework. Hydrology and water quality data collected during six periods between 2003 and 2007 were used to test Arc Hydro-DRAINMOD and its performance was evaluated by considering uncertainty in model inputs using Generalised Likelihood Uncertainty Estimation (GLUE) methodology. The DRAINMOD-N II was run to predict NO₃-N load on 95 fields in the watershed, with input based on the individual characteristics of each field. The schematic network created by Arc Hydro tools was used to route the time series of simulated NO₃-N load from each field to the watershed outlet, then the load passed at the watershed outlet was reduced using a NO₃-N removal equation to estimate NO₃-N loading entering the Baltic sea. The GLUE estimates obtained (uncertainty bands 5% and 95%) agreed satisfactorily with measured monthly NO₃-N loads. Comparing the percentage of time where the observed NO₃-N loads were bracketed by the uncertainty bands yielded 71% and 67% in calibration and validation periods, respectively. These results show that the Arc Hydro-DRAINMOD framework can be an effective tool for estimating NO₃-N loading from coastal watersheds in southern Sweden. To improve framework performance additional measurements are needed, particularly of stream baseflow and N removal in the stream network.

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***Abstract number 116* – GROUNDWATER-SURFACE WATER INTERACTION ON REACH SCALE USING A TRANSIENT THERMAL MAPPING APPROACH**

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The quantification of groundwater-surface water interaction is one of the aspects related to the ‘good groundwater status’ demanded by the Water Framework Directive (WFD) (European Commission, 2000). On a local scale the information about the interaction can be investigated by using heat as a tracer (Anderson, 2005). The use of temperature has the advantage above other methods that it can be measured relatively easily and fast allowing a better spatial distribution of the collected field data. As a natural tracer it also does not alter the environment of the examined area. We present a methodology for modeling vertical advective fluxes of water in the hyporheic zone of a river using temperature profiles and time series data of river temperature as input. The temperature profiles have been measured on a regular basis during 1.5 years in the hyporheic zone of the Aa River, Belgium. The fluxes were estimated by inverse modeling of the one dimensional heat transport equation with the numerical STRIVE model in a transient set up. In comparison to the simpler thermal steady state analysis (Anibas et al. 2009) the transient approach offers several advantages as e.g. higher temporal distribution of the flux estimates and therefore better direct verification possibilities of the model results. The point estimates of flux adopted with STRIVE can be interpolated (Schmidt et al., 2007) over the surface area of the river allowing the calculation of dynamic net exchange rates and evaluation of the interaction processes on a reach scale. In combination with head measurements the temporal distribution of the exchange fluxes can be verified, down scaled and hence better process understanding obtained. Results of the groundwater-surface water interaction for the Aa River indicate strong seasonal effects with higher discharge rates in winter. Differences between two consecutive winter seasons however also revealed significant differences in flux. In the upper reaches of the examined river section higher fluxes and more heterogeneous flow patterns are observed. It is concluded that this difference is an expression of the geomorphology of the river valley and to a lesser extent the hydrogeological setting of the area.

***Abstract number 117* – HIDROGRAPHY AND WATER QUALITY PARAMETERS IN THE MEDIUM TAGUS RIVER**

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Hidrological and water quality parameter of 150 Km located between the Bolarque dam and the confluence between the Tagus and Jarama rivers in central Spain are shown. Sampled were taken four times during 2010. Here we show the preliminary results of chemical parameters (ionic chromatography), water quality parameters (temperature, conductivity, turbidity, dissolved oxygen and

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chlorophyll) together with currents measured by ADCP. We found a large variability in the physical and chemical properties of the water due mainly to the discharge of a saline stream. Results from more than one hundred transects performed by the Riversurveyor (Sontek) ADCP are also shown together with the bathymetry and flow in a selected area. Data obtained were used as input for numerical simulation and validation of output from the model. This study is part of a more extended project aimed to understand the actual flow and the needs of instream flow with individual based models (IBMs) methodology for a sustainable management of the river.

Abstract number 119 – THE EFFECTS OF GROUNDWATER SEEPAGE ON SUBMERGED FRESHWATER PLANTS

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Availability of inorganic carbon and/or nutrients often limits growth of submerged macrophytes in freshwater lakes. In temperate lakes, the availability of inorganic carbon and nutrients often show considerable seasonal variation with low concentrations in the growth season when nutrients are bound in living biomass, and much higher concentrations during winter when mineralisation processes dominate. Hence, rooted submerged aquatic plants may have a competitive advantage if they can tap into the rich inorganic carbon and nutrient source of the sediment and in this way sustain growth when the inorganic carbon and nutrients become depleted during the summer. When evaluating the possible sources of inorganic carbon and nutrients for plant communities in clear soft water lakes, the potential contribution by groundwater seepage is largely overlooked. Groundwater seepage contains high concentrations of inorganic carbon due to subsurface respiration processes and it is often rich in nutrients due to accumulation from the catchment area. As a consequence the nutrient balance within lakes as well as the chemical composition of pore water in the littoral zones, and thus the submerged vegetation, can be significantly affected by seepage. Studies have shown that seeping groundwater can contribute with up to 50% of the annual nutrient load to a lake indicating its vast importance in groundwater fed lakes. In this study it was examined how groundwater seepage, of varying magnitude and nutrients content, affected the growth of two species of submerged aquatic plants with contrasting morphology (*L. uniflora* (short rosette type plant) and *M. alterniflorum* (long ramifying plant)). In situ experiments were carried out in a north temperate lake on transects with contrasting land use in the catchment leading to different chemical signatures of the seepage water. To evaluate the relative importance of enhanced supply of nutrients and inorganic carbon, In Vitro experiments were carried out by percolating vegetated sediment cores with artificial groundwater while manipulating the nutrient content. The study concludes that groundwater discharge significantly enhances the growth of *L. uniflora* and that the growth responses are highly correlated to the seepage fluxes. We further show that the positive growth responses are primarily caused by increased availability of inorganic carbon, whereas enhanced availability of nutrients play a minor role when evaluating the effects on *L. uniflora*. The effects on *M. alterniflorum*, were minor, and indicate that morphological adaptation to root uptake of inorganic carbon and nutrients determines how sensitive the plants are to groundwater seepage.

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***Abstract number 120* – MODELLING TEMPORAL FLUCTUATIONS OF ABIOTIC SITE CONDITIONS FOR AN INLAND SALT MARSH**

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For both coastal and inland salt marshes, vegetation zonation is commonly observed. This zonation is usually related to the salinity levels and the frequency of inundation. Most research has focused on coastal salt marshes, while inland salt marshes have remained under exposed, especially regarding the temporal fluctuations of abiotic site conditions such as salinity and soil moisture. Often abiotic site conditions are measured only once while sampling vegetation (relevés). In this way, the temporal component is not taken into account, which means that the knowledge on the full range of abiotic conditions where a plant community occurs is limited. But it is known that plants show different vulnerabilities for abiotic site conditions depending on their development stage. In this research we therefore focus on this temporal component of the abiotic site factors salinity and moisture. During a one and a half year field campaign, the vegetation zonation of an inland salt marsh was monitored. Four locations were chosen based on the observed plant communities. During monthly field visits, data on soil moisture EC, nutrients and groundwater levels were obtained for these four locations and as a function of depth. These data revealed a significant spatiotemporal variability. For better understanding of the most important processes and quantification of these processes with regard to scenario studies, we initiated a model study using the 3D-DENS-SUTRA code. In the model study, soil moisture and salinity levels for each of the four locations of the field site were simulated. The resulting time-series lead to computed frequency distributions of wetness and salt concentration for the four vegetation communities, hence in the characteristic means and variances for each community. These can be compared with indicators for these abiotic factors as derived from the vegetations. This approach serves as an example of how to characterize different plant communities while taking into account temporal dynamics, and is therefore a classification based on the full range of abiotic conditions present during the growing season.

***Abstract number 121* – ESTIMATION OF SOIL WATER CONTENT AT INTERMEDIATE FIELD SCALE USING COSMIC-RAY NEUTRONS**

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The amount of water in the subsurface is a key factor influencing a range of hydrological and other processes. New measurement methods are investigated to obtain more information on this key issue. One of them is the so called cosmic-ray method, recently introduced for soil moisture measurements by Zreda and co-workers. Secondary neutron fluxes, product of the interaction of primary cosmic-rays at the land surface, are strongly moderated by the presence of water in or above soil (soil moisture, snow and biomass water). Neutron counts at the ground/air interface represent a valuable observation at intermediate spatial scale which can be used to quantify stored water while distinguishing different water holding compartments at the land surface. Classical monitoring networks of soil moisture, other geophysical methods and soil sampling were used to calibrate and to validate the cosmic-ray method. Experimental sites in Germany with different vegetation types were selected for testing the cosmic-ray method. Different proportional counters were tested for detection of secondary neutron fluxes and local meteorological data was used to set atmospheric correction factors. Variations of vegetation cover were monitored during the measurement period. Results show time series of water mass integrated over a land surface area of several thousand square meters. Areal mean values of soil moisture based on cosmic-ray neutrons and its observed temporal variability could be compared quantitatively with classical measurement techniques. First observations under different geographical conditions than reported so far are an initial step for further applications using cosmic-ray neutrons in these regions. Other activities

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such as monitoring of tree water content in forest, real-time soil moisture cross-sections in long distance and snow water equivalent height will have to be investigated to further improve the conversion of neutron counts in a mean soil moisture of a particular area. We believe that this new approach using cosmic-ray neutrons can cover the lack of data for hydrological processes at the intermediate scale between point measurements and large scale measurements, and thus will be important for improving hydrological approaches and catchment scale modeling.

***Abstract number 122* – THE SURFACE–GROUNDWATER CONNECTION--EFFECTS OF SURFACE WATER CONTAMINANTS UPON BACTERIAL TRANSPORT AND RE-ENTRAINMENT WITHIN A SANDY AQUIFER**

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Re-entrainment of attached bacteria-sized, carboxylate-modified microspheres and groundwater bacteria (*Pseudomonas stutzeri* and uncultured, native bacteria) were assessed during in-situ transport studies involving a shallow, organically contaminated, sandy aquifer. Aquifer sediments between pairs of injection and sampling wells were initially loaded with fluorescently labeled microspheres and bacteria that had been stained with the DNA-specific fluorochrome 4',6-diamidino-2-phenylindole (DAPI). In response to subsequent hydrodynamic perturbations and injections of deionized water (ionic strength reduction) and modest concentrations (76-77 μM) of common surface water contaminants, including the anionic surfactants, linear alkylbenzene sulfonates (LAS) and the non-ionic surfactant polyoxyethylene sorbitan monooleate (Tween 80), differing patterns of re-entrainment were evident for the two colloids. Injections of deionized water and anionic surfactant were the most efficient in causing detachment of the highly hydrophilic and negatively charged microspheres, but largely ineffective in causing re-entrainment of bacteria. In contrast, the nonionic surfactant was highly effective in re-entraining bacteria, but not microspheres. The surface charge and hydrophobicities of the aquifer bacteria were highly sensitive to modest changes (0.6 to 1.3 mg L⁻¹) in groundwater dissolved organic carbon (DOC), whereas the microspheres were largely unaffected. The most negatively charged and hydrophilic bacteria were isolated from pristine groundwater having the lowest DOC. FTIR spectra indicated that the community from the lowest DOC groundwater also had the highest average density of surface carboxyl groups. In contrast, the most hydrophobic and weakly charged bacteria were harvested from groundwater impacted by surface water contaminants. The findings indicated that elevated DOC deriving from the surface environment may have a biological effect on native aquifer bacteria that can alter their attachment and transport behaviors.

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***Abstract number 124* – VARIATION OF FAUNAL ASSEMBLAGES IN GROUNDWATER ECOSYSTEMS IMPACTED BY AGRICULTURAL LANDUSE**

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As global demand for groundwater increases, so does the requirement for knowledge on how humans are impacting the delicate and largely unknown ecosystem within. In rural Australia, groundwater is a valuable resource, providing much of the domestic, agricultural and industrial water needs. At the same time, such practices threaten ecosystem health through the use of agrichemicals, particularly in areas with shallow aquifers that have strong surface-groundwater interactions. Such contamination in Australian groundwaters is widespread. Thus differences in the groundwater biotic assemblages as a result of the agricultural practices on the land above are expected. The aim of this study is to identify spatial patterns in stygofaunal and microbial assemblages of shallow alluvial aquifers in areas of differing landuse. The study was conducted in the Gwydir River catchment, north-west NSW Australia. Our hypothesis was that intensive agriculture (particularly through the addition of carbon, nutrients and synthetic chemicals) will lead to changes in groundwater conditions. We predict that extra carbon and nutrients will alter microbial assemblages, with flow-on effects to the larger metazoan assemblages. We hypothesise that such effects will be greatest in irrigated areas because of greater hydrological connectivity to aquifers. Groundwater fauna and water quality were sampled in 19 bores over two years across the Gwydir River catchment. Stygofaunal specimens were identified to Genus where possible; however, as knowledge of groundwater biota in this region is limited, many specimens are currently only identified to the Family level. Microbial activity was measured using the cotton strip assay and the BiologTM Ecoplate methods. A diverse array of stygofauna was found, with copepods, amphipods, syncarids, mites and oligochaetes widely recorded. Heterogeneity of the stygal assemblages limited our ability to detect patterns related to agricultural practice, however from the study it was apparent that the community structure (both faunal and microbial) within the aquifer differed between landuses with increases in oligochaetes and copepods (both Cyclopoida and Harpacticoida) abundances in irrigated agricultural sites.

***Abstract number 125* – MULTI-SCALE APPROACHES TO THE UPSCALING PROBLEM – DETERMINING ECOSYSTEM-GROUNDWATER INTERACTIONS AND ALLOCATING WATER FOR THE ENVIRONMENT WITH DISJOINTED AND SPARSE INFORMATION AND LIMITED RESOURCES**

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The significant role of groundwater in the healthy functioning of many ecosystems across Australia was cemented as legal requirement for consideration in the national water reforms of COAG (1994). These changes are now impacting directly on water resource managers, resulting in 'the environment' appearing for the first time in many water management plans as a user in its own right. As environmental consultants in Australia our engagement is typically focused on the identification of groundwater and ecosystem interactions and subsequent estimation of environmental water requirements and provisions, to inform water management planning. In this respect, there is a need to identify groundwater-using ecosystems across large areas; often at a catchment-/ regional-scale fitting of the groundwater body and associated management plans, with the work undertaken limited in its ecological

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analyses by the available time and funding. The ecosystem-scale typical of the scientific community has an imperative role in such assessments, however is challenging to apply in the context of water management. The talk outlines a number of case studies in which different approaches to this 'upscaling problem' have been applied in Australia. The source, quality and extent (both spatially and temporally) of data is inherently variable across the country such that individual approaches must be tailored under a general strategy aiming to combine information about the ecology, lithology, geomorphology, hydrology and hydrogeology at a local-, catchment- and regional-scale. Examples include catchment-scale studies in which field observations were used to validate remote sensing analyses identifying likely groundwater dependent terrestrial vegetation. Comparatively, field survey of aquatic fauna and vegetation transects in the Collie River Catchment in WA, were combined with local geology and depth to groundwater data to identify likely interactions between groundwater, remnant river pools and riparian vegetation, as well as the common features/characteristics that may define them. Integration of these findings with regional vegetation/depth to groundwater mapping and LiDAR data allowed regional-scale mapping of potential ecosystems interacting with groundwater. The common theme in all case studies is the need to understand the ecological processes and or physiological characteristics that indicate and facilitate (or are likely to facilitate) inter-relationships between groundwater and ecological systems and use of this information to predict the likely occurrence of such interactions across large areas.

***Abstract number 127* – CONTROLS OVER DISSOLVED FE WITHIN GROUND AND SURFACE WATER MICRO-ENVIRONMENTS IN A SUBTROPICAL COASTAL SETTING, FRASER COAST, AUSTRALIA**

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A multi-disciplinary study of surface and groundwaters and their hydrochemistry with particular emphasis on controls over Fe distribution has been conducted in forested coastal catchments and the adjoining coastal plains on the Fraser Coast in sub-tropical Queensland, Australia. The aim of the study is to determine the distribution of Fe, other metals and nutrients and whether there is potential transport of them to the marine environment. Also considered in the study is the complexity and variable scale of hydrological systems in this setting. In coastal settings, there are many forms of mixing between groundwaters and surface waters, including interaction between aquifers and rivers, estuaries, bays and ocean shorelines; all potential routes for solutes such as dissolved Fe. Within these systems, processes that affect Fe dissolution and speciation can often add to dissolved Fe loads ultimately transported to the marine environment. The aim of this paper is to describe some of these processes occurring at three sites within the study area. Regional characterisation of ground and surface waters within the study area established that waters are typically Na and Cl dominated due to the presence of cyclic salts in local rainfall, and direct mixing of brackish-saline waters. These waters showed consistent proportions of major ions (Na⁺, Mg²⁺, Ca²⁺, Cl⁻, SO₄²⁻, HCO₃⁻) overall, but highly variable physico-chemical conditions (pH, Eh and DO), organic input and microbiological activity which can all affect dissolution, speciation and consequently transport of Fe within these systems. Three sites or micro-environments were the focus of this study: a) a freshwater pond excavated for forestry purposes within the southern catchment drainage system; b) a shallow pool with intermittent interaction with the drainage system in the northern catchment; and c) a shallow monitoring well within a semi-confined alluvial aquifer close to the drainage system in the southern catchment. All three sites had unique physico-chemical and morphological characteristics and as such were considered as micro-environments within the context of broader-scale regional processes. The main sources and processes identified are water column stratification, organic complexation of Fe and microbial activity contributing to concentrations and speciation of dissolved Fe at these sites using organic (DOC), physico-chemical, ionic (Fe_{total}, Fe²⁺), and isotopic ($\delta^{15}\text{N}$, $\delta^{34}\text{S}$ and $\delta^{13}\text{C}$) analyses. We also identify flow regimes, morphology and lithology

and relate them to various processes.

Abstract number 128 – THE MIXING CELLS MODELING APPROACH FOR IDENTIFYING AND QUANTIFYING HIDDEN SOURCES OF INDUSTRIAL POLLUTANTS INTO RIVERS AND SHALLOW GROUNDWATER SYSTEMS

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A Mixing Cells Modeling (MCM) approach has been developed to elaborate on complex and vague shallow groundwater flow system with hidden sources of contaminants. It provides the user with the ability to assess the groundwater fluxes in a complex and transient hydro chemical system in which the spatial distribution of pollutants vary with time. In such a system the boundaries and hydrological conditions along the boundaries are not sufficiently clear or distinct, and there is a lack of hydro-geological and hydro-chemical information. Thus it is difficult to construct, solve and calibrate a transport hydrological model based on the continuity equation. The MCM algorithm proposed in this study is therefore based on a more simplistic yet practical approach in which the flow domain is subdivided into pseudo- homogeneous flow cells forming a multi-compartmental MCM flow model. The creation of the multi-compartmental structure is based on spatial distribution of dissolved contaminants and on environmental isotopes and hydrochemistry in a transient hydrological system. This paper demonstrates the use of the MCMsf (steady flow) and MCMtr (transient flow) mathematical algorithms for identifying and quantifying hidden fluxes of pollutants into a river and shallow aquifer from chemical industrial complex. The MCM modeling scheme is solved by an optimization scheme which is based on water and the dissolved minerals and chemicals constraints.

Abstract number 129 – MODELING ECOHYDROLOGICAL PROCESSES WITH DYNAMIC VARIATIONS OF VEGETATION PHYSIOLOGY AND ECOLOGY

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Based on structures of the Distributed Hydrology-Soil-Vegetation Model (DHSVM), evapotranspiration estimation was improved in that minimum resistance of plant r_{smin} varies with precipitation for considering the role of plant water stress and adaptive mechanism under dry and wet climate conditions. A two-period recession analysis of the hydrographs was adopted for simulation of drought flow discharges according to characteristics of flood recessions and geological conditions. A small basin of Xingfeng in the Dongjiang red-soil hilly region, southeast China, was selected for modeling ecohydrological processes in this study. Ecological and hydrodynamic parameters related with vegetations and soils in the study basin were determined on the basis of remote sensing (RS) data as well as field and laboratory experiments. Hydrological and meteorological observation data during 2004 ~ 2008 were further used for parameter calibration and model verification. Perturbation analysis method was introduced for sensitivity analysis, revealing influences of changes of the soil and vegetation parameters on runoff and evapotranspiration. The simulated results demonstrate that our improved model can be used to simulate ecohydrological processes with dynamic variations of vegetation physiology and ecology and increases simulation accuracy in hydrological processes. This research offers a scientific base for analyzing eco-hydrological effects under the changes of land uses and land covers.

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***Abstract number 130* – IDENTIFICATION OF GROUNDWATER/SURFACE WATER DISCHARGE AND EVALUATION OF IMPACT ON A LOCAL STREAM FROM AN OLD LANDFILL**

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The Water Framework Directive passed by EU in year 2000 specifies chemical and ecological status for all water bodies. It recognizes also border areas between the water bodies to be important. The hyporheic zone is a region lateral and beneath a stream, where there is mixing of shallow groundwater and surface water and significant chemical and microbial activity. Old unregulated landfills are common all over the world. Typical landfill leachate includes inorganics, dissolved organic matter and xenobiotic organic compounds. The hypothesis in this study is that the hyporheic zone will cause significant attenuation of landfill leachate compounds, and that the discharge zone in a heterogenous geological setting will be focused, with significant concentration and redox gradient between the anaerobic plume and the aerobic stream. The scope of this study is to: (1) identify the discharge zone of Risby landfill leachate into a local stream through a heterogeneous clay till system (2) evaluate the chemical and ecological impact on the stream by an integrated investigation approach. The identified groundwater/surface water discharge zone will later be subject to microbial process studies on the degradation of landfill leachate contaminants. The activities involved a multidisciplinary approach. The landfill history, geology and hydrogeology were investigated and the landfill leachate was characterized with respect to key contaminants. The landfill leachate plume was delineated (90 samples) along the downgradient borders and contaminant concentrations were quantified with time along the stream (62 samples). Temperature differences along the stream (102 points) were measured between stream water and stream bed indicating the places of groundwater discharge. Finally, contaminated groundwater was sampled in flux chambers installed in discharge areas in the stream bed. In parallel to the hydraulic and chemical approaches, the ecological status of the stream was investigated. The landfill leachate had high values of inorganics (Cl=300-800 mg/L) and dissolved organic matter (14-56 mg/L). The leachate was anaerobic with high concentrations of iron (5-34 mg/l) and indications of sulfate reduction (b.d.t. - 25 mg/l). The results of delineation along the downgradient border in combination with the stream investigations revealed two distinct discharge areas. The stream measurements showed a clear chemical impact (ammonium, chloride, cations) downgradient these areas. Currently chemical analyses for xenobiotic organic compounds are carried out on samples from the discharge zone in order to deduce the attenuation processes and potential chemical stream impact (September 2010). Evaluation of ecological impact on the stream will be accomplished in autumn 2010.

***Abstract number 133* – CALIBRATION OF AVGWLF TO LAKE KINNERET WATERSHED (ISRAEL)**

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Significant water quality problems are caused by point and non-point source pollution. Recognition of the importance of non-point pollution sources has led to increased efforts in recent years to identify and quantify non-point source pollutant loads, especially at the watershed level. Watershed simulation

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models are commonly considered to be essential for evaluating sources and control measures of sediments and nutrients (N, P) loading to surface waters. Such models provide a framework for integrating data that describe processes and land-surface characteristics which determine pollutant loads transport to downstream water bodies. This research describes the application, calibration and verification of a hydrodynamic GIS-based watershed load model (AVGWLF) to the hydrodynamic and pollution loads of Lake Kinneret Watershed (Israel), as part of integrative lake-watershed management efforts. The AVGWLF model provides the ability to simulate runoff, sediment, and nutrient loadings from a watershed given variable-size source areas (e.g., agricultural, forested, and developed land). It also has algorithms for calculating septic system loads, and allows for the inclusion of point source discharge data. It is a continuous simulation model which uses daily time steps for weather data and water balance calculations. Sediment transfer is calculated on a daily base, while monthly stream bank erosion and nutrient loads are calculated based on the daily water balance accumulated to monthly values. The objective of the research was to simulate the base-flow, runoff, sediment, and nutrient loadings contributed from different point and non-point pollution sources to Lake Kinneret. The calibration was applied on a selected sub-basin in Lake Kinneret watershed, draining to Pkaka Bridg. Model calibration was conducted based on data from the period of January 1990 through December 1999, while validation was conducted based on the period January 2000 through December 2004. The calibration and validation results demonstrate a high correlation between predicted and measured daily and monthly water volume ($R^2=0.73$ & 0.87 , Nash–Sutcliffe = 0.65 & 0.82 respectively). The loads (sediments, P & N) calibration yielded a satisfactory correspondence between the predicted and the measured values (R^2 and Nash–Sutcliffe > 0.5). To improve the loads prediction calibration an equation based on the current and pervious month precipitation was derived. Using this equation the correlation between predicted and measured sediment and nutrient loads was greatly improved ($R^2 > 0.75$, Nash–Sutcliffe > 0.7 for all variables). Results from simulations will provide information on both water quantity and quality which is crucial for understanding and evaluating future management options for Lake Kinneret and its watershed.

Abstract number 134 – MONITORING AND MANAGEMENT OF A LAKE AND WATERSHED SYSTEM—LAKE KINNERET, ISRAEL

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Lake Kinneret is the only freshwater lake in Israel, supplying about 30% of the country's potable water. In the last 15 years, the lake has exhibited increased variability in water-level fluctuations and progressive deterioration of water quality. The latter is due mainly to instability of the phytoplankton association and the occurrence of cyanobacterial blooms. Monitoring water quantity and quality in the lake and its watershed provides the basis for decision-making in planning lake and watershed management. The Monitoring and Management Steering Committee (MMS) is the Water Authority's tool for supervising activities in Lake Kinneret and its watershed. The MMS coordinates the monitoring work of all organizations and serves as an advisory board for the director of the Water

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Authority by reviewing the information generated in research studies. Historically, Lake Kinneret water levels have ranged between 208.8 m and 213 m below sea level, serving as the upper and lower "red lines". Successive drought years between 1999 and 2001 and between 2005 and 2009 led to an undesirable decline in water levels below the lower "red line". Lake level is determined by inflows and water withdrawals, and the major management issue is therefore the decision of how much to pump out of the lake, mainly to the National Water Carrier. The MMSC helps the Water Authority director decide on the minimum water level allowed and the rate of level change that will minimize disturbance to the ecology of the lake while meeting consumers' needs for water supplied from the national water-supply system. The area of the watershed is 2730 km², of which ca. 75% is in Israel and the rest in Lebanon. Some 220,000 people live in the Israeli part of the basin in four cities and 180 rural settlements. Anthropogenic activity and sewage are the main pollution sources in the basin. Almost 100% of the sewage is treated and used for summer irrigation. The major part of the basin consists of farmland (e.g., orchards, crop fields), aquaculture, cowsheds, and cattle-grazing areas. Point source and diffuse pollution from these components is therefore a significant source of the potential pollutants in the watershed. The MMSC coordinates the management of the watershed and proposes best-management practices that will exclude point-source pollution and minimize diffuse pollution flows to the lake. This management includes fishery regulations within the lake, cowshed regulations, sewage-treatment management and management of the reflooded Hula Valley in the watershed.

Abstract number 135 – POSSIBLE EFFECTS ON LONG-TERM LAKE RESTORATION FROM EXCHANGE OF HIGH P-LOADED GROUNDWATER TO A SEEPAGE LAKE

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Water residence time is an important variable in lake-ecosystem management but for lakes interacting with groundwater it can be difficult to estimate, due to the often unknown or inaccurate determined exchange of lake water and groundwater. A study of Lake Væng, Denmark (16ha and max. 1.9m deep) demonstrates that the lake water balance and probably also water quality (especially Total Phosphorus, TP) to a large degree are controlled by the exchange with the surrounding aquifer. Results of the study confirm that the residence time in the lake is very short (20 days), e.g. the $\delta^{18}\text{O}$ signal of the lake is similar to groundwater confirming the high discharge of groundwater to the lake. Groundwater account for 66 % of the total water input to the lake (14.0 m/yr), surface water 30 % (6.4 m/yr), and precipitation 4 % (0.912 m/yr). In order to maintain a good ecological status, or clear water conditions in Lake Væng, TP concentrations in the lake should not exceed an ecological threshold for eutrophication of 30-50 $\mu\text{g/l}$ of TP. In piezometers placed systematically around the lake perimeter were measured 20 - 220 $\mu\text{g/l}$ of TP (median 90 $\mu\text{g/l}$ of TP) gen) typically above this ecological threshold. The exchange of water between the aquifer and the lake was analysed with a two-dimensional numerical flow model. It is demonstrated that the source of groundwater (and likely TP) is predominantly from west of the lake and that the lake bed characteristics control discharge to the lake; with part of the groundwater discharging right at the western shore line and the rest flowing in the eastern direction beneath the lake and discharging at the opposite more sandy eastern shore line. Model results show that groundwater

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discharge to the eastern shore is highest but discharge to the western lakeshore is still substantial even with a small thickness ($\leq 0.5\text{m}$) of a conducting sand lens. A better quantitative estimate on the mass flux of phosphorus through the riparian zones and springs are planned in our future research, including dynamic water level changes in the lake and periodic flooding of the riparian zones. It is unknown whether the phosphorus in the groundwater originates from marine geological sediments less likely loss of P from agricultural fields around the lake. However, the phosphorus content in the surrounding groundwater is so high that it is very likely that the positive effect of lake restoration with fish removals will not have a continuous effect without periodic follow-up reduction in the population of roach and bream.

Abstract number 137 – WHAT CONTROLS NITROGEN CYCLING IN THE BED OF A GROUNDWATER-FED RIVER?

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Nitrogen transformations in the hyporheic zone are the result of a complex interplay between chemical, physical and biological processes. The importance of biogeochemical conditions and water residence time on subsurface nitrogen cycling has been demonstrated. Mixing of different water sources however, is often overlooked as a mechanism that could affect nitrate concentrations within the hyporheic. Here, we present findings from two field campaigns conducted during base flow conditions in the River Leith, Cumbria UK. The reach chosen had previously been identified as a zone of groundwater accretion. Local groundwater nitrate concentrations greatly exceed those observed in the river (e.g. 5 mg N/L versus 2 mg N/L). The objective of our research was to characterise processes that affect the nitrate content of the upwelling groundwater before discharge into the surface water environment. Pore water was collected from more than 100 depth-distributed samplers associated with a piezometer network (maximum depth = 1m) installed throughout a 250m section of the river. Water samples were also collected from piezometers within the riparian zone and a deeper groundwater borehole. Collected waters were analysed for a suite of parameters to investigate both groundwater – surface water mixing and nitrogen biogeochemistry within the river bed. The carbon content, grain size distribution and microbial activity of sediment recovered during piezometer installation was characterised. Measurement of groundwater upwelling strength (vertical hydraulic gradient, hydraulic conductivity) was also performed. Conservative chemical species (e.g. chloride) were used to construct a mixing model to characterise the source(s) of water within the river bed. It was revealed that at least three end members – surface water, groundwater and bank exfiltration – contribute water to the bed of the river, even under base flow conditions. Results from the mixing model were also used to assess the importance of mixing on nitrate dynamics within the river bed. Mixing alone could not adequately explain changes in pore water nitrate concentrations observed at many points within the study reach. Regions of both potential nitrate gain and nitrate loss within the river bed were identified. Interestingly, many of these areas of inferred biogeochemical activity were deeper than the zone of groundwater – surface water mixing. Where mixing failed to account for changes in pore water nitrate concentrations in the sediment profile, chemical, biological and other physical mechanisms were investigated. Preliminary results confirm that it is indeed a combination of physical, chemical and biological processes that influence the amount of nitrate removal that occurs along an upwelling groundwater flow path.

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***Abstract number 138* – RESOURCE PARTITIONING IN AN UNPREDICTABLE ENVIRONMENT:
USING STABLE ISOTOPES TO UNDERSTAND AQUATIC SUBSIDIES AND NICHE POSITION OF
SPECIALIST RIPARIAN COLEOPTERA**

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Stable isotope data ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) were collected from an assemblage of riparian Coleoptera and their potential prey to examine variations within the trophic structure of a community inhabiting a fragmented and highly disturbed habitat. Specialist riparian arthropods are known to utilise a subsidy of emerging and drifting aquatic prey, allowing them to persist within an otherwise nutrient poor environment. However, inhabiting the riparian: aquatic ecotone requires a suite of adaptive strategies to overcome the environmental pressures of frequent flooding and loss or reworking of habitat. These strategies are known to include morphological and behavioural adaptations which either enable survival during inundation, or maximise avoidance. What is not clear is how these adaptations also affect prey acquisition amongst predatory or scavenger species in an environment where resources are largely allochthonous. The study area was a 7km stretch of the River Severn with large areas of exposed riverine sediments forming the riparian: aquatic boundary. This habitat has an extensive and well studied community of specialist Coleoptera associated with it. 20 sites were sampled for terrestrial predators, terrestrial prey and aquatic prey. Each site was also mapped using DGPS to assess area and inundation potential. Morphological variations were measured and used to assign predator species to functional groups before stable isotope analysis. Stable Isotope data were input into a Bayesian mixing model (SIAR v4), and run as both a two and four source model, using ecologically probable potential prey. Outputs revealed the likely contributions of these sources to the diets of each functional group. Results show that there is a clear relationship between the degree of specialisation and the level of aquatic nutrients in the diet. Species with strong morphological and behavioural adaptations exhibit the greatest use of the aquatic subsidy, with the level decreasing along a gradient toward those species with no known affinity to the riparian environment. Investigation of trophic separation provides confirmation that the Coleopteran fauna associated with this habitat contains multiple niches and a level of resource partitioning that increases diversity in a superficially resource deficient environment. The role of inundation and area reveal the requirement of highly specialised species have for high quality habitat that experiences regular flooding and aquatic subsidies, without these, the most specialised species are likely to be at a competitive disadvantage to less specialised species

***Abstract number 139* – IMPLICATIONS OF GROUNDWATER-SURFACE WATER CONNECTIVITY
FOR NITROGEN TRANSFORMATIONS IN THE HYPORHEIC ZONE**

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An integrated approach to catchment management, which recognises the connectivity between groundwater and surface water, is an integral requirement of the Water Framework Directive (WFD) in the European Union. One area of particular interest to scientists and environment managers is the hyporheic zone, perceived to be a dynamic, redox reactive zone with considerable potential for contaminant attenuation. There is already a large body of literature on the hyporheic zone, but considerable scientific challenges remain, not least in understanding the role of the hyporheic zone in regulating water quality and ecosystem health in nutrient-rich lowland agricultural landscapes where there are increasing pressures on both groundwater and surface water resources. For example, the threat of warmer, drier summers, associated with climate change, puts new urgency on understanding the

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importance of the hyporheic zone in groundwater-fed rivers under baseflow conditions. Areas of current scientific effort include exploring the complex three-dimensional flow pathways of surface water-groundwater exchange in the hyporheic, establishing the various scales of this surface water-groundwater exchange and their associated dynamics, and understanding the effect of these exchanges on chemical fate and transport, such as nitrogen and phosphorus cycling. In this presentation we report selected results from a major multidisciplinary research project examining nutrient attenuation in the hyporheic zone, focusing on a 500 m gaining reach of the River Leith (Cumbria, UK). The purpose is to demonstrate our approach to current scientific challenges facing research in the hyporheic zone. The overall objective of the project is to couple hydrological, geophysics and biogeochemical data to determine the effectiveness of the hyporheic zone for removing nitrate from groundwater. We have (i) used a nested instrument approach to establish the direction and flux of flow pathways within the hyporheic using dilution techniques; (ii) investigated spatial variation and controls on the magnitude of SW-GW mixing to one metre depth in the hyporheic zone using a combination of chemical and isotopic natural tracers with temperature; and (iii) measured rates and magnitudes of nitrogen cycling over different scales in the hyporheic using sediment potential assays, push-pull and DET techniques. This presentation will discuss how the results from these various techniques have been combined in order to evaluate whether attenuation of nitrogen in the hyporheic zone is a realistic expectation for the maintenance of the ecological quality of groundwater-fed rivers.

Abstract number 140 – GROUNDWATER VULNERABILITY OF MOUNTAINOUS CATCHMENTS UNDER DROUGHT CONDITIONS IN SWITZERLAND

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Groundwater storage in mountain regions takes place in fractured rock, moraines, alluvial valleys and talus slopes. Such small-scale geological and morphological structures are therefore important water reservoirs and represent in their entirety the total water storage of mountain catchments. Even though groundwater modeling is widely used to study lowland and porous media, there is still a lack of research in mountainous regions where measured data is often sparse. Particularly under drought conditions it is necessary to analyze subsurface processes to identify the vulnerability of mountain areas. The complexity in modeling these systems lies in the trade-off between realistic representation of the complex system and the model uncertainty caused by a poor database. We study 25 heterogeneous mesoscale catchments in Switzerland to understand the sensitivity of storage in mountain catchments to drought conditions. Our methodology is based on a combination of groundwater modeling and stable isotope applications to recognize and validate mountain storage characteristics. Two groundwater models will be compared: the three-dimensional finite element model FEFLOW and a physically-based spatially explicit hillslope model – HillVi. Both models are well suited to simulate hydrological processes in mountain regions and evaluations are based on stable isotope O18 samples from precipitation, runoff and groundwater. Through our study, we expect to achieve an improvement in our understanding of small-scale storage structures and their contribution to the total groundwater storage in alpine and pre-alpine catchments.

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***Abstract number 141* – MEASURING RIVER BED DENITRIFICATION: AN IN SITU APPROACH**

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Denitrification represents a recognised important sink for nitrate in many aquatic ecosystems, yet quantifying it in the hyporheic zone is challenging. Here we contrast rates of denitrification measured in the laboratory for recovered sediment, with those measured in situ in the intact sands and gravels of the River Leith, Cumbria, UK, using 'push-pull' methodology and ^{15}N -Nitrate. Sediments for the initial laboratory incubations were collected from depths of up to 85cm in June 2009, while the in situ measurements were performed at depths of between 3 to 40cm during the summer in 2009 and 2010. In the laboratory, denitrification was highest for the shallow sediments (<20cm) recovered from the riffles, at up to 16 nmol N g⁻¹ (dry wt) h⁻¹ and, on the whole, denitrification was greater in the riffle sediments than those from the pools. Overall, denitrification decreased with sediment depth to below detection at 40cm, though the decrease with depth was strongest in the riffles. In situ we also measured a decrease in denitrification with sediment depth but the in situ rates of denitrification were approximately 100-fold less. Due to water depth, we could not make measurements in the pools. The lower rates of denitrification measured in situ may be due to moderate hypoxia in the river bed being replaced by true anoxia in the laboratory. In addition, measuring denitrification in situ is complicated by both advection and dispersion which can dilute both the ^{15}N tracer, and any ^{15}N -N₂ produced by denitrification. To account for the effect of advection we added chloride to the ^{15}N tracer, and used the decrease in chloride to correct the nitrate and N₂ concentrations. The lack of denitrification at depth suggested carbon limitation and we tested this hypothesis by adding carbon. Rather than the addition of glucose, which is widespread in such studies, we added a more complex mixture of organic substrates (0.025 g L⁻¹ Nutrient Broth). As expected, the addition of organic substrates stimulated denitrification; however, the increase in denitrification was neither the same at each depth, nor between riffle and pool sediments. For example, with surface sediments, we measured an almost complete stoichiometric equivalence between organic carbon added and ^{15}N -N₂ gas produced (~90%) but, at depth, this fell to < 30 %, suggesting that the denitrifying communities' ability to metabolise complex organic matter decreases with depth.

***Abstract number 143* – MODELLING SURFACE WATER / GROUNDWATER INTERACTIONS IN STREAMS CONNECTED TO EXPLOITED ALLUVIAL AQUIFERS BY MEANS OF HYDROCHEMICAL DATA**

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Alluvial aquifers have been traditionally exploited to fulfill water needs for any demand. Human development from the last decades withdrew groundwater from these aquifers which ended up with capturing water from nearby streams. Such management practices did not recognize the stream-aquifer interaction. Minor streams –i.e., those with thin alluvial formations and mean discharge rates below few cubic meters per second–, are thus affected, and such pressures go on as long as human demand is being supplied. Modelling stream discharge and hydrochemistry permits determining the origin of surface water, as well as of groundwater, and identifying the contribution of distinct end-members to the

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existing water resources in the overexploited alluvial reach. In this study, we investigate the origin of water resources in an intensively exploited stream-connected alluvial aquifer to provide potential strategies to locally ease the above mentioned human impacts. This research was conducted in the Tordera River basin (NE Spain) along a 5 km reach. The beginning of the reach is located at the confluence of a small creek, a waste water treatment plant and the major stream: the Tordera River. Discharge measurements and water samples for hydrochemical analyses were taken at different points to track discharge and chemical variations along the river. Active wells located in the alluvial aquifer were also sampled. Hydrochemical data pointed out that surface water was a mixing of distinct sources, namely, the upstream contribution of the Tordera River, that of its tributaries, the effluents from the waste water treatment plant, and additionally, groundwater contribution. Conversely, groundwater hydrochemistry also showed the influence of surface water infiltration, as expected because of the loosing stream behavior. The use of bromide as a tracer of the different sources has been significant in the hydrochemical interpretation. The main outcome from this survey indicates that surface water gets a contribution from groundwater at the beginning of the investigated reach. This contribution is attributed to the occurrence of preferential large-scale groundwater flows through regional fault lines. End-member mixing analysis shows that this specific contribution was up to a 20% of the total discharge. From a management perspective, groundwater now appears as an alternative to water supply. Wise exploitation of such resources will ease the pressures upon the alluvial aquifers, and hence to the stream discharge allowing a more frequent achievement and maintenance of the recommended instream discharge and ecological preservation. This study was funded by Spanish government (MEC) project CGL2008-06373-C03-03/BTE.

Abstract number 144 – EFFECTS OF THERMAL ENERGY USAGE ON SHALLOW GROUNDWATER ECOSYSTEMS

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The use of groundwater as a carrier of thermal energy is becoming more and more important as a sustainable source of heating and cooling. At the same time, the present understanding of the effects of aquifer thermal usage on geochemical and biological aquifer ecosystem functions is extremely limited. Recently, in a pioneering study, we have assessed the effects of groundwater heat discharge on the ecological integrity of an oligotrophic, energy-limited, shallow aquifer. We have monitored hydrogeochemical, microbial, and faunal parameters in groundwater from the vicinity of an active thermal discharge facility. The observed seasonal variability of abiotic and biotic parameters between wells was considerable. Yet, no significant temperature impacts on bacterial or faunal abundances and on bacterial productivity were observed. Also, standard microbiological drinking water analyses did not indicate an improved survival or growth of faecal bacteria with temperature. In contrast, the diversity of aquifer bacterial T-RFLP fingerprints and faunal populations was either positively or negatively affected by temperature, respectively. Statistical analysis indicated that both, the impact of infiltrating surface water from a nearby river (seasonal hydrology) and temperature were important drivers for the observed variations in aquifer biota. In follow-up laboratory experiments temperature induced effects, simulating a cooling and heating mode, were investigated for (i) non energy-limited conditions, (ii) the fate of a

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model contaminant (toluene) amended and (iii) the retention and survival of *E. coli*. Now, under these conditions, significant changes were found not only for the composition of bacterial communities but also for further microbial patterns. Moreover, the active distribution within a temperature gradient from 2°C to 30°C was investigated for selected groundwater invertebrates (amphipods, isopods). In all cases their distribution revealed a bell-shaped curve with the highest frequency of appearance between 10-12°C, which corresponds to natural conditions. Short-term incubations (48h) of invertebrates in temperature dose-response tests resulted in LT50 (lethal temperature) values of 23.2°C and 17.7°C for *Niphargus inopinatus* and *N. cf. bajuvaricus*, respectively. *Proasellus cavaticus* exhibited a LT50 value of 18.8°C after 48h. With respect to the slow metabolism of groundwater animals and possible long exposure times in heat impacted aquifers, results from long-term experiments have to be considered as well. Indeed, the selected invertebrates showed significantly lower LT50 values after several days and weeks of incubation; values which repeatedly dropped below the maximum upper thresholds for geothermal use permitted by legislation in Germany and other European countries. Our findings clearly point at an urgent need for further ecological studies with respect to geothermal energy use in shallow groundwater ecosystems.

***Abstract number 145* – GROUNDWATER THRESHOLD VALUES DERIVED FOR PROTECTION OF ASSOCIATED AQUATIC ECOSYSTEMS – SELECTED EXAMPLES FROM DENMARK**

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Pollution loads such as nitrogen and phosphorous from agricultural activities result in increasing problems for groundwater and associated aquatic and terrestrial ecosystems, globally. Even marine coastal waters are strongly affected by nutrient loads in areas such as the Baltic Sea and the Mexican gulf with e.g. increasing risk of harmful algal blooms and hypoxia events as well as loss of underwater vegetation and fish resources. Further, the effect of projected climate changes will increase the stress on water resources and ecosystems. For Denmark an expected increase in winter precipitation may lead to increasing nutrient loads to ecosystems if agricultural practices are not changed. Hence there is a strong and increasing need to regulate and reduce nutrient loads in order to protect water resources and aquatic ecosystems. The European Commission has recognised this and adopted the Water Framework Directive (Directive 2000/60/EC) and the Groundwater Directive (2006/118/EC) in order to establish a common framework for actions in the field of water policy and protection of water resources and ecosystems. The EC directives recognise that the different water bodies in the hydrological cycle is closely linked, and that e.g. the quantitative and chemical status of groundwater affects terrestrial and aquatic ecosystems. Hence, the Groundwater Directive stipulates that EU member states have to derive groundwater threshold values for all relevant pollutants that may put ecosystems at risk in order to assure at least good ecological status. However, only a few attempts have been made so far to derive groundwater threshold values based on environmental objectives and sustainable loads to ecosystems in general, and coastal waters in particular. Here, we assess the status of, and sustainable loads to selected Danish estuaries located in the Western Baltic by e.g. the use of coupled groundwater and surface water models.

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Based on these assessments we derive groundwater threshold values for N and P in the catchment of the estuaries in order to assure compliance with good status objectives. The selected Danish estuaries and catchments have been investigated in several recent studies. The principles used in the derivation of groundwater threshold values in this study will also apply for other types of ecosystems such as lakes, streams and groundwater dependent terrestrial ecosystems, which are also addressed briefly.

***Abstract number 148* – SCALE EFFECT INFLUENCED LAKE-GROUNDWATER INTERACTION IN SALINE ENVIRONMENT, DANUBE-TISZA INTERFLUVE, HUNGARY**

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Investigation of groundwater and surface water interaction is in the focus of present day research activities. The management of groundwater dependent ecosystems, implementation of EU Framework Directive, and the protection of lakes and wetlands all require the understanding of the interaction between groundwater on the surface waters. Kelemenszék Lake and the Danube Valley in Hungary is a key area to understand the connection between flow systems with high order of magnitude and the correlating surface phenomena, the wetlands and the surface and groundwater salinization. In the area an overpressured saline regime originated from the Pre-Neogene basement and a gravity-driven fresh water flow regime are prevalent. The lake is situated in the regional scale discharge zone of the two flow regimes. Detailed hydraulic investigations around the lake proved that the larger scale discharge is superimposed by local flow-through condition. The NW–SE sloping water table is determined by the elevation difference between a local topographic height to the west from the lake and the Dunavölgy Canal to the east. The local flow system around the lake is mainly determined by flow-through between these boundaries down to 20 m depth. The connection of the lake and groundwater is seasonally different and influenced by changes of the water table distribution. The water amount of the lake is mainly determined by the evaporation and precipitation and, to a lesser extent by the groundwater. The net groundwater flow contribution to the lake changes from ± 0.06 to ± 3.2 mm/d. The changing groundwater in- and outflow components compensate each other in the annual budget. Regarding the salinization detailed investigation proved that the saline water of the Pre-Neogene basement and the Neogene basinfill ascend to the surface at the eastern side of the lake transporting salt to the surface salinization. The local flow system around the lake is hydraulically perched on this ascending saline water which can contact this shallow system by diffusion. On conclusion, the lake is situated in a regional discharge area, but its water budget quantitatively is not influenced by the regional flow systems, only by the local one around the lake. Nevertheless, the saline ascending flow system is responsible for developing the main chemical pattern around the lake. This example highlights the influence of scale effect on the understanding of the interaction between lakes and groundwater which is proposed to consider during the implementation of the EU Framework Directive.

***Abstract number 149* – SENSITIVITY OF HEADWATER STREAM TEMPERATURE TO RIPARIAN LAND MANAGEMENT**

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River water temperature is an important and highly sensitive variable affecting physical, chemical and biological processes. It is particularly important for aquatic organisms that cannot regulate body temperature, such as salmonids. Stream temperature is controlled by transfers of heat and water to/ from the river system, with land and water management impacting on these exchanges and modifying river thermal characteristics. Currently, several organisations are promoting riparian forest planting as a climate change adaptation measure to reduce water temperature extremes and to improve river thermal habitat for salmonids. However, the scientific evidence for such management decisions is limited. To address this research gap, this paper analyses long-term data sets from Scottish field sites (in Loch Ard and the Cairngorms) to assess headwater stream temperature sensitivity under different forest treatments, including open moorland (control), semi-natural woodland and commercial forest. The programme of research aims: (1) to characterise spatial and temporal variability in riparian microclimate and stream water temperature regime across forest treatments; (2) to identify the hydrological, climatological and site-specific factors affecting stream temperature; (3) to estimate the energy balance at sites representative of each forest treatment and, thus, yield physical process understanding about dominant heat exchanges driving thermal variability; and (4) to use 1-3 to predict stream temperature sensitivity under different forest treatments and hydroclimatological scenarios. Results indicate mean daily water column temperature is warmer for open moorland than forest sites in winter, but cooler in summer. Daily water column temperature range is greater for open than forest sites. Daily air temperature is cooler, humidity is lower, and wind speed is much higher for open than forest. Net radiation is the dominant heat sink in autumn-winter and major heat source in spring-summer for open and summer for forest. Net radiation is greater in summer and lower in winter for open than forest. Sensible heat is an energy source in autumn-winter and sink in spring-summer, with loss (gain) greater in summer (winter) for open than forest. Latent heat is predominantly a sink, with magnitude and variability higher for open than forest. These findings yield new insights into: (1) dynamic heat exchange processes that drive stream temperature under different forest treatments, and (2) extent and scales of influence of riparian land cover on headwater stream response. This research provides a basis to predict stream thermal impact given advocated changes to forest practice, and has potential to inform decision making by land/ water managers.

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***Abstract number 150* – PERFORMANCE EVALUATION OF CROP COEFFICIENT MODELS IN THE ESTIMATION OF WEEKLY CROP EVAPOTRANSPIRATION**

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Evapotranspiration is one of the major components of hydrologic cycle and its accurate estimation is essential for many studies such as hydrologic water balance, irrigation system design and management, crop yield simulation, and water resources planning and management. Because of the interdependence of most of the factors affecting evapotranspiration and, their spatial and temporal variability, it virtually may not be possible to formulate an equation that can be used to estimate crop evapotranspiration (ET_c) for different crops under different climatic conditions. A two step approach is applied to estimate ET_c, the atmospheric demand is quantified through the calculation of reference ET (ET₀), and the surface characteristics are incorporated into a crop factor called as crop coefficient (K_c). The widely used reference equations for accurate estimation of ET₀ are of the combination type and the one recommended by FAO 56 is the physically based Penman-Montieth (PM) equation. However, the precise information on K_c is a major impediment in many regions. The K_c values suggested by earlier investigators based on lysimeter measured ET_c have to be locally calibrated to account for the differences in crop canopy under given climatic conditions. The daily climatic data and crop evapotranspiration data at the meteorological centers of Tirupati, Nellore, Anakapalli, Rajahmundry and Rajendranagar regions of Andhra Pradesh, collected from the meteorological department, Pune, India were used in the data analysis and model development. A part of the data was used for model development and the rest for model validation. The performance of the models developed was evaluated by numerical and graphical performance indicators. The present study derives weekly K_c values for groundnut, paddy, sugarcane, tobacco and castor crops commonly grown in the regions and compares them with those computed based on the procedure recommended in FAO 56. The K_c curve, fitted to follow the trend similar to that recommended in FAO 56, significantly deviated for most of the crops in the regions at different stages of crop growth, barring a few exceptions. A third order polynomial K_c models for different crops in the regions have therefore been developed for use in the ET_c estimation for weekly time step. The study also compares ET_c computed using PM ET₀ values and, K_c values derived from the models proposed with that of observed ET_c. It has been observed that ET_c values computed based on K_c values estimated using the models proposed are comparable with those of lysimeter measured ET_c.

***Abstract number 152* – LOCAL PHYSICAL HABITAT QUALITY CLOUD THE EFFECT OF PREDICTED PESTICIDE RUNOFF FROM AGRICULTURAL LAND IN DANISH STREAMS**

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In Denmark 62% of the total area (43,000 km²) is used for agriculture. Total length of the stream network is 64,000 km, the majority of which are small (< 2 meters wide). The combination of intensive agricultural activities and the close connectivity between land and stream being enhanced artificially by drainage and narrow buffer strips (2 meters) emphasise the potential risk of pesticide exposure. Benthic macroinvertebrates are applied in the assessment of stream ecological status, and some sensitive species

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have been shown to respond strongly to brief pulses of pesticide contamination. In this study we investigate the impact of agriculturally derived pesticides on stream macroinvertebrate communities in Denmark. As a measure of toxic pressure we apply the Runoff Potential model that has been developed to quantify the risk of pesticide runoff to streams from agricultural land. We investigated a total of 212 streams. These were grouped into distinct classes according to the magnitude of pesticide contamination in the period from 2004-2007. A total of 24 different macroinvertebrate indices were applied to detect effects of pesticide runoff (e.g. the SPEAR-index, # EPT taxa and the Saprobic index) on the macroinvertebrate community. We found high predicted pesticide runoff in 39% of the streams, but we found no significant effect of predicted pesticide exposure on stream macroinvertebrate indices. We, additionally, examined the influence of a series of environmental parameters ranging from site scale to catchment scale on the macroinvertebrate community. Relative proportions of gravel and silt on the sampling site explained most of the variation in macroinvertebrate indices as well as the upstream riparian habitat quality. We infer that the influence of these parameters is strongly interconnected, because agricultural activities in addition to pesticide contamination also involve comprehensive habitat degradation (facilitated by channelisation, dredging activities and siltation) and eutrophication. It is therefore a major challenge in future investigations to disentangle the effects of pesticides from those of other environmental stressors across different spatial scales and an experimental approach may be highly useful in meeting this challenge.

***Abstract number 153* – LINKAGE BETWEEN GROUNDWATER-LAKE WATER-EXCHANGE AND BIOGEOCHEMISTRY IN AN ACIDIC MINE LAKE**

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Lake sediments are of major importance for the turnover and balance of solutes, e.g. nutrients and – especially in acidic mining lakes – acidity and thus the chemical water quality of such lakes. Mining lakes are characterized by a low pH < 3 and inflow of groundwater with a moderately acidic pH and high concentrations of ferrous iron and sulfate, driving biogeochemical processes in the sediments. Lake sediments are the interstitial zone between groundwater and lake water and often characterized by hydraulic and biogeochemical gradients. Due to high differences in the chemical composition of the adjacent water bodies, biogeochemical gradients in mine lake sediments are particularly strong and might be controlled by groundwater-lake water-exchange. Therefore, we choose a mining lake as a model system to study interactions between groundwater flow and biogeochemical processes. We quantified flow rates by means of seepage meters, studied the pore-water using peepers, and analyzed the lake sediments. The lake water was characterized by groundwater inflow (up to +7 L/(m²d) in the north and outflow (< -3 L/(m²d) in the south, except for some local hotspots. Both, infiltrating and exfiltrating conditions modified the chemical composition of the sediment pore-water. High pore-water concentrations of sulfate and ferrous iron were observed where groundwater infiltrated into the lake (> 10 mmol/L, each) while they were lower at outflow sites. At some inflow sites, the concentration depth profiles of iron and sulfate indicated an active turnover of these solutes either via reductive processes or through mineral transformation of the iron oxide schwertmannite to goethite. Furthermore, the pore-

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water pH was higher at inflow sites (below or above pH 3.5...4, respectively). A higher pH is a driver for several biogeochemical processes, e.g. sulfate reduction or schwertmannite transformation and might thus have triggered the active turnover, there. In order to resolve the interplay between hydrology and pore-water composition on sediment characteristics (e.g. iron and sulfur reduction rates, mineral composition), we performed a multivariate statistical analysis of the measured sediment parameters. Using cluster analyses we found 5 clusters which grouped samples with similar sediment characteristics. The spatial cluster pattern could be partly related to the observed hydrological pattern. For instance, clusters which combine samples with high pH, sulfate concentrations, and high reductive turnover are found in the northern part of the lake. Our study thus clearly indicates that biogeochemical processes in the sediments are driven by groundwater flow.

Abstract number 157 – EXPERIMENTAL IMPACT OF AMMONIUM, CARBON DIOXIDE AND WATER LEVELS ON AMPHIBIOUS SOFTWATER PLANT COMMUNITIES

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In this study on amphibious softwater macrophytes it was tested whether existing knowledge of ecological niche and life strategy readily allow valid predictions on community composition (relative performances of species) and competitive interaction mechanisms under different nitrogen and carbon levels. Softwater lake habitat was simulated during one growing season in laboratory conditions, regarding water level fluctuation, photoperiod and temperature. Experimental communities consisted of small populations of the 4 softwater macrophyte species *Luronium natans*, *Baldellia ranunculoides* ssp. *repens*, *Eleocharis multicaulis* and *Hydrocotyle vulgaris*. These communities were subjected to two levels of carbon dioxide and ammonium, with the levels being monitored in both surface and ground water. Monocultures of *Baldellia ranunculoides* ssp. *repens* and *Eleocharis multicaulis* were grown at the high nutrient level combination in order to measure their competitive response in community. The experiment pointed out that water level (hydrological stage) and species identity were the only consistently significant factors to the community outcome. The competitive response was in accordance with expectations. Carbon dioxide had a supplementary effect on the within-species performance in *Luronium*, *Baldellia* and *Eleocharis*, with the high level mainly resulting in more flowers and more stolons. The results generally match the competitive hierarchy model of Keddy, with *Hydrocotyle* as the competitive dominant and the other species as subordinates. However *Baldellia* performed less at the presumed most preferred end of the habitat gradient, so that the assumption of inclusive fundamental niches of Keddy's model may not always hold.

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***Abstract number 158* – MODELLING OF SOIL SODICITY DEVELOPMENT DUE TO CAPILLARY UPFLOW OF SALINE GROUNDWATER IN THE STOCHASTIC ECOHYDROLOGICAL FRAMEWORK**

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The occurrence of salt affected soil is a main hazard to agriculture especially in the semi-arid regions. The effective management of salt affected soil requires adequate understanding, not only of how water and, hence, salt are transported in the rootzone, but also how water, salt, and composition of salt interact with each other in groundwater dependent ecosystems. Groundwater uptake can be an important source of water, salt and composition of salt in semi-arid areas and therefore capillary pressure induced upward water flow may cause rootzone salinization and then as a result soil sodication. To identify which conditions may lead to either acceptable or hazardous salt concentrations or hazardous level of soil sodicity in the rootzone, we combined the mass balance equations for water, salt, and calcium assuming Poisson-distributed daily rainfall and brackish/saline groundwater. Due to temporal development and interaction of soil water, salinity and sodicity, wetter climate leads to a less saline rootzone in general and relatively lower order of magnitude of soil sodicity (ESP). As ground water levels become shallower, this leads to wetter conditions that favor leaching in dry climates. For these wetter rootzone conditions, the concentration of salt in the soil solution takes relatively less time to approach a steady state, but soil ESP takes relatively more time to have a steady state condition which of course depends on the groundwater ESP, groundwater depth, soil and vegetation properties, rootzone salinity, exchange rate of cations between soil solution and exchangeable complex, and climate. The quantification of these factors affecting soil salinity and sodicity can lead us towards effective management of sustainable agriculture.

***Abstract number 162* – SPATIOTEMPORAL PATTERN OF GROUNDWATER-LAKE-EXCHANGE DURING A LAKE WATER LEVEL MANIPULATION EXPERIMENT**

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Beside groundwater-surface water exchange the water balance of lakes is driven by precipitation, surface water inflow and outflow, evaporation and storage. All parameters may vary with implications on the exchange rate. This rate is driving water quality since it is related to transport of solutes and water with different pH. Especially in former mining areas where acid mine drainage (AMD) infiltrates into the lakes, the water quality is typically low because the high input of iron and its subsequent oxidation leads to a drop of the lake water pH to below 3. Hence, the knowledge of exchange rates is an important factor estimating water quality development in such environments. In order to investigate the effect of a changing lake water level on the groundwater-surface water exchange, a manipulation experiment at a mining lake in Germany was conducted. After the first year under steady state conditions with a high

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lake water level the water table was lowered by ~0.4 m. Had there been groundwater infiltration in the north and lake water exfiltration in the south we expected the system to change into infiltrating conditions over the whole area and a significant increase of seepage rates. In the field, pressure data, temperature depth profiles and seepage rates were measured over the course of two years. An inverse simulation to estimate seepage fluxes at the interface was calibrated for steady state and then run as transient simulation, using VS2DH. First results indicate changing hydraulic conditions at lake 77. Hydraulic pressure as well as temperature time series suggest an increasing importance of groundwater inflow on the lake water balance. Comparing directly measured and inverse simulated flux rates, they result in the same flow direction and magnitude of groundwater-lake exchange. Further, to proof the modelled rates from temperatures, chloride depth profiles were also inverted, using the same dataset of input parameters in VS2DT. So, due to changing hydraulic conditions, namely an increase of the hydraulic gradient, not only the seepage rates but also the underground temperature change. This may enhance biogeochemical processes within the sediment, as mineral transformation (Schwertmannit to Goethit) and an increase of the pH, respectively.

***Abstract number 164* – USING ISOTOPES TO UNDERSTAND COUPLED HYDROLOGICAL AND BIOLOGICAL PROCESSES**

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Isotopes have many applications for understanding coupled processes in ecosystems. Stable isotopes in particular are powerful tools because of their sensitivity to particular sources, transformations, and flow processes. Although less commonly used in an ecohydrological context, radioactive isotopes can also be valuable especially when questions related to groundwater or catchment residence times are involved. In this presentation, we will illustrate how isotopes can improve coupled processes understanding in ecosystems. For example, investigations of coupled vadose zone/plant/atmosphere systems using stable isotopes show that both vertical and horizontal spatial variability of isotope values can provide important clues to understand how evaporation and transpiration partitioning varies across the landscape and how these processes impact water flow and pore water chemistry. The links to pore water chemistry are important because they show how strongly coupled vadose zone flow and transport, plant water use, and biogeochemical processes can be. Over the last few decades the use of isotopes has transformed understanding of coupled hydrological, biological, and biogeochemical processes from both conceptual and quantitative viewpoints. In addition, recent advances in laboratory- and field-analysis methods for stable isotopes using laser absorption based methods have already had large impacts on scientific research and such impacts will almost certainly grow in the next few years. However, there are still important research questions and deficiencies in our sampling and analytical capabilities remain. These issues significantly hamper efforts to make better quantitative estimates of important fluxes (evaporation being one example). We conclude by discussing some of the key areas that require further development.

***Abstract number 165* – MODELING GROUNDWATER-SURFACE WATER INTERACTION IN THE
HYPORHEIC ZONE USING VERTICAL TEMPERATURE PROFILES**

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Understanding of groundwater/surface water interaction is fundamental especially for determining the fate of contaminants both in the streams and the ground water due to the fact that groundwater and surface water are in a continuous dynamic interaction in the hydrologic cycle. The interaction has practical consequences in the quantity and quality of water in either system in the sense that depletion and/or contamination of one of the system will eventually affect the other one. The transition zone between a stream and its adjacent aquifer referred to as the hyporheic zone and plays a critical role in governing contaminant exchange and transformation between the two water bodies. When groundwater combines with surface water in this zone the characteristics of each are blended and new contaminant gradients are established. The use of heat as natural tracer in conjunction with water level measurements has shown to be an effective method for estimating water flow (fluxes) between groundwater and surface water. Groundwater temperature is relatively constant; however the temperature of surface water varies both between day and night, and seasonally. The difference in temperature between groundwater and surface water results in a temperature gradient across the hyporheic zone. Thus, observations of streambed temperature variations with depth can give qualitative indications of the nature of streambed flux. In this study temperature time series measured in the surface water and at multiple depths below Zenne River (Belgium) were simulated using VS2DH (a two dimensional groundwater flow and heat transport model) to obtain an improved spatial and temporal understanding of the groundwater and surface water interaction in the hyporheic zone.

***Abstract number 167* – EVAPOTRANSPIRATION IMPACT ON SAPFLOW AND OTHER
HYDROLOGICAL PHENOMENA**

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Diel fluctuation of hydrological features in forested lands is not a highly researched area. In this paper some meteorological (net radiation, temperature, relative humidity data) and eco-hydrological (electrical potential differences data measured on the trunk of riparian trees, riparian groundwater level and stream base-flow data) parameters have been compared to each other at small time scale under forest covered environmental conditions. Analyzed data set was measured at the outlet of the Hidegvíz Valley experimental catchment located in the Sopron Hills at the eastern border of Alps. Meteorological data have been recorded in the neighborhood of streamflow (Rák Stream), groundwater level readings and electrical potential differences measuring sensors. Groundwater level and streamflow discharges were calculated from data of pressure transducers. Electrical potential differences (EPD) have been recorded for several years between electrodes inserted in selected sites at two different levels of the trunk of alders (*Alnus glutinosa* L.). The measured EPDs are related to the xylem-sapflow density, but strongly influenced by many geophysical effects. Therefore it is necessary filter and post-process EPD data carefully to gain useable fragments of sapflow-related time-series. All of the examined fluctuations of measured eco-hydrological phenomenon are induced by the evapotranspiration. Therefore Penman-Monteith evapotranspiration rate were calculated on the basis of meteorological data for comparison of EPD, groundwater and streamflow signal. Detailed stochastic analysis (spectral and cross-correlation)

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was employed on the detrended eco-hydrological data series. These initial results help us better understanding of atmosphere, vegetation, water relationship in case of a stream-side zone in hilly region.

***Abstract number 168* – RIVER CHANNEL HABITAT MODIFICATION INFLUENCES
MACROINVERTEBRATE RESPONSE TO FLOW**

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We describe the results of a series of studies which used national Environment Agency monitoring data to describe common patterns in the response of one particular biotic index, LIFE (Lotic Invertebrate index for Flow Evaluation) to the combined effects of flow (discharge, measured in m³/s) changes and habitat modification. Across an upland-to-lowland geographical gradient, LIFE score responded to antecedent high and low flows. More modified sites not only had lower LIFE scores but also a steeper response of the LIFE score to antecedent low flows. The results are consistent with the hypothesis that there is a greater variety of physical habitat niches in less modified channels, and that these habitats change less as flow changes. Although these results are to some extent unsurprising, this is the first time this has been demonstrated using routine monitoring data, and the first time parameters have been estimated for these effects. We briefly demonstrate a spreadsheet-based tool for applying the methods in a management context. Although the LIFE index was initially developed to be sensitive to flow (discharge) change, we demonstrate that it is also influenced by physical habitat quality: there are interactions between these two factors. This reinforces the notion that river management needs to consider changes to flow regimes and channel structure together and provides a preliminary mechanism for quantification and comparison on a common scale. The relationships are in the expected direction and there is considerable commonality across lowland and upland sites. The results demonstrate that less modified channels are more resilient to flow extremes. This finding is very important if future climate change leads to greater or more frequent extremes.

***Abstract number 169* – THE FOREST THROUGH THE TREES: QUANTIFYING LOCAL
CONTROLS ON WATERSHED SCALE IMPACTS**

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Land use and climate change have recently been implicated in reduced ecosystem services (ie: high quality water yield, biodiversity, agricultural and forest products). Therefore, the prediction of ecosystem services expected under future land use decisions and changing climate conditions has become increasingly important. Complex policy and management decisions require the integration of physical, economic, and social data over several scales to assess effects on water resources and ecology. This study examines local-scale measurements and simulations and how they can be incorporated into

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larger watershed-scale decisions. A watershed catchment in Haean-Myun, South Korea has been used for intensive field-based studies of meteorology, hydrology, biology, soil physics, plant production, solute and sediment transport, economic, and social behavior data. The complex interactions of field-scale measurements throughout the catchment are being simulated at the studied process-scale through a variety of models (Erosion-3D, HBV-Light, VS2DH, Hydrus, PIXGRO, DNDC, and Hydrogeosphere). Sensitive, local-scale parameters are identified from the local-scale model results, which are then used as inputs into a large-scale watershed model. The experimental field data measured throughout the catchment was integrated with the spatially-distributed SWAT2005 model. Typically, macroscopic homogeneity and average effective model parameters are assumed when upscaling local-scale heterogeneous measurements to the watershed. Our study approach was to quantify the range in local-scale model parameter results to define the sensitivity and uncertainty in the large-scale watershed model. The field-based, laboratory, and simulation modeling framework described is being used to develop scenarios to examine spatial and temporal changes in land use practices and climatic effects on water quantity, water quality, and sediment transport. The development of accurate modeling scenarios requires the explicit understanding of individual and policy management relationships. The economic incentives and basin wide social relationships may be significant drivers of land use practices, the value of sustainable resources, and ecosystem services.

Abstract number 170 – IMPACTS OF LAND USE LAND COVER CHANGE ON THE WATER RESOURCES IN THE HYDROSYSTEM MONO-COUFFO (WEST AFRICA)

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In West Africa in general and in Benin and in Togo in particular, river poles are particularly attractive to people because of the diversity of socio-economic activities they enable. However, variations in rainfall and human pressure in recent years, have had a negative impact on water resources and ecosystems. The case of Mono-Couffo watershed complex has been particularly affected. The data used are rainfall, the flow river at Athieme and Lanta, land use and land cover (LUC) estimates, turbidity, solids deposition rates and fish production. These data were used to analyze on the one hand, the influence of variation of precipitation on runoff and sediment loads and also the relationship between LUC dynamics rates (between 1985 and 2000) and solids carried by runoff on the other hand. The calculation of the denudation reflects a monthly or interannual variability of sediment in the basin. The determination of the aggressivity can be used to analyze the contributions of the direct solid complex load. This can be used to assess the vulnerability of the complex to the erosion over the period 1961-2000. Finally, field studies and literature review were used to assess the potential effects of erosion on the complex hydrology of Mono-Couffo. The storm and river flows resulting from the topography and of dynamics of land use of the environment continues to fill the lower valley of the complex. The savanisation of the basin led to a 10 % increase in the rate of denudation. Sediment loads issued by the estimated runoff in the basin ranges from 0.2 to 1 tons in the dry season against 1 404 to 16 807 tons in the rainy season and contribute to the filling and / or siltation of the lakes and lagoon. This accelerated rate of siltation and filling of the complex by the suspended solids (TSS) induces more and more destruction of habitats of fish species and, consequently, leads to lower productivity. This situation could be remedied somewhat by the restoration of the vegetation including mangroves along the Mono- Couffo complex and the conservation of forest environment galleries.

Abstract number 171 – INCORPORATING SPATIAL HETEROGENEITY OF FLOW-VEGETATION INTERACTION IN AN INTEGRATED RIVER ECOSYSTEM MODEL

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Within a river basin, as well a transport as a transformation of mass (water, nutrients, sediments, ...) can be observed. These processes are highly influenced by temporal effects (eg. high versus low floods, changing roughness due to vegetation throughout the season,...) and spatial effects. The occurrence of macrophytes in a lowland river is a good example of these spatial heterogeneity, as the distribution is far from homogeneous and a patchy formation occurs. This results in areas with higher stream velocities (between the patches), where eg. erosion becomes important, and areas with limited velocities (in the patches itself), where eg. sedimentation is more important. These flow heterogeneity has also an effect on ecological parameters like retention times (and its distribution), concentration of nutrients, etc. To learn about these ecosystems characteristic functioning, a STRIVE (STReam River Ecosystem) model package that enables the construction of integrated river ecosystems to capture cascade effects and feedback mechanisms is developed. This model package consists of several modules, representing different aspects of the ecosystem, like a hydraulic module (1D), a macrophyte growth module, a transport of solutes module, ... To account for the spatial heterogeneity described before, the current STRIVE version is extended with a 2D hydrodynamic module. In such a 2D hydrodynamic model, a local description of friction should be implemented, which is a function of the position and characteristics of the macrophytes in the river. A method to obtain these roughness description will be presented and model results will be compared to measurements.

Abstract number 172 – INTEGRATED MODELLING OF ECOLOGY AND HYDROLOGY: AN EXAMPLE OF INTERACTIONS BETWEEN VEGETATION AND GROUNDWATER IN FORSMARK, SWEDEN

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Spent nuclear fuel from nuclear power plants in Sweden is managed by the Swedish Nuclear Fuel and Waste Management Co, SKB. SKB has performed site investigations at two locations in Sweden. In 2009 Forsmark was selected for compilation of information needed to file an application to build a deep geological repository for spent nuclear fuel. Data from the site investigations and connected modelling activities have provided a wealth of information and knowledge about the present hydrogeological, hydrological and ecological conditions at the site. By integrating hydrological and ecosystem models, the hydrology gains support already in early stages of conceptualisation. One example is the mass balance models that can be developed using chemical and water flow data from the site. This information is useful to support and validate the numerical models. In the end, results from hydrological modelling are used to refine the ecosystem conceptualisation and to function as a driver for transport of matter within ecosystem models. In case of a future release of radionuclides from the repository, the

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radionuclides will be convected by groundwater flow through the bedrock towards the surface system and eventually reach ecosystems like rivers, lakes and wetlands. Identification of discharge areas of deep groundwater at the ground surface, and their associated ecosystems, is therefore an important task within hydrological modelling. Results from the numerical modelling show that, in general, lake areas act as discharge areas for deep groundwater. When the water flow paths reach the Quaternary deposits in the surface system the transport velocity is reduced. The low conductive lake sediments, which are present under the major part of the lakes at the Forsmark site, reduce the groundwater flow and a horizontal transport from the centre of the lake towards the littoral zone takes place. This phenomenon is seen during the whole year. However, during summer the transpiration from surrounding vegetation has a large impact on the groundwater levels around the lake and hence also on solute transport. Time series data from the site show a clear interaction between the potential evapotranspiration and the shallow groundwater in the area. Fluctuations in the groundwater levels can be seen as an effect of the evapotranspiration. Data from a monitoring network of surface water gauging stations and groundwater level monitoring points in both Quaternary deposits and bedrock show that during periods of longer draught the hydraulic gradient is directed from the lake towards the area around the lake. The surface water in the lake supplies the vegetation in the surrounding ecosystem with water, a process that is also reproduced by the numerical models.

***Abstract number 173* – ESTIMATION OF SUBDAILY RIPARIAN EVAPOTRANSPIRATION FROM HIGH FREQUENCY STREAMFLOW DATA**

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Obtaining accurate evapotranspiration rates of riparian ecosystems is very important for natural protection tasks and water resources management. Diurnal patterns of stream baseflow (which can be detected only by high frequency streamflow rate measurements) are rarely investigated in the hydrologic literature although these short-term fluctuations may incorporate useful information for the characterization of hydro-ecological systems. A new technique was developed to calculate evapotranspiration rates in the riparian zone from the stream-baseflow diurnal signal. The new method utilizes the water balance equation and a linear reservoir model for the subdaily estimation of groundwater evapotranspiration. The calculations require only basic geometric characteristics of the riparian zone (length, width), but no soil hydraulics parameters. The method was successfully tested with a dataset of the Hidegvíz Valley experimental catchment, located in the Sopron Hills at the western border of Hungary, and verified by numerical model experiments.

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Abstract number 176 – ASSESSMENT OF CHANGE IMPACT ON EUROPEAN AND MEDITERRANEAN RIVER ECOSYSTEMS USING MONTHLY HYDROLOGICAL INDICATORS

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The potential flow-driven impact of change on river ecosystems at the pan-European scale under various climatological and development scenarios was assessed using a methodology based conceptually on the Range of Variability Approach (RVA) using Indicators of Hydrological Alteration (IHA), a desk-top technique for assessing if environmental flow requirements are met. This paper presents an adaptation of the IHA approach using monthly flows. European and Mediterranean river networks were modelled as circa 35,000 cells (0.5o longitude x 0.5o latitude). For each cell, modelled monthly flows were generated for 22 scenarios. They consist of combinations of two climate scenarios (IPCM4 and MIMR) and four socio-economic water-use scenarios (each with a main driver of economy, policy, security, or sustainability), projected for both 2025s and 2050s; these also include baseline conditions, either current or projected under both climate scenarios. IHA-styled statistics based on monthly data were calculated. Tailoring the RVA, acceptable baseline environmental flow ranges and departures from these of the projected hydrological regimes were aggregated via a traffic-light colour-coding (green for environmental flows met, amber minor variation, red major variation). The results show spatial patterns of potential river ecosystem impacts across the wider European continent, and suggest that climate change may be more an influential driver than water-use change.

Abstract number 178 – AQUATIC MACROINVERTEBRATES COMMUNITIES IN AN AGRICULTURAL AREA OF A TROPICAL RIVER BASIN. A CASE STUDY IN THE MIDDLE CATCHMENT OF THE GUAYAS RIVER BASIN (ECUADOR)

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Aquatic macroinvertebrates were sampled in the middle catchment of the Guayas River Basin and in the influence area of the wetland “Abrás de Mantequilla” (RAMSAR site). The sampling was performed during the dry season (August 2009). Samples were collected in 12 sites located mainly in 3rd stream order rivers. Upstream the study area, there are two important hydroelectrical projects. The main land use in the area is agriculture, basically: banana, coffee, corn, and rice. A total of 3490 specimens, belonging to 54 families and 11 orders were collected in the 12 sites. Single metrics, such as abundance, richness, diversity, evenness, Biological Monitoring Working Party-Colombia/adaptation (BMWP/Col) and Average Score per Taxon (ASPT) were calculated in order to analyze community assemblages. The class Insecta dominated the macroinvertebrate community; being Ephemeroptera and Diptera the most abundant with 23% and 25% respectively. The sites were grouped in four water quality classes (WQC) according to the results of the BMWP/Col: good (I), acceptable (II), doubtful (III) and critical (IV). Physico-chemical parameters were measured at site and water samples were taken for further laboratory analysis in all sites. One-way ANOVA was used to test significant difference between BMWP/Col WQC with physico-chemical parameters. Of all results, nitrogen-related parameters (inorganic and organic forms) were significant ($p < 0.05$), showing that Nitrogen components could be used as a good discriminator parameter that can help to distinguish the different BMWP/Col WQC. Pearson correlation was applied to explore relationships between the abiotic (physico-chemical) and biotic (single metrics) parameters; correlation values greater than 0.7 were selected. The relative abundance (%) was calculated for each taxonomic order. In general, biotic indices (diversity, evenness, BMWP/Col-ASPT) were negative correlated with nutrient compounds (N, P). Regarding taxonomic groups, the Orders Coleoptera, Hemiptera and Lepidoptera showed correlation with some environmental parameters. A

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Non-metric Multidimensional Scaling method (NMS) was applied to analyze the macroinvertebrate community composition, and to visualize their similarities considering the taxa composition.

Abstract number 180 – WHEN HYDROLOGY MEETS CHEMISTRY - INSIGHTS INTO THE COUPLING BETWEEN TRANSPORT AND REACTION

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The effect of transport on rates of chemical reactions has been recognized very early in chemical engineering in the context of optimisation of product yields. To account for such transport effects a dimensionless parameter, the so-called Damköhler number, was introduced which relates the chemical reaction rate to the mass transport rate. Transport limitation occurs at Damköhler numbers less than one. Such effects are of significant relevance in porous media where reactants are frequently separated between the solid and the liquid phase, e. g. the interaction between dissolved sulphide and solid phase ferric oxides $2 \text{FeOOH} + \text{H}_2\text{S} \rightarrow \text{S}^\circ + 2 \text{Fe}^{2+} + 4 \text{OH}^-$ (1) This reaction is of paramount importance for the redox state of subsurface waters. It controls the concentration of sulphide and the formation rate of pyrite. Various steps in the reaction sequence of pyrite formation again depend on transport (Hellige et al, 2010). We therefore performed column experiments to study the effect of flow rate on turnover of sulfide (Kurtz et al, 2010) which turned out to strongly depend on residence time. We performed numerical modelling with the computer code TBC (Schäfer et al, 1998) into which the surface-controlled reaction kinetics between sulphide and the ferric oxides were implemented in order to simulate these findings. $R = k \cdot c_{\text{FeHS}}$ (2) k: rate constant [s⁻¹] c_{FeHS} concentration of sulfidized surface species in mol m⁻² The simulation showed that the interplay between reaction kinetics and residence time is strongly affected by the surface speciation and particularly by the surface-site density. These findings have severe implications for ground-water biogeochemistry. The penetration front of sulfide within an aquifer depends on flow rate. At short residence times relative to the characteristic reaction time (low Damköhler number), sulfide will be less reactive. As a consequence sulphide may not be competitive in regard to iron reducing bacteria under those conditions so that the switch between microbial and chemical reductive dissolution becomes transport controlled and contributes to biogeochemical patchiness.

Abstract number 182 – INTEGRATED ASSESSMENT OF THE IMPACT OF TCE GROUNDWATER CONTAMINATION TO SURFACE WATER ECOSYSTEMS

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Release of chlorinated hydrocarbons to the subsurface is recognized as a significant threat to groundwater resources, however, little is known about the impact of these compounds on groundwater-dependent surface water ecosystems. Traditional approaches for managing aquatic resources have often failed to account for the potential effects of anthropogenic disturbances on biota. In fulfilling the requirements of the Water Framework Directive, it is necessary to evaluate all pressures potentially stressing an ecosystem. To do this, field sites are needed where the effects of a particular stressor can be distinguished. This study follows earlier work conducted on a Danish case study involving a 750 m long TCE groundwater plume discharging into a stream, located in an area with protected drinking water interests. Although little data exists regarding the source zone, measured TCE concentrations (in the

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mgL-1 range) reveal the presence of separate phase of contaminant indicating that the source will not be depleted for many decades. The integrated modelling approach utilized explicitly linked the contaminant point source in groundwater with both surface water and ecological impacts. Volatilization was found to rapidly attenuate TCE concentrations in the surface water. Thus, only a 300 m stream reach failed to meet surface water quality criteria. The purpose of this study was to: (1) evaluate ecosystem impacts from chemical and ecological perspectives; (2) compare model simulations with field data to validate the ecological model system; (3) extend the model to a range of compounds with other physiochemical properties. An intensive field campaign was conducted, encompassing analysis of xenobiotics in surface water, BOD, inorganic chemistry, diffuse source (run-off) impacts and ecology along a gradient of contamination in the stream. Sampling for xenobiotics was conducted for 24 locations along a 2.5 km stream stretch in August 2010. Kick-sampling was conducted in early spring and summer and late summer (August) in order to capture the direct impact of TCE on benthic macroinvertebrates at 5 of these 24 locations. Both the modelling results and the field campaign indicate that TCE contaminant plumes with μgL^{-1} concentrations entering surface water systems do not pose a significant risk for benthic macroinvertebrates. Model simulations of additional volatile organic compounds, as well as pesticides for a range of flow and contaminant concentration scenarios are presented in order to generalise the findings in the case study. Furthermore, a sensitivity analysis is conducted, including chemical, physical and ecological parameters, to assess the dominant controls potentially affecting stream ecosystems.

Abstract number 183 – THE ROLE OF MICROTOPOGRAPHY IN THE ASSESSMENT OF ECOLOGICAL CONDITION ON LOWLAND RAISED MIRES OF CONSERVATION IMPORTANCE

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Hydrology is a key factor in maintaining favourable ecological condition of ombrotrophic mires. In lowland raised mires, a loss of hydrological condition is usually followed by a decline in ecological condition. As remaining raised mires are almost all under statutory national or international protection, the preservation of favourable ecological condition becomes of the utmost importance for land managers and policy makers. Direct monitoring of botanical condition is expensive, time consuming and requires specific species identification skills. Hydrological monitoring is often used as a proxy for ecological condition as it is less specialised, but traditionally, hydrological monitoring involves direct measurement of the water table either using automated equipment with associated costs, or manual measurement, and this again has time and personnel cost implications. This project has investigated spatial micro-topographic variation of the surface of two raised mires in Cumbria in the United Kingdom and its relationship to both hydrology and vegetative species composition. The sites studied were Bolton Fell Moss and Walton Moss; both sites are designated as both Sites of Special Scientific Interest and Special Areas for Conservation. The relationship between micro-topographic variation and hydrological condition has been investigated, and also whether such variation is as a consequence of changes in species composition or the morphology of the underlying peat surface. The sites have been subject to regular hydrological monitoring since 2003 using five dipwell transects established on both sites to measure depth to water table. Vegetation quadrats associated with each dipwell were surveyed to inform ecological condition. Micro-topographic variation was measured using Leica 1200 differential GPS surveying equipment to record such variation along the transects and in 2m plots associated with each dipwell. In addition to the directly measured topographic data, a commercially available LiDAR survey dataset was obtained for the study areas, and the variation in these data was compared with the variability in micro-topography recorded using dGPS in order to assess the viability of using airborne remote sensing methods to record micro-topographic variability and thus spatial variation in hydrological condition. It is hoped that such methodology can be used in assessment of large areas of raised mire and may prove a useful and cost effective tool for land managers without the additional expense of commissioning precautionary surveys.

***Abstract number 187* – CONCEPTUALIZATION OF A BRACKISH COASTAL KARST SYSTEM:
IMPLICATIONS FOR RESILIENCE OF A GROUNDWATER DEPENDENT WETLAND**

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The Gokova wetland located on the coast of the Aegean Sea in western Turkey is dependent on groundwater and is under protection by the Ministry of Environment. The wetland occurs along a brackish springs zone discharging from a karstified carbonate rock aquifer. The total discharge rate of the springs is measured as about 12 m³/sec. The spring water is slightly brackish with an average total dissolved solids of 3000 mg/l. Water scarcity in the region leads the authorities to develop projects toward desalination of this brackish water for use. However, dependence of the wetland on the groundwater requires assessment of resilience of the wetland ecosystem. An accurate assessment of resilience of groundwater dependent wetland requires first a thorough understanding of the hydrodynamic interactions between the wetland and the groundwater supplying aquifers. This can be achieved by hydrogeological conceptualization on the basis system approach. The Gokova wetland constitutes as system interacting with a karstic aquifer, in alluvial aquifer and the sea water. The complex hydrodynamics makes the problem more complicated. It is important to assess the impact of natural (such as climate change) and anthropogenic (such as derivation of some of the water for desalination) effects on the wetland ecosystem, prior to any development of the brackish springs. The amount of brackish water that can be diverted should be calculated on the basis of how resilient the ecosystem is against this change. This paper outlines the hydrogeological, hydrochemical and isotopic studies carried out to understand. The salinization mechanism and to conceptualize this complex ecohydrologic system.

***Abstract number 189* – ECOHYDROLOGICAL SITE CONDITIONS IN ALLUVIAL FORESTS WITH
FRAXINUS EXCELSIOR AND ALNUS GLUTINOSA (N2000 CODE 91E0)**

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“alluvial forests with *Fraxinus excelsior* and *Alnus glutinosa* (*Alno-Padion*, *Alnion incanae*)” is a high priority Natura 2000 habitat, often in deplorable state in Western Europe. . This habitat consisting of several phytosociological vegetation types (i.e. *Sphagno-Alnetum*, *Carici elongatae-Alnetum*, *Macrophorbio-Alnetum*, *Alno-Padion* and *Carici-remotae-Fraxinetum*) Was studied elaborately in a comprehensive set of reference sites in the northern part of Belgium. A number of crucial site conditions such as groundwater dynamics and chemistry, soil chemistry and texture, .) were measured; for some variables over a period of several years. The qualitative results are synthesised in numerical as well as in a decision scheme for use in restoration projects.

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Abstract number 190 – USE OF NUCELLA LAPILLUS L. AS BIOINDICATOR OF TBT POLLUTION IN MARINE WATERS: NORTHWEST IBERIAN PENINSULA, SPAIN

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The chemical tributyltin (TBT) was included in antifouling paints for boats and submerged structures because of its high power as biocide. Its toxicity led to a total ban in 2003 in European coast after a series of partial regulations. One of the most noticeable examples of its hazard is imposex, the superimposition of male sexual characters into the females of many aquatic gastropods. A graded phenomenon, this disorder led in its most extremely expression to the female infertility in some species and, consequently, to the extinction of populations. Imposex in *Nucella lapillus*, a neogastropod that is the commonest predator in European Atlantic intertidal rocky shores, is used as the official biomarker of TBT because of its unsurpassable dose-dependency and its high sensitivity. Two indices are widely used to assess imposex in *N.lapillus*, the vas deferens sequence index (VDSI, semi quantitative scale of 0-6) and the relative penis size index (RPSI, in %). From 1996 to 2009, we have regularly monitored the incidence of imposex in 35 dogwhelk populations from the Northwest Iberian Peninsula (NWIP). This extensive temporal series reveals an important drop after 2003, evidencing the effectiveness of the regulations implemented along these years. In fact, in the survey of 2009 we detected the first case (in 14 years) of a population totally free from imposex. In *N.lapillus* the intensity of imposex is minimized by a genetic disorder named Dumpton Syndrome (DS) that inhibits the development of male sexual characters. DS afflicts both males and females but in females DS has the advantage of diminishing the severity of imposex in very polluted localities. A characterization of the DS cases in our study reveals an increase in the proportion of afflicted males from 1.78% in 1996 to 5.64% in 2009. Still females show a more erratic evolution increasing from 3.99% in 1996 up to 9:18% and 8.91% in 2003 and 2006, to experience a decrease again in 2009 (3.24%). The erratic behaviour of females may be attributed to an artefact of the difficulty of identifying DS females under a scenario of low TBT levels. In conclusion our results show an important decrease of TBT pollution and suggest that DS may have been positively selected due to the chronic exposure of populations to TBT.

Abstract number 191 – IMPORTANCE OF GROUNDWATER FLOW SYSTEMS IN RIVER BASEFLOW AND ECOLOGY IN A MEDITERRANEAN CATCHMENT: SANTA COLOMA RIVER (CATALONIA, NE SPAIN)

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Mediterranean river basins generally show seasonal periods of water shortage, mainly in summer. During this season, when the river is more sensitive to human impacts (wastewater and water withdrawals), groundwater contributions are significant in aquifer-river connected systems to keep base flow and sustain a good ecological status. The objective of this contribution is to detail the role of groundwater in a river-connected alluvial aquifer in a Mediterranean catchment where different scale groundwater flow systems occur. This study was carried out at the Santa Coloma River basin (NE Spain), a range-and-basin area where regional faults have an important role in the regional flow hydrodynamics. Following the calibration of a numerical groundwater model for the superficial aquifer, two field surveys were carried out during September 2009 and May 2010. Field data include

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piezometric head in several wells of the alluvial aquifer, river flow measurements in 10 points along 2.2 km at the main stream channel, and hydrochemical analysis of major and some minor elements (F and Br) of both surface water and groundwater. Groundwater head maps indicate that the river mainly behave as a “loosing stream” along the year, including the wet season. It means that river water infiltrates into the alluvial aquifer, which may end up with no-flow in some reaches during the summer months. Only at the upper reach, a “gaining stream” behaviour permits a relatively constant water composition in the river. Despite the dominating “loosing stream” character, river flow measurements and hydrochemical data indicate that regional groundwater flow systems locally increase groundwater and surface water resources, being most important during the summer months. These inputs into the system produce an increase of the river discharge that may have an important influence on the stream ecological status during the driest periods, maintaining the some river flow and diluting waste waters. These inferences indicate that in order to preserve a good ecological status, river discharge will be much more sensitive to surface water deviations than to groundwater extractions. Furthermore, the “gaining stream” behaviour observed in the upper part of the river, showing a relatively constant water quality, may allow a better ecological status than in most of downstream reaches. Finally, the contribution of regional flow systems to the river-alluvial aquifer water budget also helps to maintain a base flow during the summer months. This groundwater input allows some wastewater dilution and, thus, a better hydrochemical quality in surface waters. This study was funded by the Catalan Agency of Water through project CTN1001026 and by the Spanish government (MEC) project CGL2008-06373-C03-03/BTE.

Abstract number 193 – RELATION BETWEEN GROUNDWATER FLOW CONDITION AND DENITRIFICATION POTENTIAL IN THE COASTAL AGRICULTURAL CATCHMENTS

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Many previous studies have confirmed that agricultural practices such as fertilizer application have resulted in nitrate (NO₃⁻) contamination of groundwater. To improve this problem, it is important to clarify about the natural function of nitrate attenuation such as denitrification process in groundwater. In recent years, several researchers have suggested that landscape hydrogeology and groundwater flow condition can provide an important framework for understanding nitrate removal capacity in groundwater of the riparian zones. However, the effect of groundwater flow condition on the denitrification potential has not fully evaluated on the catchment scale. The objective of the study is to clarify the relation between groundwater flow condition and denitrification potential at the coastal agricultural catchments with large nitrogen load. The study area is located at Ikuchijima-island (IK) and Etajima-island (ET) which are one of the islands in the Seto Inland Sea, southern Japan. Both areas are temperate and marine climate region with wide expanse of orange groves. The study catchments are mainly composed of granite and characterized by relatively steep topography with alluvial fan deposits from the midstream to the downstream area. The observation boreholes were installed at the coastal area of both catchment using PVC pipes with 5cm diameter. The depths of boreholes are 3m, 15m and 30m in the IK catchment, and 5m, 20m and 40m in the ET catchment, respectively. Hydraulic conductivity, porosity, darcy flux and pore velocity were determined by laboratory experiment and in situ water level

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monitoring data. Simple in situ tracer injection experiment was conducted at the observation boreholes to evaluate the denitrification potential. The result of injection experiment shows that denitrification occurred in the 3m and 30m boreholes in IK and 20m in ET. In the groundwater of these boreholes, darcy flux is estimated to be less than 5.3×10^{-7} cm/s, and pore velocity is less than 3.4×10^{-6} cm/s. However, denitrification was not confirmed at the 15m in IK and 5m and 40m in ET characterized by relatively high groundwater velocity. These results suggest that denitrification process is influenced by groundwater velocity, and it tends to be more significant in the low velocity condition.

***Abstract number 194* – COMPLEX LINKAGES BETWEEN HYDROLOGIC DYNAMICS AND BIOGEOCHEMICAL PROCESSES IN THE NEAR STREAM ZONE – NEW WAYS FORWARD**

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The interface between streams and aquifers is an inherently three-dimensional zone that is typically characterized by sharp transitions in hydraulic, thermal and biogeochemical properties. The dynamic processes in this zone facilitate the exchange of water, solutes, and energy (e.g. heat) and have the potential to affect a multitude of environmental processes such as groundwater recharge, environmental flows, the transformation of nutrients, pollutant attenuation, fish spawning and the selection of habitat and refugia. Due to the high temporal dynamics of stream flows and the typical geologic heterogeneity of alluvial aquifers, stream-aquifer exchange is often characterized by complex patterns in space and time. Despite significant improvements in methods and techniques to characterize these patterns and to quantify exchange fluxes our fundamental understanding of the intricate interplay between hydrologic dynamics and biogeochemical processes in this zone and the implications for water quality and nutrient cycling is still weak. Such knowledge, however, is an important prerequisite for a sustainable management of environmental and water resources. Examples of dynamic interactions between streams and their near stream zone will be presented for different stream aquifer systems. The use of physically-based numerical models to improve our understanding of processes and to facilitate the development of new theories and conceptual models of stream-aquifer interactions is outlined using the example of a simulation study of stream flow generation in a riparian wetland. Combining new enhanced methods to quantify spatial and temporal patterns of river-aquifer exchange with explorative modeling could provide a viable starting point in this context.

***Abstract number 195* – EVALUATION OF SURFACE-SUBSURFACE INTERACTIONS FOLLOWING AN EMBANKMENT OPENING FOR THE ENHANCEMENT OF STREAM-FLOODPLAIN CONNECTIVITY**

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For over a decade embankment opening has been discussed as a measure to improve the lateral connectivity between river and floodplain during inundations. Embankment opening initiates intense changes in floodplain hydraulics (e.g. velocity, ponding duration etc.) as well as variations in the extent of the interface areas and hydraulic conditions between surface and subsurface water bodies. The

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reestablished hydraulic connection implies an enhancement of surface-subsurface interactions and has a profound impact on hydrological conditions even at large distances from the stream through altered groundwater level fluctuations. For the evaluation of the hydrological and ecological development in floodplains following levee opening it is essential to investigate the hydraulic interactions between groundwater, floodplain interstitial water and adjacent surface water as the cardinal driving forces. In 2009 a cultivated area of more than 420 hectares (4,2 km²) at the Elbe river near the village of Lenzen, till then protected from natural stream dynamics by an embankment, was reconnected to the river by a series of breaches cut in the existing embankment totaling a length of about 2 km. In addition to the breaches flood chutes were excavated in the alluvium, partly down to the permeable pleistocene layers. With flood rise the river steps from its bed and inundates the floodplain through the breaches and flood chutes throughout the whole floodplain area up to the new built levee. The flood chutes act as hydraulic link between surface and subsurface water bodies. At present the Lenzen Elbe embankment opening / floodplain restoration scheme is among the largest projects of its kind at the European scale. The restoration site under investigation is characteristic for many embanked floodplains. It lies on a broad valley in-filled with pleistocene fluvial gravel and sands. These sediments are covered by silty clay loams and river alluvium, which form the present floodplain surface. Due to agricultural practice the embanked area was drained in winter and watered in summer by a ditch system dug in the alluvium. Years before opening the levee groundwater dynamics were monitored. In addition rainfall, temperature and river water level data were collected. The river-groundwater interactions were analyzed based on a transient groundwater model over a period of two years. These studies confirmed a close hydraulic contact between stream and groundwater through the quite permeable sand and gravelly sediments into which the river bed cuts. The range of propagation of stream water level fluctuations on groundwater depends in such a layered system on whether the phreatic surface reaches the confining alluvium layer or not. A proper description of confined-unconfined transitions proved crucial for accurate predictions of groundwater reactions on stream water dynamics. These aspects are important for ecological evaluation since during dry seasons the duration of the groundwater-alluvium contact can be crucial for vegetation through limited root water uptake. Based on the calibrated groundwater model predictions of surface-subsurface Interactions following the embankment opening were carried out for large periods of time. The nodal values of the groundwater dynamics were analyzed as graphs representing the time during which the value the groundwater level, is equalled or exceeded, regardless of continuity in time. These graphs were evaluated in the context of a fractile approach which allowed to quantify the changes of groundwater dynamics in spatial manner. Field observations of groundwater and surface water dynamics during flooding and depletion following the opening promise insights on surface-subsurface interactions at a relevant scale.

***Abstract number 197* – IMPACTS OF LAND MANAGEMENT ON STREAM WATER FLOWS IN BLANKET PEAT MOORLAND IN THE PEAK DISTRICT, DERBYSHIRE, ENGLAND**

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Conservation management of blanket peat moorland is being pursued by organisations keen to protect this important habitat, listed as a priority under the UK Biodiversity Action Plan (European Habitats Directive), but this also has implications for hydrological processes and water supplies. However, few hydrological studies have extended beyond two years. In 2002 a paired-catchment project commenced to investigate the role of gully blocking, cessation of managed burning and removal of sheep grazing in the production of stream runoff and DOC (dissolved organic carbon) flux in the Ashop catchment of the Peak District. Six small catchments (less than 1 square km each) were instrumented. After fourteen months of baseline data, treatments were implemented on 3 catchments in late 2003 and the managed catchments were compared to 3 remaining "control" catchments over 3 years. Further blockages were implemented in 2007 on one of the original unchanged catchments and the investigation was reinstated

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in 2008. This paper will discuss findings on changes in flow and dissolved organic carbon response. The impact of gully blocking on stream flows appears to be related to catchment wetness. Evaluation of the success of gully blocking is dependent upon the agenda of the stake holders involved.

Abstract number 198 – MONSOON-DRIVEN TOTAL HEAD AND TEMPERATURE VARIATIONS AT THE GROUNDWATER-SURFACE WATER INTERFACE – IMPLICATIONS FOR BIOGEOCHEMICAL PROCESSES

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Extreme precipitation events associated with a monsoon-type climate can strongly influence the hydrologic and biogeochemical dynamics of an entire watershed with implications for river-aquifer exchange. River-aquifer exchange in turn can significantly affect nutrient retention and transformation and therefore influence the corresponding export of nutrients from catchments. Under monsoonal climate conditions often more than 60% of the annual precipitation falls within two months. The rapid basin-wide change in flow patterns controls the spatial and temporal variability of downstream river-aquifer exchange as well as downstream water quality. Using previous sub-catchment measurements as background information, the focus of this study is to investigate how monsoonal storm events affect the dynamics of river-aquifer exchange on the reach-scale and how exchange flux reversals may influence nutrient transformations and export. In order to investigate river-aquifer exchange fluxes, a piezometer transect was installed across a third-order stream in the Haeon Catchment of South Korea, which is strongly influenced by monsoonal storm events. The piezometers were equipped with single-channel temperature thermistors and pressure transducers to characterize and quantify flow patterns using heat as a tracer. The data loggers recorded the temperature and head response at 15 min intervals. In order to investigate the biogeochemical dynamics influenced by extreme precipitation events and the corresponding river-aquifer exchange behaviour, surface water samples and groundwater samples were collected once per week and at higher frequency during monsoonal storm events. The collected samples were analysed for nitrate, ammonium, dissolved organic carbon (DOC) and phosphorous. River samples were additionally analyzed for turbidity and suspended sediment concentration (SSC). Our field data indicate that the river reach exhibits primarily losing surface water conditions throughout most of the year. Gaining groundwater conditions at the river reach are evident after extreme monsoonal precipitation events and are probably caused by bank storage effects. At the transect streambed aggradation and degradation due to bedload transport was observed, consistent with significant erosion previously reported throughout the catchment after extreme events. Results indicate that the event-based changes in streambed elevation, is an additional control on river-aquifer exchange. Sub-catchment measurements from 2009 indicate that nitrate concentrations in the rivers rapidly decrease during monsoonal storm events due to dilution and the DOC concentrations increase to values up to six times higher than background concentrations. Contrary to the river water, nitrate concentrations in the groundwater increase during storm events, whereas DOC concentrations increase during dry conditions.

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***Abstract number 199* – VARIATIONS IN BENTHIC MACROINVERTEBRATE ASSEMBLAGES WITH PHYSICO-CHEMICAL CHARACTERISTICS IN HEADWATER**

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Invertebrate samples were collected in headwater streams of the Mau Forest within the Mara River Basin in Kenya with distinct land use types namely forest, agriculture and mixed. A total of 9006 individuals within 75 taxa belonging to 13 orders were identified from the 25 investigation sites. The most dominant orders were: Ephemeroptera 41 %, Diptera 31 % and Annelida 17 % of total individuals. Macroinvertebrates have remained a key indicator of changes in the physical and chemical conditions of aquatic ecosystems. We tested the ability of macroinvertebrates to detect changes in the physical and chemical conditions of aquatic ecosystems due to human activity, both on catchment scale and reach scale. A non-metric multidimensional scaling (NMS) ordination method was selected for the analysis of benthic macroinvertebrate community composition and it was based on Bray-Curtis dissimilarity matrices computed from log (x+1)-transformed benthic taxa abundances. The Bray-Curtis dissimilarity matrix was also subject to testing for effects of the various factors (catchment and reach scale). Differences in location and dispersion were tested using non-parametric permutational MANOVA (abbr. PERMANOVA) and a permutational analogue of the Levene-test (abbr. PERMDISP). Turbidity, conductivity and TSS showed significant difference at both catchment and reach scale ($p < 0.05$) demonstrating the alteration in the water chemistry composition. Single metrics like total taxa, family taxa, SASS score and ASPT showed a negative correlation with TSS and turbidity. The outcomes of this study support the assertion that the reach is a sensitive scale at which macroinvertebrate assemblages show variation.

***Abstract number 201* – TSUNAMI IMPACTS ON SOIL AND SHALLOW GROUNDWATER QUALITY ON CENTRAL-SOUTH COAST OF CHILE**

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Chile as mainly coastal country of Pacific Ocean has been affected regularly by violent earthquakes and tsunamis. In May 22, 1960 occurred the strongest earthquake of the twentieth century (9.4 Richter scale), with an epicenter located in the southern part of central Chile. The recent earthquake of February 27, 2010 (8.8 Richter scale) that hit Chile triggered a tsunami that severely devastated the coastal regions of central-south Chile. Giant waves swept inland affecting agricultural areas where the majority of the population, which is rural, is relying on shallow groundwater for their agricultural activities. In these areas most farmers use shallow open dug wells in the sandy aquifers. The aim of this study was to evaluate the extent of the tsunami impact on soil and shallow groundwater salinity and sodicity in these areas, and to assess the impact of salt damage to cultivated species. This study was conducted in the coastal area of Duao, VII Region of Chile, one of the most affected areas with waves up to 4 m, where sea water inundation of cultivated lands caused by tsunami has adversely affected ecosystem. Shallow ground water and soil samples were taken after the tsunami in order to assess the changes occurring in

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soil chemical properties, such as pH, electrical conductivity (EC), cation exchange capacity (CEC) and sodium adsorption ratio (SAR). Exchange sodium percentage (ESP) was estimated from SAR values. Soil and water samples were collected before winter rainy season. The analytical results revealed that immediately after tsunami shallow open dug wells increased salinity values over 5 dS m⁻¹, where the water was no longer suitable for domestic or agricultural use. Similarly, the upper soil (0-30 cm) became saline sodic due to accumulation of soluble salts that increased soil EC and ESP immediately. In consequence, crop cultivation in the area, mainly Chilean papaya (*Carica candamarcensis* Hook f.), showed visual symptoms of salt toxicity. Additional soil and water measurements are planning in the same area in October 2010, after winter rainy season. Results from this study, will help to provide on-site technical advice and develop appropriate measures to restore the ecology and the environment of these seriously affected areas.

Abstract number 202 – HYPER-ALKALINE AQUIFERS OF CALUMET WETLANDS (SOUTH CHICAGO, IL): BIODIVERSITY AND REMEDIATION STUDY

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The microorganisms in the groundwater of the Lake Calumet wetlands, Chicago, IL, have been described as one of the world's most extreme alkaliphiles. Over the 100 years, the wetlands have been infilled with steel slags. The slags were deposited from local blast furnace mills and were comprised primarily of high-temperature calcium silicate minerals and could contain as much as 50% metallic iron, manganese, and other steel additives (Cr, Mo, V) varying in composition within meters of each other. The weathering of the calcium silicates subsequently formed an aquifer with groundwater pH up to 12.8. Previous research of the microbial communities has been performed on the groundwater but nothing has been done to examine the communities in the soils in contact with this high pH groundwater. The objective of this research project is to determine the ecology of the microbial communities at different locations of the Calumet area, and their response to varying conditions. Also the composition of soil and groundwater communities will be compared. Results suggest that buffering system is highly sensitive to temperature changes (the lower the temperature, the higher the pH), chemical analysis of sediment and groundwater cation compositions revealed extreme concentrations of heavy metals, and screening of environmental DNA showed fairly large microbial diversity. The second part of this project focuses on laboratory remediation column experiments in which sediment from Calumet wetlands together with three different permeable reactive barriers (silica sand, dolomite, apatite) was incubated. These materials are reported to be capable of decreasing either both – the pH and heavy metal concentrations (dolomite), or the pH (silica), or the heavy metal concentration (apatite). Incubating the columns under defined temperatures (4° and 25° C) resembled the most striking differences from field. The columns were continuously flushed with alkaline water from Calumet site and amended with nutrients (nitrate or phosphate). With controlled laboratory conditions and regular monitoring of pH, heavy metal concentration, and microbial activity in column effluents, we will be able to compare between particular reactive barriers, incubation temperatures and reactions of the microbial communities. The multidisciplinary character of this project will significantly enhance the field of environmental hydrogeology and extremophile microbiology by novel findings about microbial response to pH and heavy metal remediation efforts.

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Abstract number 205 – IMPACTS OF STUMP HARVESTING ON NITROGEN LEACHING AND CARBON FLOW IN THE BOREAL FOREST ENVIRONMENT

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The availability and the quality of water are strongly influenced by forests. To develop best forest management practices to protect water quality is important when the use of stumps as a source of energy is increasing. However, the impacts of stump harvesting are still inadequately understood and can cause a number of risks to the forest environment. Increased carbon loss and nutrient leaching from disturbed soil into the groundwater can be the most harmful. To evaluate these and other environmental impacts the new project was launched in the Finnish Forest Research Institute in 2007 with several research scientists. The nutrient leaching into groundwater, carbon flow, microbiology, restocking and plant succession have a significant role in the study to produce information for application in the field and policy makers. The project has been implemented in three geographical areas in the form of an intensive study: Southern Finland, Central Finland, and Northern Finland. The experimental layout in each area with three replications is as follows: (1) Uncut control, (2) Clear-cut without soil preparation or planting, (3) Clear-cut + patch mounding + spruce planting, (4) Clear-cut + 70 % logging residue removal + patch mounding + spruce planting, (5) Clear-cut + 70 % logging residue removal + stump removal, retaining 25 stumps/ha + patch mounding + spruce planting and (6) Clear-cut + 100 % logging residue removal + 100% stump removal + patch mounding + spruce planting. The field experiments are established in close co-operation with UPM-Kymmene, which is one of the leading companies in the utilization of forest bioenergy. Moreover, cooperation with various universities will play a significant role in the project. Experimental layout, forthcoming aims, collaboration and new results will be presented in the conference.

Abstract number 207 – INFLUENCE OF DAM REMOVAL AND PAST SEDIMENT MINING ON RIVER MORPHOLOGY AND BIOLOGY: EXAMPLE OF THE VIENNE RIVER (FRANCE)

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The removal of the dam of Maisons Rouges on the Vienne River (Indre-et-Loire, France) was decided in the Masterplan Loire Grandeur Nature and done in 1999. The removal of the dam, located just downstream the confluence between the Vienne and its main tributary the Creuse River, triggered several consequences on both physical and biological components of this fluvial system. The morphological evolution of the Vienne and Creuse Rivers was monitored using a detailed bathymetrical survey of the channel in 1998, 1999, 2000, 2002, 2005 and 2009. Sediment grain size analysis and aerial photographs were also carried out in order to understand the flushing of sediments trapped behind the dam. The surveys highlighted a significant upstream erosion and the downstream progradation of a bedload sedimentary wave migrating at an average velocity of 2.5 km/year. This morphological response of the river was influenced by the presence of ancient mining sites (stopped in 1998) and bedrock outcrops. Some reaches of the Vienne characterized by low bed slope values were recognized to be preferential deposition sites. At these sites, sediment deposition exerted a strong control on the development of in-channel species such as benthic macroinvertebrates and the freshwater mussel

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Margaritifera auricularia. This mussel, protected by the IUCN (International Union for Conservation of Nature) was found in the Vienne in 1998. Since 2002, approximately one third of the population was lost due to the migration of bedload sediments. Most of the losses were due to sediment burying and located in the part of cross sections where flow velocity was significant. Concerning the macroinvertebrates, the migration of the bedload sediments triggered some temporary changes such as the predominance of the Chironomidae family just after the migration of the bedload wave.

Abstract number 209 – GLOBAL CHANGE ON RURAL WATER SYSTEMS IN SOUTHWESTERN ANAMBRA STATE, NIGERIA

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Change in global climate systems are key environmental issues in the world today. These changes are both naturally and humanly induced; and thus affect mankind adversely. The effects on the world water systems especially in rural sources are alarming. The rural communities of Southwestern Anambra State, Nigeria typifies rural water sources and global change effects, poor water quality from the sedimentary formation of the floodplain, eutrophication and presence of water hyacinth on the surface water supply systems. The effect of sedimentary formation on the groundwater was determined using physical and chemical analyses of the deep ground water. Questionnaire administration and focus group discussion were adopted to get information on the impact of the environmental changes with respect to water supply on the local communities. Ph, turbidity and Iron (Fe) values were recorded respectively with most values above the World Health Organisation standard limits. The study examines water quality components and its interrelationship to global change effect while the paper recommends that the geotechnical changes in the ground water formation be taken into consideration for sustainable rural water.

Abstract number 210 – COMPARISON OF FIELD-EMPLOYED EXTRACTION AND ISOLATION METHODS TO CHARACTERIZE DISSOLVED ORGANIC MATTER FUNCTIONAL FRACTIONS IN KARST WATERS

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Comparison of field-employed extraction and isolation methods to characterize dissolved organic matter functional fractions in karst waters Microbially-induced processes in groundwater affect biogeochemical cycling, with implications for aquatic food web structures and pollutant mitigation. Simple metrics that link these microbial functions with broader ecosystem-level processes are lacking and limit the data available for water resource management. Because many microbial processes are directly influenced by the nature and quality of organic carbon, fluorescence spectroscopy is a powerful tool that can be used to characterize organic carbon as dissolved organic matter (DOM) from allochthonous (i.e. terrestrial, humic-like material) or autochthonous (i.e., microbial, protein-like material) sources. Water was sampled from a losing surface stream and corresponding cave stream under base flow conditions and limited photodegradation. The organic carbon component as DOM (defined as passing through a 0.2 µm filter) was separated into four functional fractions via Solid Phase Extraction (SPE) and ion-exchange resins. SPE compares favorably with XAD resin and ultrafiltration, is selective for low-molecular weight DOM, minimizes the use of solvents and generation of waste products, and reduces processing

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time and sample alteration. Four sorbents were tested in a field situation. Bond Elut C18, an octadecyl bonded phase, silica-based sorbent, and Envi-18, a styrene divinyl-benzene co-polymer resin, retained the hydrophobic neutral fraction at natural pH and by-passed the hydrophobic acid fraction at pH 3. The weakly basic anion exchanger diethylaminoethyl cellulose (DEAE) retained the hydrophilic acid fraction and by-passed the hydrophilic neutral fraction. DOM isolates were analyzed by Fourier Transform Infrared Absorption spectroscopy, which revealed notable spectral variations in the hydroxyl, carboxyl, amide, and carbohydrate groups. Significant contrast between the hydrologic settings was expressed in the hydrophilic acid fraction of groundwater as a ten-fold increase in relative hydroxyl concentrations, a distinct amide peak, and increases in low molecular weight acids. The hydrophilic neutral fractions of groundwater and surface water exhibited inverse relationships in the spectra of three carboxyl groups and the ester/fatty acid region. Carbohydrate concentrations increased in both hydrophobic fractions of groundwater. Results are indicative of biogeochemical transformations occurring along the 1.8 km flow path possibly related to the microbial degradation of larger organic molecules. The investigation continues to elucidate the processes associated with these changes using fluorescence characterization and other techniques. Such efforts to correlate DOM properties with ecological processes may lead to the development of indices and monitoring strategies needed to enhance integrated water resource management programs.

Abstract number 211 – PROPAGATING CLIMATE CHANGE INFORMATION TO IMPACTS ON AQUATIC STREAM HABITATS

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A nested multi-scale, coupled model including hydrologic, hydrodynamic, and ecological models is developed to investigate the ecological implications in response to streamflow variations due to hydrological processes and climate change. Many studies have recently testified that streamflow alteration, represented by magnitude, frequency, duration, timing and rate of change, causes negative effects on the ecological services such as fish, macroinvertebrate and riparian plants. Hence, quantification of the relationship between streamflow characteristics and aquatic habitat is an important task for ecohydrology. In this study, a comparison of the hydrological regime and its effect on flow hydrodynamics is carried out for present and future climate conditions. Future regional climate information is downscaled from eight global circulation models using the IPCC 4AR A1B emission scenario. Fifty eight meteorological scenarios are generated using a stochastic weather generator combined with the Monte-Carlo simulation. A number of hydrodynamic channel metrics are investigated that have been shown to determine stream habitability. These are depth, velocity or turbulent metrics (vorticity, area-integrated vorticity, turbulent intensity and turbulent kinetic energy), which are introduced in a spatially explicit manner. The multi-scale coupled model has been applied for a case study watershed located near Manchester, Michigan, U.S.A.

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Abstract number 214 – REDERES: A TOOL FOR ASSESSING LONG-TERM INFLUENCE OF SMALL DAMS ON DOWNSTREAM FLOW RELEASE OF STRATEGIC WATER RESERVOIR IN BRAZIL'S NORTHEAST SEMI-ARID

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Ceará state has the largest density of small dams in Brazil. These small dams testify the history of droughts and human fight for surviving on the semi-arid of Brazil. We recognize the role of these small constructions in supplying water for diffuse population and small villages. Although, we saw the big number of small lakes did have cumulative impact downstream, changing the hydrology of bigger rivers. This paper shows the implementation and use of a specific simulation tool, REDERES, developed exactly to assess the long-term mass balance for such complex physical setting, using simple assumptions and extensive mapped data. We based our database on NETCDF file archive standard, solving eventual problems of large matrix storage and computation of synthetic time series. Results show that, on each of the eleven basins of Ceará, the size and reservoir areas follow closely an exponential distribution; and the modeled water balance captures the impact downstream on a nonlinear fashion.

Abstract number 215 – ECOHYDRAULIC MODELLING OVER DIFFERENT SEASONS WITH VARYING VEGETATION

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The presence of vegetation in lowland rivers has a large influence on the flow capacity of these rivers. Mowing the vegetation along the riverbed can be necessary to protect against flooding. However, this has to happen in a controlled way driven by a decent water management and policy, as vegetation plays an important role in the whole river ecosystems. A proper understanding of the exchange processes in river ecosystems is therefore required. Both, a numerical model was developed and measurements were conducted. The river Aa near Poederlee (Belgium, Flanders) was selected as study area, where discharge, water level and biomass measurements are carried out on a regular base in a period from 2003 to 2009. The vegetation biomass is low during winter time, followed by a fast increase during spring, to reach a maximum which remains during summer. In autumn, the vegetation decreases rapidly. Manning's coefficient is selected to represent the resistance to flow in the model and is related to the varying amount of vegetation and discharge over the year. The developed STRIVE (STReam RIVER Ecosystem) model package is set up in the FEMME environment (a Flexible Environment for Mathematically Modelling the Environment) and has already proven its worth in a large number of calculations. A 1D hydrodynamic model for unsteady free surface flow has been implemented, yielding accurate modelling of surface flow characteristics, which subsequently has been coupled to ecological processes to achieve the required interaction between the subsystems of the ecosystem. The original relationship between Manning's coefficient, amount of biomass and discharge is optimized taking into account that the relation between Manning's coefficient and discharge is steeper in summer than in winter. Further, the increase of Manning's coefficient with the vegetation growth is larger for lower discharges. High discharges will flatten the vegetation, with a decrease in Manning's roughness coefficient as a result. Good results of water levels and discharges are obtained in winter months. The inaccuracy increases with increasing amount of biomass. So are water level peaks broader during summer time. This may be due to a variation of the downstream Qz relation e.g. caused by the presence of vegetation on the weir. Deviations on the modelled discharge are random.

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ABSTRACT NUMBER 219 – AN OPERATING STRATEGY FOR ECOLOGICAL WATER REQUIREMENTS AND RUN-OF-RIVER ABSTRACTIONS FOR DOMESTIC WATER SUPPLY USING SILOAM VILLAGE AS A CASE STUDY

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The study focuses on the development of an operating strategy for optimum scheduling of low flows for ecological water requirements and run-of-river abstractions for typical rural water supply schemes using Siloam Village as a case study. Efficient operation of low flow rivers in a water-stressed country such as South Africa requires an operating strategy as a decision support tool. Although system operation methods for dam supply have been developed and applied, such methods have hardly been developed or applied for low flow rivers used for ecological purposes and water supply to rural communities dependent on run-of-river abstractions. Simulated runoff was used to derive unregulated river yield at different levels of assurance of supply (LAS) for Nzhelele River at Siloam Village using 1 day Flow Duration Curves. This was used together with the water quality data to assess the availability and sustainability of Nzhelele River water for domestic use and the environment. The results of water resources assessment were used to derive operating rules for Nzhelele River at Siloam Village. The results show that Nzhelele River can meet the low flow and domestic water requirements at LAS of approximately 90% (1:10). High levels of turbidity make Nzhelele River water unsuitable for domestic use and require treatment at point of abstraction or household level to reduce turbidity and microbiological risks to acceptable levels. The derived operating rules for Nzhelele River at Siloam Village are that the river water can be scheduled daily for low flow requirement (LFR) and domestic use at approximately 90% LAS, and other sources of water should be used to optimize the supply of domestic water requirements. The generic operating strategy for LFR and run-of-river abstractions has been derived by summarizing the procedure used in developing the operating rules for Nzhelele River at Siloam Village and can be applied to any river system to meet LFR and fully or partially supply the community with water.

Abstract number 222 – LONG TERM HYDROLOGICAL MODELING OF A HIMALAYAN WATERSHED USING SWAT MODEL

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The mountainous watershed of upper Ramganga river in Kumaun region of Himalaya due to its complex topography, varied landuse and soil distribution call for a comprehensive distributed model to simulate runoff response. Review of past literature reveals that in mountainous watersheds of Himalaya, the SWAT model has not been tested. The present study is undertaken with aim to test the performance of SWAT model in a predominantly forested hilly watershed defined at gauging site at Naula in uppermost part of Ramganga River comprising of an area of 1074 sq.km. Climatological data from 1962 to 2006 is collected from Divisional Forest Office, Ranikhet and analysed to prepare climatological inputs for SWAT model. Daily data for observed rainfall, runoff and other meteorological variables at two gauging stations namely Chaukhtia (intermediate location; drainage area = 573 sq.km) and Naula from 1975 to 1982 were available and used for this study. Available hydrological data (about 8 years) is split into two groups and data of one group (i.e. 1975 to 1978) is used for calibrating parameters of the model and the data of other group (i.e. 1979 to 1982) which is not used for calibration of model parameters is used to

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validate model results. It is worth mentioning here that the calibration of the parameters of the model is done based on the observed data at gauging station at Naula and the calibrated model is also used to test the performance at upstream intermediate gauging site at Chaukhtutia. Model performance is adjudged based on visual comparison of observed and model computed runoff as well as on statistical measures of mass balance error, coefficient of determination and Nash-Sutcliffe efficiency (NSE). Comparative analysis of results is done on daily and monthly time scale. The performance of the calibrated model at intermediate test site (for full data range from 1975 to 1982) has shown good agreement between observed and model computed hydrographs at Chaukhtutia gauging site which are comparable to NSE achieved for entire watershed indicating the applicability of the model at intermediate locations also. Visual hydrograph comparison reveals that barring some extreme peak events – which the model underestimated – the agreement between observed and model computed runoff is reasonably good at daily time scale and very good at monthly time scale. Therefore, the model fit can be rated as reasonable to very good. It follows that the SWAT model is applicable to even predominantly forested sub-Himalayan watersheds.

***Abstract number 225* – ENVIRONMENTAL FLOWS AND CLIMATE CHANGE IN THE EBRO RIVER BASIN, SPAIN**

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During the last decades, the establishment of environmental flows has become a major issue for water resources management, especially in Mediterranean countries. This fact has been reflected in the numerous methodologies that have been developed to establish environmental flows in regulated rivers. The Basic Flow (BFM) is a hydrological methodology used to establish environmental flow regimes for river regulation, which is becoming widely accepted and applied in Spain. The BFM is based on natural streamflow data (hydrological series of daily mean flows) to determine key values of temporal variability and magnitude of streamflows in order to set environmental flow regimes. Thus, this methodology reflects the main characteristics of the natural flow regime of the river, and the results of its application (environmental flow regime) can be affected by both, natural or human hydrological alterations. Climate change is one of the greatest threats facing the planet, causing effects of different magnitude at regional and local scale. Some of the reported effects include, among others, an increase of extreme droughts and a change in the precipitations regime, which can affect water resources distribution and availability at the watershed level. The purpose of this study was to analyze the evolution during the last decades of the environmental flow regime estimation for a Mediterranean river using the BFM. The Ebro river basin (Northeastern Spain) was chosen as a study area. Unaltered hydrological series of natural daily mean flows of selected gauging stations were used as the database for analysis. The results have been compared with climate indicators to look for relationships between trends in climate change and instream flow needs calculated by this methodology.

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***Abstract number 226* – GROUNDWATER RECHARGE AND GROUNDWATER DISCHARGE: THE ECOLOGICAL IMPORTANCE OF SPEAKING THE SAME LANGUAGE**

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Groundwater recharge seems a well known and established term in hydrology, hydrogeology, groundwater modelling etc. However, when looking at more detail to the processes occurring at the groundwater table it is not so clear anymore what is meant by groundwater recharge. Infiltration and percolation might lead to a 'recharging' process of the saturated zone. But at the same time water from the saturated zone might be lost due to transpiration, capillary rise or evaporation from the groundwater. This results sometimes in the use of terms like net recharge, effective recharge or negative recharge. Hence, it is unclear if researchers use the term 'recharge' for the same type of flux process. This condition of vagueness is also reflected in how the recharge process is incorporated and has to be parameterized in different hydrological models. A similar problem exists for the term 'groundwater discharge', or is it maybe 'seepage'? Also here confusion exists between researchers, when hydrologists cooperate in multidisciplinary teams e.g. with ecologists. This ecological term is important since many high biodiversity locations are groundwater dependent and receive therefore a contribution of groundwater discharge. If we want to understand better the functioning of vegetation types such as phreatophytes, or wish to protect these groundwater dependent terrestrial ecosystems, we will first have to better define which processes are occurring and especially agree on how we define the eco-hydrological terminology. Few authors have explicitly tried to clarify this terminology in a general, area specific way, which results inconsistencies. This is most likely because the interpretation of the terms seems to be dependent on regional hydrogeology, climatic differences and national differences. In this contribution we aim to review some of the important terms used in dryland and wetland eco-hydrology for describing relevant processes at the interface of the groundwater table. We will give examples and propose a conceptual sound structure for an unambiguous use of terms.

***Abstract number 228* – FLOOD RISK ANALYSIS IN AL-MADINAH AREA, WESTERN SAUDI ARABIA**

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Al-Madinah area which is located in western Saudi Arabia, as an extremely arid region, is characterized by extremely high spatial and temporal variability and unpredictable rainfall. This area is also subject to flash floods occurring immediately after heavy and short rainstorms, which is causing of loss human life, infrastructures and properties. This valuable and important area needs sustainable developments and saving from flood hazards. Unfortunately, suitable and continuous hydrometeorological data are limited or incomplete. In the present work, a runoff model, adapting the method of Soil Conservation Service (SCS), was built for 5 ungauged dry wadis in Al-Madinah area. 16 rain gauges of annual maximum daily rainfall that have a recorded length of at least 30 years in this area were analyzed and derived with EV1 probability density function in different return periods. The results of EV1 pdf's and the results of morphometric parameters of the wadi catchments, which derived from Digital Elevation Model. Hydrographs with different return periods were drawn. Regional maps of maximum probable

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precipitation (PMP) and probable maximum flood (PMF) were also produced for study area. These results can help to make significant decision in planning, management, operation and maintenance of flood occurrences related to social, environmental and engineering activities in this important area of Saudi Arabia.

Abstract number 230 – DEVELOPING INTEGRATED HYDROLOGICAL MODEL FOR RIVER ECOSYSTEM ASSESSMENT

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With the increasing concern of global warming, the hydrological impact of climate change has attracted considerable attention. It will also induce the changes in available water resources in the global scale. In recent years, the global climate model, especially, the general circulation models (GCMs) based on physical principles of fluid dynamics or heat and radiation transfers, are becoming the most reliable tools for projecting future climatic environment. By using global GCMs, the changes in air temperature, the amount of sea or glacial ice, ground water in the aquifer, precipitation supply and evapotranspiration losses are projected in the continental or regional scales. In the hydrological point of view, disappearance of a permafrost layer, a glacial recessions and change of snowfall/melt will induce a severe impact on the water cycles in the cold region. Moreover, the magnitude and frequency of the extreme event such as heavy rain accompanying with a typhoon will cause serious flood disasters in the humid regions, and they are projected to increase in the end of 21st century with the global warming. From ecological stand point of view, the potential evaporation will increase with directly correspond to the air temperature rise. However, the actual evapotranspiration often does not increase with air temperature rise because it is restricted by soil moisture content and vegetation physiology (i.e. photosynthesis activities). The spatial distributions of potential vegetation are mainly dependent on air temperature and available water in the root zone. According to warmness index and wetness index analysis, the potential vegetation will change significantly until the end of this century, and it will alter the long-term regional water balances. On the other hand, change of the stream flow regime such as flow velocity, water level and water temperature/quality will have large influence on river ecosystems. Therefore, in order to conserve biodiversities and to clarify its potential impacts on hydrological cycle, the ecological and environmental knowledge must be collaborated with the hydrological studies more closely. Under these circumstances, to clarify the eco-hydrological impact of climate change, we attempt to improve our distributed hydrological model called Hydro-BEAM (Hydrological river Basin Environment Assessment Model) for River Ecosystem assessment. The model can predict not only river discharges but also water temperature by using several GCMs output. In this paper, we try to apply our model to some major river basins in Japan and introduce our model performance for integrated eco-hydrological impact assessment under the global warming.

Abstract number 231 – SPATIAL VARIABILITY IN GROUNDWATER N₂ AND N₂O IN THE SAN JOAQUIN RIVER

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Groundwater inputs from agricultural areas can have severe negative effects on water quality with high nitrate concentrations being a major concern. Riparian zones are important ecological habitats that mitigate nitrogen loading from groundwater discharging into rivers primarily by denitrification. Denitrification is a permanent removal of nitrate by anaerobic microbial communities via the reduction to NO, N₂O and N₂. However, previous studies have shown that these areas can be source of N₂O

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emissions. Although removal of nitrate through denitrification is advantageous from a water quality perspective, N₂O is a harmful greenhouse gas. This study aimed to investigate nitrogen dynamics and dissolved N gases in surface and groundwater of the riparian zones of the San Joaquin River. Excess N₂ and N₂O concentrations were measured in surface and groundwater at 4 locations along a 33 km reach of the river. Samples were collected within bank sediments and 5 transect points across the river at depth intervals between 2-3 cm and 150 cm. Dissolved N₂ and Ar were measured by membrane inlet mass spectrometry and used to estimate excess dissolved N₂ concentrations. Dissolved N₂O concentrations were measured using the headspace equilibrium technique and analyzed with a gas chromatograph. Both N₂ uptake and excess N₂ were present, ranging from -3.40 to 8.65 N₂ mg/L with a median concentration of 1.20 N₂ mg/L. Significantly lower concentrations of N₂O were present ranging from 0.0 to 0.12 N₂O mg/L. Deeper groundwater sites had significantly higher N₂ and N₂O concentrations coinciding with decreased O₂. The presence of excess N₂ and low N₂O concentrations documents the importance of denitrification in removing nitrate from groundwater. Further investigation will examine N₂O emissions from riparian soils and benthic sediments using static chambers and focus on nitrogen pathways that contribute to high ammonium concentrations with increasing depth.

Abstract number 232 – USE OF A REGIONAL GROUNDWATER MODEL TO ASSESS AREAS POTENTIALLY AFFECTED BY GROUNDWATER ABSTRACTION

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Modelled results from a regional groundwater model are evaluated to identify areas environmentally affected by changes in groundwater abstraction. Hydrologists and ecologists have discussed and agreed on different types of results that could be used as indicators for a potential impact on the environment. Focus has been drawn towards any ecological effects on protected biotopes (according to The Danish Nature Conservation Act) and especially sites designated as Natura 2000 sites by The Habitats Directive (Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild flora and fauna) or the Bird Directive (Council Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds). The consequences of these changes are still to be evaluated as part of an Environmental Impact Assessment (EIA). Groundwater is the dominating resource of water for drinking water in Denmark. The implementation of the EU Water Framework Directive (Directive 2000/60/EC establishing a framework for the Community action in the field of water policy) has increased the focus on available water resources and sustainable use. The water resources are limited in the Copenhagen area and the competition for water between the environment and the human demand is a recognised problem. The regional water supplier, Københavns Energi, abstracts 55 million m³/year from 55 well fields. These are often situated near streams and low lands where the water is abundant, but these locations do also imply risks for reducing the water flow in the streams and affecting the environment in the adjacent wetlands, meadows and bogs. As part of an EIA, a regional and integrated groundwater and surface water model has been developed covering the entire Zealand (9,400 km²) with a grid spacing of 500 m. Three types of modelled results have been used to identify areas which need further investigations and detailed ecological considerations regarding any consequences for the environment. Firstly; the stream discharge during the summer months (base flow) is evaluated and minor reductions from 5 up to 10 % compared to natural conditions are usually acceptable. Secondly is the water table in the surface layer evaluated. It is estimated that reductions of the water table larger than 0.25 m could have an impact on the environment. Thirdly, the direction and range of the vertical flow of groundwater is considered. The protected biotopes affected by changes in the groundwater flow are mainly wet biotopes and these could be sensitive to small changes in the water flow. The water flow is typically

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upwards in these areas and a reduction or a change in the flow direction could be crucial. Thus the gradient and flow in the upper layers are evaluated. Results are presented from a Natura 2000 site (Vasby Mose) where a large protected biotope has co-existed with several well fields for many decades.

Abstract number 234 – COMPARISON OF WATER QUALITY OF SÉD STREAM IN VESZPRÉM AND HOLT-SEBES-KÖRÖS TOGETHER WITH SEBES-KÖRÖS IN BÉKÉS

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The most essential purpose of the modern society is able to handle and find solution for environmental problems especially water pollution that is serious not only for present but future generation. As the load to our surface water has become more significant consequently a continuously increasing demand has been created for adequate quality and quantity water. The Water Framework Directive is a long-term water policy of the European Union. Aim of WFD is the classification and protection of the water according to consistent viewpoints. Objectives of the researches are the identification and testing of the effects of the potential pollutants sources and critical sites in Séd (Veszprém) and in Sebes-Körös in Békés. According to measurement taken on field and laboratory the water quality of Séd and Körös is classified excellent and good but in some cases water quality is categorized as tolerable. Several parameters refer direct flowing of sewage that requires further detailed measurements. In conclusion in both cases the pollution resources originated from point sources such as sewage treatment, husbandry. These activities have significant effect on the quality of surface water. Further measurements are required that the pollutant sources are become easily identified. Information about water quality in Séd and Körös are available at Local Governments. The critical polluted sites have been assigned so collective action plan have to be worked out based on WFD instruction.

Abstract number 237 – THE EFFICIENCY IN NITROGEN REMOVAL OF A IRRIGATED BUFFER AREA

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Semi-natural floodplains, where the water flow must be strongly managed as it occurs for instance in drained wetlands, can potentially remove large amounts of nitrate. A pilot-scale experimental system (0,8 ha), located 15 km from Venice, was planned and built to demonstrate the efficiency of the wooded riparian soil in removing the exceeding nitrogen from the river flow. The experimental site was built in 1999 on an area previously used to grow arable crops. It was constructed to allow the precise management of the system hydrology, because the water is electrically pumped from the Zero River into the irrigation ditches (ridges). The particular structure, characterized by ridges and furrows, facilitates sub-surface water flow through the woodland area. The creation of a suspended artificial aquifer, seldom in contact with the groundwater, was the result of the artificial irrigation. A grid of 30 piezometers was

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used to measure the sub-superficial water level and to collect water samples. A detailed monitoring program has been carried out since October 1999, so a huge data base of meteorology, hydrology, water quality, soil chemical parameters and denitrification rates, is now available. The experimental site was monitored in two periods; first for three years from 2000 to 2002, and then again from 2007 to 2010. Thanks to this second monitoring opportunity it was possible to evaluate the long term efficiency of the site. The results indicated that the nitrates retention capacity increased strongly from about 40 to 85% from the first to the third year. Overall, total nitrogen retention increased from 26% in the first year, to 62% in the third year. In 2008 it was possible to start a new experiment and to remarkably increase the discharge in the system. The results confirmed the percentage nitrate reduction capacity of the system and as a consequence the quantity of nitrate removal was higher. In 2009 and 2010 we are analysing the efficiency of the system after adding higher amounts of nitrogen.

***Abstract number 238* – APPLIED STUDIES ON BUFFERING CAPACITY OF AN EXPERIMENTAL RIPARIAN WOODLAND FOR THE TREATMENT OF DIGESTED SLURRY**

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This study is part of a main project, called "Riducareflui" conducted by Veneto Agricoltura, aimed to study and evaluate currently available solutions for reducing groundwater and freshwater pollution originating from digested slurry produced by biogas plants. The experimental site is located, 15 km from Venice, within a forested buffer area of about 30 ha that was planted in 1999, in historically reclaimed land where the crop fields are lower than the River. It is irrigated with freshwater from the river, so that the wet woodland can operate similarly to a natural riparian woodlands. The experimental site, a monospecific (*Platanus hybrida*) productive woodland, covers a total area of two plots (0.35 ha each). In the two plots the trees were partially cleared to allow the slurry distribution and the remaining trees act as a buffer strip. One plot is irrigated as all riparian woodland while in the second one, there is no irrigation. In the first plot as a consequence of the irrigation (about 17,500 m³ year⁻¹), a perched aquifer is created with the water level between 25 to 60 cm below the soil surface. The upper 15 cm soil layer is subjected to the normal seasonal cycle. The second plot is characterized by the natural fluctuation of the water table. The impermeable clay-soil makes the system very conservative and as a consequence the digested slurry was applied within parallel furrows 10-15 cm depth and sprinkled one per year. From the first results, of water collected within the unsaturated zone, it was possible to see how the two treatments (irrigated and no irrigation) act differently. The irrigation water seems to actively wash the nitrate produced by the digested slurry toward the lower layers at 30 and 50 cm depth. As a result the nitrate concentration increased (up to 86 mg/L) also in the artificial aquifer sample in the well located on the edge between the distribution zone and the wooded buffer zone. In the area without irrigation the digested slurry is stored in the upper soil until heavy rain moves it very slowly toward the ground water. Thanks to this conservative situation the nitrogen amount could be used more efficiently by the vegetation (uptake) or converted into gaseous molecules throughout the denitrification process.

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***Abstract number 240* – INVESTIGATION OF DIFFUSE GROUNDWATER CHEMICAL IMPACTS ON GROUNDWATER-DEPENDENT TERRESTRIAL ECOSYSTEMS IN ENGLAND AND WALES: IMPLICATIONS FOR WFD GROUNDWATER BODY CLASSIFICATION AND PROGRAMMES OF MEASURES**

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Procedures for risk screening and assessment of significant damage to groundwater-dependent terrestrial ecosystems (GWDTEs) for EU Water Framework Directive (WFD) implementation have been developed by the Environment Agency for England and Wales (Hulme et al 2007; Brooks et al 2009; Whiteman et al 2009; Whiteman et al 2010). Field investigations have been undertaken at a small number of wetlands to test the procedures, and to improve our ability to detect significant damage and help us to prevent further deterioration in groundwater status. This paper reports the results of these investigations, which focus on diffuse groundwater chemical impacts, and their implications for significant damage assessments, research needs and policy implementation through groundwater status assessments in the second cycle of WFD river basin planning. Investigations have been based on a source-pathway-receptor approach, quantifying these linkages at each site. Multiple sources and pathways of nitrates have been demonstrated by a combination of techniques, including high resolution logging of multilevel piezometers, combined with hydrochemical and nitrogen isotope sampling, geophysical and hydro-ecological surveys and ecological mapping. At each stage of the investigation, the eco-hydrological conceptual model has been reviewed and updated by a multidisciplinary team of ecologists and hydrogeologists. It has also been important to consider the timing of impacts and lag time in the ecological response, as some GWDTEs may still be responding to historic chemical pressures rather than current pressures. The results suggest that desk-based risk screening procedures are inadequate on their own to confidently predict the likelihood of significant damage. A combination of risk screening methods and targeted site-based data analysis will be required to ensure good status of WFD groundwater bodies in future river basin cycles. Site specific chemical data are required, along with knowledge of hydrological and chemical thresholds to trigger detailed assessment of significant damage. Existing groundwater monitoring networks do not provide this site-specific data. Multiple sources and pathways may contribute in combination to eutrophication-related impacts or damage (for example atmospheric deposition of nitrate), making impact assessment more complex. The implications of the investigations for WFD Programmes of Measures, groundwater quality sustainability and effective management of the GWDTEs will be discussed in the paper.

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***Abstract number 241* – HYDRODYNAMICS OF PHYTOPLANKTON BLOOM IN SHALLOW WATER ENVIRONMENTS**

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Phytoplankton bloom is often seen in shallow water environments, such as lakes, rivers and reservoirs. Its occurrence can be a threat to the security of the hydro-ecological systems. In China, this is of increasing concern as related to the tributaries into the Three-Gorges reservoir, the downstream reach of Hanjiang River in relation to the mid-route of the South-to-North Water Transfer Project, and also the proposed dam across the northern end of Poyang Lake, 27 km from the Yangtze River. One of the key factors for the occurrence of phytoplankton blooms in these cases is the substantially altered hydrodynamic regime due to the construction of the large-scale dams. This study aims to identify the threshold hydrodynamic conditions for the occurrence of phytoplankton blooms under differential nutrients and light inputs in shallow waters. A coupled hydrodynamic-ecological model is deployed based on the fundamental fluid dynamics and suspended sediment transport theory. Three background conditions are considered, i.e., light limited, nutrient limited and light-nutrient limited. It is found that phytoplankton population develops in time and space appreciably differently under the distinct background conditions. In shallow waters, phytoplankton population develops rather uniformly along the flow depth in the early stages, but it can evolve to appreciably differential in the long run, similar to the case in deep waters. The implication of this observation is clear, i.e., existing models hydro-ecological models based on depth- or cross-section averaging is not justified and warrant reformulation.

***Abstract number 242* – NUTRIENT VARIATION FROM UPSTREAM TO DOWNSTREAM : EFFECT OF GROUNDWATER DISCHARGE AND RIVER TOPOGRAPHY**

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Nutrient condition in water environment controls the ecosystem. Groundwater discharge to the oceans is significant as nutrient supply (Slomp et al, 2004 etc). This situation is similar to the nutrient condition in rivers. Most of river line generally is discharge area of groundwater, but a part of river line is recharge area of groundwater. In addition, nutrient concentration changes by the trap in dammed lake in the way of flowing to downstream. On the other hand, recent human activity has caused the intensive and excessive supply of nutrient. To clarify the nutrient condition in river environment, it is necessary to confirm the groundwater discharge to river as well as estimate the nutrient load by human activity. However, these types of researches have not been conducted enough. In this research, we aimed to confirm effects of groundwater on nutrient supply to rivers of various properties. Our research areas are around Hiroshima of western Japan and around Busan of southern Korea. We collected river water samples from upstream to downstream. All water samples were analyzed in the laboratory for the ^{222}Rn , nutrient and inorganic element concentration, respectively. In addition, water samples of groundwater around there, bottom sea water, and river water at some points around the station were collected. Spatial variations from upstream to downstream in ^{222}Rn and nutrient concentrations indicated decreasing trends. These suggest that head water is source area of nutrient. But some areas in midstream had high values, and it indicated heterogeneous groundwater supply. Phosphorus concentration increased in downstream. It was higher at groundwater of discharge area and downstream.

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This also suggests phosphorus supply by groundwater to rivers. Especially, the phosphorus concentration was high in the tidal river. This would be supplied by the diffusion from river bed sediment as well as by groundwater discharge.

Abstract number 243 – SMALL RESERVOIR EFFECT ON SEASONAL VARIATION OF RIVER NUTRIENT FLUX

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As macronutrients are required by primary production of phytoplankton which is a base of food chain, nutrient dynamics such as nitrogen, phosphorus and silicate is important for river, lake and ocean ecosystems. Surface water bodies with very low velocity such as lakes and reservoirs has typical biogeochemical properties, in which nutrient exchange rates between dissolved content and solid content, and water body and bed, are relatively larger than nutrient counterchange rate in them. Therefore, nutrient concentrations of input to reservoirs are usually different from them of output. To confirm the nutrient discharge and condition in rivers and reservoirs, it is important to estimate and evaluate nutrient exchanges in reservoirs. The objective of this research is to confirm nutrient exchange processes in a small reservoir in a suburban basin with a developing city in Japan. The study area is the Takaya River watershed in western Japan with the area of 141 km². It is a tributary of the Ashida River. There are many small reservoirs on the main stream for irrigation to expanded paddy field in the watershed. In the reservoir, it was confirmed that denitrification in the surface of reservoir bed sediment proceeded as well as nitrogen assimilation by phytoplankton. That is a nutrient absorbing process in a reservoir. On the other hand, ammonium was produced by mineralization of organic matter in sediment. These estimated dissolved nitrogen (DN) flux by mass balance method suggested nitrate was removed in the reservoir. The removed amount was dominated by assimilation process in the summer season and by though denitrification process in autumn season. In addition, diffusion of nutrients such as N, P and Si from sediment has been estimated by concentration gradient and diffusion coefficient from pore water in the sediment to the water body, with considering the water flow from water body to bed sediment according to hydraulic gradient. The diffusion flux of nutrient from bed sediment to water body has been large throughout the year. In summer, input nutrient flux decreased in the reservoir due to large flux of nutrient absorbing in the reservoir. On the other hand, output flux increased due to large flux of diffusion flux in winter. Such small reservoirs usually distribute in a mid to downstream area of a watershed. Therefore, such large effect of small weirs on nutrient discharge should be considered more.

Abstract number 244 – HOT MOMENTS IN COLD SPOTS MULTI-SCALE TRACING OF REACTIVITY HOTSPOTS IN HYPORHEIC ENVIRONMENTS

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This study presents a combined application of distributed sensor networks, in-stream geophysical exploration techniques and multi-scale approaches of hyporheic pore water sampling for investigating the reactive transport of nitrate at the aquifer-river interface of a UK lowland river. Spatial patterns of hyporheic redox-conditions, dissolved oxygen and organic carbon content as well as concentrations of major anion including nitrate and its decay products have been observed in 48 nested multi-level mini piezometers and passive gel probe samplers. The hyporheic pore water sampling identified hot spots of

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increased nitrate attenuation beneath semi-confining peat lenses in the streambed. The intensity of concentration changes underneath the confining peat pockets has been found to correlate with the state of anoxia in the pore water as well as the supply of organic carbon and hyporheic residence times. In contrast, at locations where flow inhibiting peat layers were absent or disrupted – fast exchange between aquifer and river caused a break through of nitrate without significant concentration changes along the hyporheic flow path. In order to identify the spatial patterns of reactivity hot spots in the streambed, distributed temperature sensor networks and hydro-geophysical exploration methods have been applied to identify the structural streambed heterogeneity including location and extend of flow inhibiting structures and to trace the exchange flow patterns between groundwater and surface water. At focus areas characterising representative streambed geomorphic features, the complex spatial distribution of highly conductive sandy and gravely sediments in contrast to semi-confining, low conductivity peat lenses has been identified by in-stream ground penetrating radar. Reach scale spatial patterns and temporal dynamics of aquifer-river exchange fluxes have been analysed by heat tracer experiments based on Fibre-Optic Distributed Temperature Sensing (FO-DTS) in combination with 2D thermocouple arrays and a small scale heat pulse injection methods for tracing shallow (25 cm) hyporheic flow paths. Temperature survey results indicate that during summer, patterns of cold spots in the investigated streambed sediments can be attributed to fast groundwater up-welling in sandy and gravely sediments resulting in low hyporheic residence times. Contrasting conditions were found at warmer areas at the streambed surface where groundwater – surface water exchange was inhibited by the existence of peat or clay lenses within the streambed. FO-DTS observations of regional groundwater up-welling patterns were complemented by heat pulse injection experiments which provided essential information of the shallow (< 25 cm) aquifer- river exchange fluxes.

Abstract number 245 – ANALYSIS OF THE DEGREE OF CONNECTIVITY BETWEEN THE SÃO FRANCISCO RIVER AND RIPARIAN LAGOONS: EVALUATION OF THE HYDROLOGY AND PHYSICAL AND CHEMICAL VARIABLES

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Threats to aquatic ecosystems are increasingly worrisome situations often leading to irreversible loss of biodiversity and environmental services. Therefore the identification, reduction and reversal of these impacts should be based on understanding the ecological processes responsible for biodiversity and productivity in the existing environment. The river-floodplain tropical systems are integrated ecosystems that create aquatic and transitional environments that facilitate the maintenance of considerable biodiversity. The periodic flooding of rivers promotes an increase of habitats, redistribution and dispersal of young fish and adults. However, oxbow lakes that are not flooded regularly fail to serve as breeding refuge, affecting the future recruitment of species to the adult population. This research highlights the effects of damming on the river San Francisco, the 4th largest Brazilian river, on your flooding areas. The system of dams and the eight power plants, impose profound changes in hydrology resulting in serious environmental and ecological consequences. It is of fundamental importance to identify the situation of the connectivity of the river and adjacent water bodies, especially the lagoons, in order to have an estimate of the prospective potential for providing environmental and ecological services. This study analyzed physical and chemical variables of water in the lower course of the Sao Francisco River and two lagoons, considering the conditions of water flow and local topography. The research is based on observing the degree of surface and ground connections of the river with these lagoons, both hydraulically and in terms of water quality in order to recognize patterns of exchange and mutual influence.

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Abstract number 246 – CONTAMINANTS IN A MUNICIPAL WASTEWATER PLUME IN GROUNDWATER DISCHARGING TO A RIVER

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In a municipal wastewater plume discharging to the Athabasca River at Jasper, Alberta, the following pharmaceuticals were found to be prevalent at trace concentrations in samples collected in 2009: carbamazepine, clarithromycin, lincomycin, primidone and sulfapyridine. Other contaminants that were commonly detected in 2009 samples included caffeine, cotinine, the artificial sweetener acesulfame, and nutrients. Carbamazepine and acesulfame were strongly correlated in these samples. A larger suite of samples to be collected in September 2010 will also be discussed, in particular, from a shallow zone immediately beneath the river bed where the plume is discharging (hyporheic zone), in order to probe the behavior of these contaminants as they discharge to the river.

Abstract number 247 – HYDROLOGIC, 1D- AND 2D-HYDRAULIC STREAM MODELLING – AN INTEGRATED SYSTEMS APPROACH FOR RIVER RESTORATION

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Aquatic freshwater habitats are strongly influenced by human activities along the water course but also by land use and catchment management. In order to find suitable measures to improve habitat quality ecohydrological models can help to assess the impact of environmental stressors. For a comprehensive analysis however, landscape processes as well as instream processes have to be modelled in an integrated manner and in a satisfying resolution. As basis for our modelling system we used three freely available models, first the river basin model SWAT2005 (ARNOLD et al., 1998) to evaluate water balances and erosion as a function of catchment characteristics. In order to include the flow velocity regime, the water depth profile and instream sediment transport processes, a two-step hydraulic model cascade is applied. HEC-RAS (USACE, 2006) is used to depict the whole river reach one dimensionally and the two-dimensional hydraulic ADH model (BERGER & TATE, 2007) with a refined resolution is applied on selected areas only. Most important steps for setting up the SWAT model were the consideration of drainages and landscape surface water retention potential in the 50km²-lowland catchment. The necessary boundary conditions and data for the HEC-RAS model were derived from the SWAT model, area-wide available morphological data and cross sectional measurements. An interface transfers the SWAT flows and sediment fluxes at tributaries and along the channel to HEC-RAS. For applying ADH, morphological mapping campaigns were conducted to gain detailed maps with information on the substrate, its extent and distribution along a 200m-section. The available bed and bank bathymetry from the HEC-RAS model was refined by transferring morphological information to topographic data. Flow boundary conditions were supplied from HEC-RAS. The established hydrological model performs well in depicting the catchment hydrology for the ten year modelling period. HEC RAS shows good agreement with measured flow velocity and surface water profiles along the stream channel as well as total sediment loads. The ADH results show a high dependency on the morphological and topographical channel characteristics. The two-dimensional results are compared and verified with stream velocity and water depth measurements. To enable a comprehensive assessment of river restoration measures, parameter functions are used to dynamically describe the habitat conditions for selected macro-invertebrate species based on the modelling results. The simulated aquatic habitat conditions are compared with species samples. Additional advantages of the modelling system and the developed coupling methodologies are the cheap and practical application in the GIS environment.

***Abstract number 251* – THE APPLICATION OF A SIMPLIFIED METHOD TO MAP THE AEROBIC ACETATE MINERALIZATION RATES AT THE GROUNDWATER TABLE OF THE NETHERLANDS**

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A simplified method is used to assess the microbial activity of subsoils and soils across a broad geographic scale. Acetate was selected because it is a major intermediate in catabolic biochemical pathways. In order to get minimal disturbance, only a small amount of tritium labelled acetate and water are added to the subsoil material. After an incubation time, the subsoil material is separated from the water by centrifugation and the formed tritium labelled water is separated from the remaining acetate by evaporation. The data of 128 locations in the Netherlands were plotted in a soil map and were also compared with the depth, dry weight, electric conductivity, pH and nitrate concentration. The peat areas consisted of limed meadows with a high groundwater level whereas the sand areas often showed deeper groundwater levels and a lower pH. The subsoils at the groundwater table of the peat areas, which are in contact with soil air, showed a higher mineralization rate compared with the surface soils in our study. In contrast, the mineralization rate of the subsoil at the groundwater table of sandy soils showed on average a factor 30 lower rate. Nevertheless, the self purification capacity of the subsoil can be vital under weather conditions where the surface soil becomes less active.

***Abstract number 252* – POTENTIAL REDUCTION OF HYDROLOGICAL EXTREMES IN HEADWATERS: CASE STUDY OF UPPER VLTAVA RIVER BASIN, CZECHIA**

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Increasing frequency of catastrophic “flash floods“ and extreme droughts in recent years results in an urgent need of solving of flood protection questions and measures leading to discharge increase in dry periods. Runoff flattening is related to a use of untraditional practices as a suitable complement to classical engineering methods. These measures should be represented by gradual increase of river catchment retention capacity in headstream areas. Research carried out in the upper part of Vltava River basin (Šumava Mts., SW Czechia) on the base of a number of present automatic hydrological gauges and climatic stations consists in a runoff dynamics and rainfall-runoff conditions detailed analyses. Streamflow generation processes and present peat bog revitalization activities were studied using hydrological statistics and ion, carbon and oxygen isotopes balance analyses especially within periods of high or low discharge rates. Pedological survey of different soil types and textures was carried out to precise the determination of its water capacity. Practised detailed snow cover monitoring should markedly help with precisng of estimation of retained water storage and significantly improve a hydrological prognosis during snow melting process. Detailed analyses of extreme runoff ascending and descending phases and minimum discharges in profiles closing several subcatchments with different physical-geographic conditions show higher peak flow frequency and their shorter reaction to causal amount of precipitation in the case of highly peaty areas, therefore more distinct runoff variability of streams draining peat land localities. These findings were affirmed by geochemical approach laboratory outcomes within the meaning of significant contribution of runoff from peat lands to the total runoff during extreme flood situations. In order to achieve retention potential enhancement in the source areas of czech rivers a possible former accumulation reservoirs (used for wood floating in former times) restoration should be considered. The system of such small storage bins (similar to dry polders with temporary water impounding) could function as an alternative and supplement to greater dam reservoirs. Modern equipment and methods are able to evaluate its effectiveness. Implementation of these

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unforceable measures realized in river headstream areas could contribute to reduction of peak flows during flood situations and to retention of sufficient water resources for potential dry episodes in future.

ABSTRACT NUMBER 253 – RECOVERY OF HEADWATER STREAMS AND RESERVOIRS FROM ACIDIFICATION

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After the World War II, in the Jizera Mountains, the anthropogenic acidification led to drastic deterioration of headwater catchments. In the 1990s, headwaters were successfully re-stocked with brook trout (charr). These populations show an adaptation to extreme conditions, they are stabilized and self-reproducing, however, they are still endangered by episodic acidification events with elevated concentrations of the toxic fraction of aluminium. An experimental reintroduction of brown trout and minnow to the reservoirs was not successful but on sites with higher values of pH (in lower parts of some streams), the brown trout becomes successful in competition with the charr. In the second half of the 20th century, in the Jizera Mountains, the anthropogenic acidification led to a drastic deterioration of headwater catchments. Consequences of acidification (peaked in the mid-1980s) were, namely, a decrease in pH and life degradation in surface waters, as well as the die-back and large scale harvest of spruce plantations. The number of species in plankton and benthos communities was reduced and fish became extinct already in the late 1950s. First signs of a recovery from acidification were observed in both the water chemistry and biota at the beginning of the 1990s. Headwater reservoirs and streams were successfully re-stocked with brook trout (charr) in 1991 – 1998, and its populations were studied for ecology, ethology, and feeding behavior. These populations show an adaptation to extreme conditions (low temperature of the water, low pH with peaks of acidity in snowmelt and flood events. Nowadays, they are stabilized and self-reproducing, however, they are still endangered by episodic acidification events with elevated concentrations of the toxic fraction of aluminium. An experimental reintroduction of brown trout and minnow to the reservoirs was not successful but on sites with higher values of pH (in lower parts of some streams), the brown trout becomes successful in competition with the charr.

Abstract number 256 – LANDCOVER CHANGE AND HYDROLOGICAL REGIMES OF THE RIVERS OF WESTERN NIGERIA

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Climate-landcover interaction is a two way feedback. Landuse and cover change is a strong factor of catchment fluxes and hydrological regimes of rivers. There is a general belief that forest degradation and spread of cultivation increases rate of run-off and mobilization of sediment in catchments and sediment loads being discharged. Landuse and cover change that reduces canopy ecosystems will correspondingly increase surface albedo, reduce leaf area index (LAI), reduce infiltration, increase surface run-off, and impair nutrient cycling. Changes in LAI can significantly affect the regional and local climate especially rainfall by changing the moisture available for evaporation at the surface. This is particularly relevant in Savannah of Nigeria where a large proportion of annual rainfall is due to mesoscale processes triggered by local forcing especially terrain and vegetation. Reduced forest and woodland mean reduction in LAI with significant impact on the local forcings. This study employs coupled Cellular Automata_Markov (CA_Markov) land change model to investigate expected landcover changes under present and future climate around the 'eco-climatic complex' that doubles as the headwater for the main rivers of western

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Nigeria. Historical flows from some of the rivers were also correlated with changes in landcover and seasonal changes in the pattern of the eco-climatic complex. There is a consistent relationship between landcover change and historical flows. Under future climate scenario, gallery forest is projected to replace much of the present forest. This will have implications for the flow of the rivers with the possibility of precipitating water crisis in western Nigeria.

***Abstract number 257* – TSUNAMI AND ITS EFFECT ON COASTAL AND MARINE ECOSYSTEMS OF SOUTHERN AND EASTERN COASTAL ZONES OF SRI LANKA**

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Coastline of Sri Lanka circles about 1585 km and the coastal zone is defined in the Coast Conservation Department Act No : 57 of 1981 which is having high demographic pressure when compared to other regions of the country. Also there are highly variable coastal and marine ecosystem can be observed within this area. These ecosystems include; mangroves, sea grass, salt marshes, beaches, sand dunes, estuaries, lagoons, coral reefs, ...etc. There are many socioeconomic and environmental problems arise within the coastal zone of Sri Lanka with the increase of population and natural influences. The tsunami which had happened on 26 th December, 2004 was the most serious environmental hazard that Sri Lanka had ever experienced. It was created huge damage for the coastal ecosystem, properties as well as lost more than 40,000 human lives. Deposits of debris and sand were carried by tsunami was a serious challenge to the solid waste management system. Water contaminated by these debris, water became more saline due to over-pumping of wells and well water got contaminated with chemicals carried from tsunami water were some of the serious issues influenced on damaging marine, shoreline and inland ecosystems. After the tsunami, threatened for the marine, shoreline and inland ecosystems was badly experienced specially along the Eastern and Southern coastal sectors. This is mainly due to contamination of coastal aquifers and surface water bodies from the water and debris carried by the tsunami. This implies that the tsunami was seriously affected by some of the coastal regions of Sri Lanka and created many environmental as well as social impacts and also will take another couple of years to recover from some of these issues.

***Abstract number 258* – STRUCTURE AND FUNCTIONS OF RIVER ECOSYSTEM - ROLE OF SUBSURFACE FLOW IN ALTERNATE SAND BAR**

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Importance of ecosystem management has been recognized as well as that of flood mitigation and water resources management, but ecosystem dynamics has not been well understood. In this paper, the structure and functions of river ecosystem are discussed from three aspects: (1) interrelating system of physical underpinning based on fluvial process, biochemical materials cycle and biocoenosis; (2) hierarchy structures in space and their connectivity by water/material flux network; and (3) flow and stock structure. As for (1), the physical patterns provide habitats for various species and peculiar spaces for various elementary processes in biochemical material cycle, and biomass of organisms are closely related to biophilic material cycle. The interactions correspond to respective ecological functions. We can postulate various local landscapes identified with local ecosystem as an interrelating system. There are categories in various scales and they show spatial hierarchy (nesting structure). For example, river system is composed of several segments, and a segment composed of reaches, a reach composed of units, and a unit composed of sub-unit scale landscapes. Those space units are connected to one another by surface flow and subsurface flow with containing materials. As for (3), water, sediment and biophilic

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elements are flowing as flux, and exchanging with stock such as aqua-areas, morphology and bio-activities. Then, we have focused on ecosystem function brought about by subsurface flow in alternate sand bars. On a sand bar, there are various landscape units such as vegetated areas, fine-sand mounds, coarsened zones, temporary waters and so on. Those landscape units are connected to one another by surface flow and subsurface flow with materials such as particulate organic matters and inorganic dissolved ions. Particularly along subsurface flow, materials are transported and changed their forms such as nitrification and denitrification by biochemical actions. By taking an example of denitrification, the structure and functions of river ecosystem is discussed. Firstly in the field, by monitoring the concentrations of nitrate ion and stable isotope of nitrogen, we confirmed that denitrification occurs along the subsurface flow route in alternate sand bars. Then, numerical analysis has been conducted. The subsurface flow is analyzed in horizontal 2D scheme under Dupuit-Forchheimer assumption, and then the Michaelis-Menten's reaction term is added to the material transport equation. The analysis has clarified how the spatial layouts of sub-bar scale landscapes change the output of ecosystem function (denitrification rate) as well as the areal occupation of those landscape units in a sand bar.

Abstract number 260 – FRESH-BRACKISH GROUNDWATER INTERFACE RESPONSE TO HYDRO(ECO)LOGICAL MANAGEMENT IN THE NAARDERMEER WETLAND, THE NETHERLANDS

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Wetlands in the Netherlands are of international importance with respect to low-productive species-rich fen vegetation. These ecosystems dependent on seepage of nutrient poor, alkaline groundwater seepage which, under natural conditions, is provided at the edge of river plains by outflow at the base of sandy glacial ridges. This natural outflow got disturbed by human intervention, notably introduction of drainage for agriculture in river valleys, and groundwater extraction for drinking water and industry on the sandy ridge recharge areas. The decrease in groundwater flow led to deterioration of biodiversity in the river plain wetland fens. Policy recognised the deterioration and measures were taken like reduction of groundwater extraction and of drainage in river plains by elevation of surface water levels in polders. However, the effect of these restoration measures are debated. This study looks at the effects of hydro(ecological) restoration measures in the Naardermeer wetland, The Netherlands' oldest nature reserve well known for its species-rich fen vegetation located in the groundwater outflow zone located at base of a glacial sand ridge. The edge of this seepage outflow zone is marked by a fresh-brackish groundwater interface. The interface marks the edge of the outflow zone of fresh nutrient poor alkaline groundwater from the ridge. Therefore displacement of the interface may provide information on changes in fresh groundwater outflow following hydroecological restoration measures. The interface is relatively easily distinguished by waterquality measurements in the field and thus may be used as a proxy. The study uses a non-stationary density-dependent groundwater model to simulate the displacement of the fresh-brackish groundwater interface over time in a vertical transect along the general groundwater flow direction, in order to analyse: - The genesis of the brackish groundwater seepage as a function of water management in the area over the past century; - The effects of hydro(ecological) management aimed at restoring the outflow of fresh groundwater into the Naardermeer nature reserve, by using the spatial movement of the fresh-brackish groundwater interface as a proxy. With respect to the restoration measures it evaluates whether measures will lead to: - enlargement of the fresh groundwater outflow area; - and/or enlargement of the fresh outflow flux. The model simulations show some unexpected responses of the movement of brackish groundwater, stressing both the effects of remnant local drainage within the nature reserve, as well as the necessity of considering density differences in modelling restoration scenarios in this fresh-brackish groundwater

system.

Abstract number 261 – NATURE CLOSE TORRENT CONTROL IN ORE MOUNTAINS

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Abrupt change of discharge during torrential rains is characteristic for torrent catchments. The flow increases suddenly, has a short duration and after reaching its maximum discharge it decreases rapidly. This is caused by the relatively small catchment, which is often impacted by heavy rainfalls, sharp slope of the torrent catchment as well as of the torrential channel itself. Furthermore, torrents usually manifest a fluctuation in discharge, i.e. the rate between maximal and minimal discharge amount to 1: 5000 or more. Another important aspect is that the biggest damage is not caused by the embankments overflow and subsequent flooding of large areas, as is the case in the water courses situated in plains, but by damage and devastation in large sections of the catchment and adjacent constructions by a great shear stress on the stream bed and stream embankment, due to flowing water masses. Accumulation of sediments in the lower sections of the catchment is also a significant problem. Hence, it is necessary to design torrent control measures in such a way that they may meet the required purposes, i.e. greater stream bed capacity and resistance to strain, as well as ecological requirements for migration permeability and acceptable consolidation. Currently, there are discussions going on in the Czech Republic concerning apparently over-dimensioned and even “superfluous” torrent control measures. However, recent flood events and their devastating effect on torrent catchments and the surrounding constructed area justify comprehensive flood control and erosion control measures, while respecting nature. This paper deals with hydraulic assessment of the torrent catchment bed and its inundation zone for various consolidation measures within the proposed discharge capacity, with a focus on selected hydraulic characteristics: torrent bed capacity, velocity and shear stress. Migration permeability is also taken into consideration. As a means for verification of these methods the mathematical model HEC-RAS was used. This model has been calibrated and validated for the Jindřichovický Brook in the Ore Mountains (Western Bohemia).

Abstract number 262 – EVALUATION OF A NOVEL INTEGRATED WATER RESOURCES MANAGEMENT MODEL ON A PILOT AREA HEAVILY AFFECTED BY EXCESS WATER

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The fate of the water resources is determined by a combination of various – oft erratic – internal and external environmental, social and political effects. Scientific understanding and forecast should form the basis of professional management of the available water resources. Still, for the Carpathian basin no widespread interdisciplinary, scenario-based methodology is available to support political decision-making. In 2009 a three-year long research and development project (called WateRisk) was launched to resolve this situation. The main achievement of the ongoing project is the implementation of a scientific water management decision support system (data base and user-friendly software application). Latter provides risk-based analysis of different social-political-environmental scenarios with accentuated consideration of ecological aspects of water availability (e.g. water scarcity or excess water during growing period). Current paper deals with the performance evaluation of the developed model system. The WateRisk model system attains the integrated water resources management approach, which means that hydrological processes are treated in their complexity at system level. The application realizes the

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description of the regional hydrological cycle by a set of novel or state of the art, dynamically interlinked, physically based, distributed parameter hydrological-hydrodynamic models. Infiltration, recharge, baseflow and groundwater movement has decisive influence on the ecological availability of water resources. Therefore – beside typical hydrological surface phenomena such as runoff, storage, ponding and open channel flow – great emphasis was laid onto subsurface processes during the model development. The coupled methodological description of the groundwater-vadose zone-surface water coverage interactions can be considered as notable novelty and advantage of the model system. To validate the application a pilot study has been carried out. The selected test area is a 400 km² lowland region of Hungary. Geological and hydrologic characteristics of the area expose it to frequent occurrence of excess water. The special phenomenon of ponding has significant ecological consequences, and is in some way or other related to all considered components of the hydrologic cycle as well as to human intervention. The case study aimed to simulate the spatial and temporal variation of water coverage and root zone saturation, which provides the basis of further analysis to assess ecological corollaries of excess water. Precursory results suggest the adequate performance of the model system: beside acceptable computational time demand and water budget errors the observed and simulated water coverage and pumped volumes show promising fitting. Anticipatory estimate of excess water related losses was also done.

Abstract number 264 – TWO WAY COUPLING OF A CONCEPTUAL HYDROLOGICAL MODEL TO A REGIONAL ATMOSPHERIC MODEL

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The simplest way of combining atmospheric and hydrological modeling is by using fields (typically precipitation and temperature) resulting from the atmospheric model as input to the hydrological model. This is known as the one-way coupling, as the atmospheric model influences the hydrological one, but not the other way around. This procedure is typically done off-line, i.e., the models run separately. Facility, simplicity and low computational costs are the main advantage of this methodology and it has been widely used in studies of climate change impacts (e.g. Ottlé et al. 2001) and evaluation of performance of atmospheric models (Benoit et al., 2000; Ducharne et al., 2003). Atmospheric and hydrological models can also be two-way coupled. In this case, exchange of fluxes from the atmospheric to the hydrological models, and vice-versa, takes place creating a feedback from the surface processes to the atmosphere (Goswami and Himeshi, 2002; Mölders and Raabe, 1997; Overgaard et al., 2006). In this case, it is important to correctly simulate the spatial distribution of soil moisture (Ookouchi et al., 1984) as important regional thermal circulations can be created by the difference in soil moisture (e.g. Grimm et al., 2007). A key question of the two-way coupled model is its ability to deal with different time and space scales characteristics of the atmosphere and the hydrology (Goswami and Himeshi, 2002). Due to the different spatial scales, a regional atmospheric model is more suitable for a two-way coupling than global ones (Xu, 1999). Even so, upscale and downscale procedures may be necessary to consider depending on the models' resolution (e.g. Mölders and Raabe, 1997; Seuffert et al., 2002), and may be facilitated by the use of remote sensed data. This work created a two-way coupled modeling system using regional and hydrological models widely applied in the South American tropical region. The chosen models are the Brazilian Regional Atmospheric Model System (BRAMS) and the Large Basin Model – Hydraulic Research Institute (MGB-IPH). In this first two-way coupled system, MGB-IPH is fed by BRAMS 24-hour accumulated precipitation and returns soil moisture to the atmospheric model. To test the coupled system a simulation run was performed on Rio Grande river basin, Brazil, where MGB-IPH had been previously calibrated to. Preliminary results shows an enhancement in the soil moisture and evapotranspiration indicating the importance in considering a hydrological model running online with an atmospheric model.

***Abstract number 265* – SIGNIFICANCE OF O-18 AND HYDROCHEMICAL COMPOSITION TO CHARACTERIZE WATER DYNAMICS IN HYPORHEIC ZONE OF YAMUNA RIVER FLOOD PLAINS IN DELHI AREA**

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The Yamuna River meets about one-fifth of Delhi's water requirement, and the rest is met from other river basins and groundwater. About 4000 MCM of surplus monsoon discharge in the river (almost four times the annual supply) flows unused to the Bay of Bengal. In floodplains of the river, groundwater wells which are used for drinking contains a significant contribution of bank filtrate. Since, the river along the Delhi stretch remains highly polluted, the wells close to the river are vulnerable to contamination. Over the last few decades, withdrawal of water for drinking and irrigation upstream leads to lower-than-normal residual flow, reduction of flood frequencies and peak flows during floods, adversely affecting the floodplains recharge and the ecosystem. For millions of years, the river has been depositing sand to form the floodplains, and the accumulated sandy layer exists to an average 40m depth. In flood plains, since floods lead to an enhanced water exchange between the river and groundwater, there is scope to restore the annual recharge under the floodplains via the hyporheic zone. In this context, for water resources protection, the extent of hyporheic zone, the proportion of freshly infiltrated water, and the movement of water into and out of it at the river/aquifer interface, in response to discharge, has been characterized based on spatial and temporal variations in $\delta^{18}O$ and hydrochemical composition, and groundwater levels in numerous shallow wells. The study indicates that compared to river water, the groundwater under the flood plains generally contains very low NO_3 and NH_4 all along the river stretch, but, at some stretches the adjacent groundwater contains more NO_3 , and biogeochemical gradients exist within the hyporheic zone. The total and fecal coliform bacterial count varies from 1-570000MPN/100ml and 1-420MPN/100ml respectively, exceeding the standards at all locations. Groundwater ($\delta^{18}O$ -5.6 to -9.6‰) is enriched compared to river water $\delta^{18}O$ (-9.7‰). Simple mixing model on $\delta^{18}O$ suggests 2-96% river contribution to groundwater under the flood plains at different stretches. Freshly infiltrated hyporheic groundwater could be distinguished from other groundwater by its short residence time of a few days in the subsurface. Regional recharge from rainfall to relatively older groundwater adjacent to the flood plains ranges from 1-10%. The findings helped to assess the groundwater development potential and contamination risk below the flood plains, and bridge research gaps on the functional significance of the hyporheic zone to river floodplain management and restoration.

***Abstract number 267* – ENVIRONMENTAL FLOW ASSESSMENT UNDER DIFFERENT OPERATION SCENARIOS, A CASE STUDY OF NEKA DAM IN IRAN**

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With the purpose of water resources sustainable development, a flow is defined under the title of Environmental Flow Requirement. There is an extensive literature devoted to determining how much water a river needs to sustain a healthy ecosystem, and so far different methods have been inscribed and used throughout the world. These methodologies have been divided to 4 groups: Hydrological Methodologies, Hydraulic rating Methodologies, Habitat Simulation Methodologies, and Holistic Methodologies. Presently, regulated rivers are managed in a manner to cover a broader range of goals including sustaining downstream of dam ecosystem. This purpose might be achieved via releasing and

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sustaining estimated Environmental Flow Requirements. The water needs of humans and natural ecosystems are commonly viewed as conflicting each other and releasing the Environmental Flow Requirement towards the downstream of dam ends to a decreased level in the amount of usable water in order to provide off-stream Requirements. Also regarding the increasing competition to exploit rivers in order to supply the human-needs and lack of enough water resources, in the process of determining the amount of Environmental Flow Requirement, we need to take into consideration the effect on the amount of providing off- stream requirements. In this study in order to consider both groups of competing uses, some scenarios entitled Environmental Flow Requirement scenarios are defined in downstream of a dam site. The site of Environmental Flow Requirement is on Neka River which is located in northern part of Iran. In various scenarios, Indicator of Hydrologic Alteration of the flow regime which is an indicator of the eco-hydrological condition of the river have been estimated and analyzed using the IHA/RVA methodology. Also by using the WEAP model for each scenario, the Reliability index of providing for off-stream flow requirements has been calculated. Finally with examining different scenarios, the one which led to a more suitable relationship in providing for In-stream Flow Requirements and Off-stream Flow requirements was selected.

Abstract number 269 – CLIMATE EFFECTS ON RIPARIAN ZONE CONTROL ON DOC IN BOREAL HEADWATERS STREAMS: DOES RIPARIAN ZONE CONTROL AMPLIFIES CLIMATE RESPONSE ?

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Dissolved organic carbon (DOC) plays an important role in the biogeochemistry of many natural surface waters. Key controls on the DOC dynamics in natural waters have been shown to include discharge, soil moisture and soil temperature, all of which are anticipated to change in a warmer future climate. In order to study possible changes in the DOC dynamics in boreal areas, we conducted a simulation study using down-scaled climate data from the Hadley GCM, and the Riparian Profile Flow-Concentration Integration Model (RIM; Seibert et al., in prep.) for modelling dissolved organic carbon in forested headwater catchments. Development of the RIM model using observed stream and soil water TOC data (about 90-95% of TOC is dissolved in these systems) from the Västrabäcken headwater catchment in northern Sweden for the years 1993-2005 has identified soil temperature as a key factor in defining the influence of the riparian soil on runoff DOC. This means that an expected future shift in the timing of flows from spring with colder soils to autumn with warmer soils, could amplify the effects of climate change on stream DOC. For the future climate simulation study we used downscaled precipitation and air temperature data from a RCM RIM to run the HBV rainfall-runoff model to simulate future discharge and a simple empirical model to simulate soil temperature (Köhler et al., 2008). The HBV, RIM and soil temperature model were calibrated using data from the Västrabäcken catchment. The RIM was calibrated, using a GLUE approach running the model 100 000 times (Nash-Sutcliffe, Nash-Sutcliffe on log-transformed concentrations, and mean absolute error as likelihood measures). The discharge and soil temperature data were then used as input data to the RIM, using the behavioural parameter sets, to simulate future DOC dynamics. To avoid the problem with large discrepancies between modelled and observed data the simulation study was compared to modelled DOC concentrations using modelled current climate and discharge. The RIM model predicted that the future climate, with an increase in runoff, and a shift in the timing of runoff from the spring to the autumn, will increase annual mean DOC concentrations by XX%, from YY to ZZ mg/L. A purely statistical analysis of the 1997-2006 DOC data, suggested that the increase in median DOC under a future climate would be about ~2-3 mg/l (ca. 128%) (Köhler 2009), and Erlandsson et al, using 30 years of data from some 30 streams predicted that the future climate would increase DOC by just 6%, also using statistical techniques. We believe that these results not only show the sensitivity of DOC to climate change, but also the importance of using process-understanding to predict the effects of climate change, rather than just statistical methods.

***Abstract* NUMBER 272 – CURRENT AND FUTURE WATER BUDGET OF A MEDITERRANEAN COASTAL WATERSHED: QUINTO BASIN, RAVENNA, ITALY**

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The contribution of (natural) vegetation to the hydrologic budget of Mediterranean watersheds is important, because of high evapotranspiration rates, especially in summer. The seasonal water budget of the Quinto Basin, a coastal watershed along the Adriatic sea in Italy, is calculated based on land use under current and future climate conditions. Estimates of the future hydrologic surplus or deficit helps to understand whether salt-water intrusion will be even a larger problem in the future than it is today, threatening both agriculture and natural ecosystems. The evaporation of open water and the evapotranspiration of wetlands, pine forests, bare soil, and irrigated agriculture are calculated with the Penman-Monteith equation (Cropwat, FAO). The current hydrologic deficit or surplus is based on average climate data from 1989 to 2008, drainage and irrigation data. Predictions for future evapotranspiration, net irrigation and hydrologic deficit are calculated with climate data from IPCC (2007), scenarios A1b and A2. From the study results that soil type may determine whether or not a crop will need more or less irrigation in the future. Water budget analysis under scenarios A1b and A2 both show an increase of water deficits in summer and an increase of water surplus in winter. This is explained by the fact that a larger percentage of the annual precipitation will fall in winter. The open water evaporation will decrease under future climate scenarios as a result of increased relative humidity in winter and decreased wind velocity. This may have a positive effect on the water cycle. The current irrigation is abundant but has beneficial effects in contrasting soil salinization and salt-water intrusion in the coastal aquifer as confirmed by groundwater monitoring and chemical data analysis. It is difficult to quantify the water use of natural areas. As an alternative to using the Penman Monteith equation for calculating the water use of the coastal pine forests, we used published sap flow measurements to get an estimate of pine tree water use. A pine tree takes up between 27 l/day and 47 l/day if water is readily available and between 10 l/day and 30 l/day if there is a limited water supply or the groundwater has a high salinity. Especially in summer, these values may exceed average daily rainfall in the area. Therefore pine tree transpiration contributes to the hydrologic deficit and salinization of the coastal aquifer.

***Abstract number* 273 – MODELING ECO-HYDROLOGICAL IMPACTS OF TEMPERATURE CHANGES IN A CATCHMENT**

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The sensitivity of fish populations, such as salmonids, to stream temperature changes has been a major concern in many areas that depend on these species. Silver Creek, Idaho is a spring-fed stream highly valued for its abundance in trout species. The aquifer system that recharges Silver Creek is located in a semi-desert mountain valley. Approximately 60% of the land in the valley is cultivated, 80% of which is irrigated. Over the past few decades increases in population and efficiency of irrigation practices have stressed the available water resources of the valley. Studies indicate that groundwater levels in the valley have declined over the recent decades. Moreover, the morphology of Silver Creek and some of its tributaries has been altered by erosion, which has caused increases in the width-to-depth ratios in some areas. These factors and possibly climate change have led to changes in the hydrologic and temperature

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regime of the Silver Creek Basin. Higher temperatures and decreased flows in Silver Creek during the summer are threatening the aquatic habitat. A spatially distributed and integrated surface water, groundwater and temperature model of the Silver Creek Basin was developed in order to quantify the changes of these processes under different conditions. The model includes natural and anthropogenic hydrologic processes, surface heat balance components and movement of heat by advection-conduction. Measures of the ecological impact on trout can be evaluated by using a bioenergetics-based model that links temperature effects to trout growth. Growth rate is a good measure of fish health because it links temperature to other bioenergetic processes such as food consumption and metabolism. Optimal growth occurs at specific range of temperatures, which vary among different species of fish. The mathematical relationships previously developed and tested based on these concepts will be used to dynamically link an ecological model to the flow and temperature model. The integrated tool will allow the evaluation of several management strategies at the catchment scale in order to find an optimal set of solutions for ecosystem status traded-off against other priorities of the basin. The model development process and results have shown that agricultural practices in the basin are critical in controlling flows to Silver Creek. Furthermore, model runs representing stream restoration conditions, i.e., deeper channel profiles, showed reductions in the water temperature peaks and oscillations up to 10 degrees Celsius, approximating the range of optimal temperatures for trout.

***Abstract number 274* – HIGH CHLORIDE CONCENTRATIONS IN THE SOIL UNDER TREE HEDGES IN CATCHMENTS IN THE WEST OF FRANCE, USED AS EVAPORATION INDEX: CAN WE GENERALISE?**

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Earlier work showed a phenomenon of accumulation of chloride (more than 200 mg/kg of dry soil at some depths) under a bottomland hedge located in a rural catchment. This observation, unexpected in temperate and oceanic areas is at the origin of this study in order to determine the occurrence of this phenomenon on different sites distributed in West of France. Accumulation of chloride can indeed be used as an indicator of root extension and intensity of hedge transpiration, as well as indicator of water movement in soil. First, we prospected a dozen hedges that show a quite important spatial variability between sites: chloride content does not exceed a few tens of mg/kg on some sites and reach up to 412 mg/kg on others. This is apparently due to multiple factors such as trees transpiration, root extension, topography, soil type... Secondly, temporal variability has been established by comparing, in one site (Pont Lagot), concentrations of chloride during the months of October 2006, 2007 and 2009 and April 2007 and 2010. The main factor for this variability is certainly climate variability that affects water flow. Dry years probably increase capillary rise of groundwater more concentrated in chloride as rain and tree transpiration. In contrast, wet years may cause leaching of chloride stock accumulated in soil. In this study, we calculated that ten years would be required to obtain the concentrations of chloride measured under the hedge of the local site. Lastly, discussion is done on the relation between soil chloride and the flush of chloride in rivers when the discharge resumes at the beginning of winter.

Abstract number 277 – HYDROLOGICAL CONDITIONS OF EUROPEAN WETLANDS – OVERVIEW OF CURRENT SITUATION AND FUTURE PERSPECTIVES

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An appropriate hydrological regime within a wetland is essential to maintain goods and services. This regime is related to the source of water which is different for particular kinds of wetlands. This paper presents an overview of hydrological conditions of European wetlands based on a representative sample of 102 protected wetlands larger than 5000 ha. In order to avoid use of confusing number of terms and names, for purposes of this work, wetlands were divided into four different classes based on peat accumulation and major hydrological characteristics. Wetlands where peat has or is being accumulated are called mires. Depending on the main source of water, mires can be divided into bogs and fens. In case when the area of peat accumulation is being drained for agricultural, farming, peat extraction or any other purposes, it is called peatland. Riparian wetlands are divided on two classes: marshes and swamps. Wetlands where peat does not arise are called marshes. Swamps are the wetlands where it is not a rule that peat will be formed. They are characterized by very long inundation period during each year. The major hydrological characteristics important for the particular kind of wetlands were calculated. There were: frequency and duration of floods for swamps and marshes, ratio of precipitation to evapotranspiration for bogs, ratio of groundwater discharge and precipitation to evapotranspiration in case of fens and finally changes in fresh water inflow for the estuaries. In the second phase of the analysis the impact of future climate change and water management scenario were introduced. Based on results of the WaterGap model, major potential changes in hydrological regime (i.e. precipitation, groundwater recharge and river flow) were identified. If the change of the component was greater than the arbitrary chosen threshold, the particular wetland was flagged as endangered. The final results show the distribution of potential threats to wetlands status in Europe

Abstract number 278 – SIMULATION OF THE HYDROLOGICAL AND NITROGEN BALANCE AND CYCLE WITHIN THE ODENSE RIVER BASIN

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As the diffuse sources of pollution especially those of agriculture origin are becoming major problem versus the point source pollution, catchment scale modelling is a useful tool in estimating pollution loads from the agricultural activities in the river basin. Farmlands accounting for 68% of the basin area is the most important source of pollution in the Odense river basin, Denmark which is chosen as the case study in this research. There are two catchment scale models built for the Odense river basin to simulate hydrology and nitrogen transport and transformation with different concepts and different levels of complexity which are SWAT and the integrated DAISY-MIKE SHE model. The paper aims at comparing the performance of the two models in modeling the water quantity and nitrogen dynamics and the effect of different processes in flow and nitrogen results of the two models. SWAT is a semi-distributed catchment model which simulates water quantity and pollutant loadings based on hydraulic response units (HRUs). Nitrogen is modelled by SWAT in the soil profile and in shallow aquifer. Nitrogen processes in the soil profile include: mineralization, residue decomposition, immobilization, nitrification, ammonia volatilization and denitrification. The loss of nitrate shallow aquifer is specified by the half-life nitrate parameter which is uniform for the whole shallow aquifer. The DAISY MIKE-

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SHE approach consists of coupling a physically-based root zone model DAISY and a physically-based and fully distributed catchment model MIKE-SHE which are running sequentially. DAISY substitutes the unsaturated zone of MIKE SHE and calculates daily mass of nitrate leaching and water percolation which are then used as input for MIKE SHE to simulate the saturated zone and the river. The MIKE SHE model simulates denitrification in groundwater by considering both oxidized and reduced layers which are separated by the redoxcline. It is assumed in MIKE SHE that nitrate reaching the redoxcline is removed instantaneously. According to preliminary results for Odense river basin, both SWAT and DAISY-MIKE SHE give satisfactory results for flow, in which Nash – Sutcliffe coefficient of the SWAT model is a bit higher than the DAISY-MIKE SHE model. Water balance in the two models are also slightly different. For nitrate simulation, the magnitude and the trend of nitrogen flux from SWAT model are quite similar to the measured data. However, SWAT model does not capture very well the measured values in each time step especially the flood period while DAISY-MIKE SHE gives more satisfactory results.

Abstract number 283 – ATTEMPT TO VERIFY SWISS OBJECTIVES ON GROUNDWATER ECOLOGY

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The Swiss Water Protection Ordinance not only defines microbiological and chemical water quality standards but also ecological objectives for groundwater. The ordinance demands that biocenoses in groundwater should be in a “natural state adapted to the habitat” and “characteristic of groundwater that is not or only slightly polluted”. However, today experts are still looking for ways of developing such assessments on the basis of clear concepts. This issue was the starting point to conduct a survey on a national scale based on the network of the Swiss Groundwater Monitoring. It comprises the sampling of 50 groundwater stations all over the country representing different macrochors and aquifer types. As microbial assemblages form an important part of the groundwater biocenoses samples were analysed for several microbiological parameters, including indicator organisms and total cell count. Modern methods using molecular microbiological techniques allowed non-cultivable microorganisms to be detected and the microbial assemblages to be characterised. Although the structural and geochemical heterogeneity of the aquifers is reflected in the heterogeneous distribution of the microbial community, correlation with the aquifer type, i.e. porous, fissured or karst aquifers, is demonstrated in terms of colonisation, variability and impact of pathogens. Furthermore, the study provided ranges of total cell count and pathogen occurrence. Some groundwater ecosystems, i.e. in karst aquifers, also showed strong temporal variations. Finally, data were processed with a linkage to other criteria for anthropogenic and surface water influence, such as nitrate concentrations, organic matter content, or vulnerability examination. An intact ecosystem is the prerequisite and an indicator for good groundwater resources quality. The study discusses, based on field measurements, how to define and verify the natural state of the biocenoses that is requested by the Swiss Water Protection Ordinance. A first attempt consists in assessing (i) the actual microbiological inventory of Swiss aquifers, (ii) typical ranges for specific microbiological parameters for the main aquifer types, and (iii) their spatial and temporal variations. In this context, the study displays the advantages and limits of the ecological approach to groundwater protection.

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***Abstract number 284* – BIOGEOCHEMICAL PROCESSES ALONG THE GROUNDWATER FLOW LINE IN A RIPARIAN WETLAND**

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In a Danish minerotrophic riparian wetland covering an area of 3136 m² the groundwater flow pattern along a flowpath transect was mapped from the hillslope to the stream bank. Along the transect the concentration of reducible elements revealed a very clear reduction sequence reflecting the constant flow pattern of the wetland. The sequence began with reduction of oxygen followed by reduction of nitrate, which took place within a narrow zone close to the hillslope covering an area of 330 m². The wetland was very effective in nitrate reduction through both autotrophic and heterotrophic denitrification. Autotrophic denitrification with pyrite as electron-donor was responsible for 28-64 % of the total nitrate removal, i.e. 1.30-2.97 g NO₃⁻-N m⁻² d⁻¹. The heterotrophic denitrification rate was 1.67-3.34 g NO₃⁻-N m⁻² d⁻¹. When nitrate had completely disappeared ferrous iron appeared, but only in small amounts. Although sulphate was produced in the nitrate reduction zone near the hillslope, sulphate reduction, 1.06 g m⁻² d⁻¹ also took place closer to the stream. The annual water balance, showed that the wetland was recharged by 6 % precipitation and 94 % groundwater. The discharge was divided into 5 % evapotranspiration, 83 % overland discharge through two rivulets, and 12 % groundwater discharge. The annual mass balances per ha showed a high removal of nitrate-N, 1719 kg NO₃⁻-N ha⁻¹ yr⁻¹, net retention of ammonia, 7 kg NH₄⁺-N ha⁻¹ yr⁻¹, loss of organic-N, 31 kg organic-N ha⁻¹ yr⁻¹, loss of total-iron, 41.4 kg Fe ha⁻¹ yr⁻¹, loss of sulphate, 3164 kg SO₄²⁻ ha⁻¹ yr⁻¹, and loss of phosphate-P and organic-P, 11.6 kg PO₄³⁻-P ha⁻¹ yr⁻¹ and 5.3 kg organic-P ha⁻¹ yr⁻¹, respectively.

***Abstract number 286* – MODEL CONCEPT FOR THE PROJECTION OF WATER RELATED LAND-USE PARAMETERS**

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The future water cycle with related matter fluxes analogue to climate change will be influenced by land-use change. Hence there is an increasing need to project land use over long-term time horizons in integrated water resources management (IWRM). Given the numerous interrelations between land use and the water cycle, projection may not be restricted to land cover only. Instead in principle all relevant parameters describing pressures, dependencies and sensitivities of land use with their specific change should be considered. This is particularly true if complex hydrological systems e.g. of river catchments are analysed with coupled models. To deal with this challenge the model PWF-LU is being developed which aims at a projection of land-use parameters interrelated with the water cycle. Main objective of the tool is to provide consistent sets of parameter values for future scenarios of regional development. The model is based on a conceptual framework with a generic system analysis. Hereby 17 hydrological processes are identified such as evapotranspiration, discharge, or leaching which are influenced by land use. These processes are distinguished for two principal systems, one representing build-up areas, and the other one embracing areas with a predominant cover by vegetation, soil and water (open spaces). Parameterisation of the two principal systems for a study area is carried out in various steps. Firstly, it covers the classification of land-use types which goes beyond existing land-cover classification and reflecting features relevant for the water cycle. For instance the build-up areas are classified using urban structure types (UST) with at least two more classification level compared to CORINE. Secondly, for each land-use type a comprehensive set of parameters is derived from the principal system analysis. In case of the UST, these are 19 parameters (e.g. sealing or water consumption), whereof the open spaces are treated with 27 parameters (e.g. root depth or fertilization). For each land-use type specific parameter values are determined from literature reviews and field surveys. The latter encompass in-depth

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investigations at test sites and their statistical analysis for a transfer to all sites of the same land-use type. Thirdly, the PWF-LU model combines a GIS topology derived from remote-sensing data and a settlement-analyser tool with the parameter values of individual land-use types considering site-specific natural and societal conditions. It allows importing algorithms for land-cover change as well as changes of parameter values (e.g. decrease of water consumption). Consistency of these values is insured due to a particular scenario method which is being developed in parallel to the model. Model output is a comprehensive set of space and time-dependent parameters. Some of these parameters are available in different units and scales to facilitate uptake by various hydrological models. The presentation shows the concept of the model and first results from its testing in the upper part of the Western Bug River (Ukraine). The study is embedded in the international research project IWAS which is dedicated to new tools and knowledge on integrated water resources management and their proving in five model regions in the world.

Abstract number 288 – ARSENIC SOURCE AND RELEASE PROCESS IN A COASTAL WETLAND LOCATED IN THE SOUTH EASTERN PO PLAIN (ITALY)

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We studied the hydrogeochemistry of the phreatic aquifer in the coastal area included between Uniti and Bevano rivers (southern part of the Po plain, near the city of Ravenna). Arsenic is a natural pollutant of these waters and is connected to iron hydroxides dissolution, which is caused by redox potential fluctuations. A regional Arsenic anomaly is well known in deeper groundwater (in the range 50 - 100 µg/l, according to Farina et al., 2005). This study is one of the first attempts in the area to investigate on the distribution of As within the phreatic aquifer. High As concentrations in the confined aquifers of Ravenna are supposed to be due to Fe hydroxide dissolution, which can be caused by redox potential fluctuations (Ravenscroft et al., 2009; Marcaccio et al., 2005). The crystal lattice of Fe hydroxides has the capability of adsorbing As and is easily altered by redox variations (Smedley & Kinniburgh, 2002), which occur after water-table lowering due to groundwater extractions (Farina et al., 2005). The As source for the phreatic aquifer is still the dissolution of iron hydroxides, which can be extensively found throughout the silty sands of the study area. Iron hydroxides are also commonly associated to organic-rich fine grained sediments in the hyporeic zone of ponds and ditches. It is well known that arsenic mobility is maximum in neutral waters. As behaviour is also marked by its still great mobility at negative redox potential conditions (Bissen & Frimmel, 2003). In the case of the phreatic aquifer, eh fluctuations are caused by the alternation of rainy periods, when more oxygenated groundwater infiltrates into the shallow system, and of dry seasons, when redox potential is lower due to evaporation and evapotranspiration. Furthermore, the highest As concentrations were found close to stagnant surface water bodies. Arsenic release is therefore linked to the processes taking place at the interface between groundwater and surface water, such as evaporation, evapotranspiration of aquatic plants, accumulation of organic matter and the upconing of Fe and As rich groundwater from the bottom of the aquifer. During four seasonal monitoring survey in the study area, we collected 94 samples of groundwater and surface water. Arsenic concentrations were measured with hydride generation methods for the ICP (inductively coupled plasma). The method is based on the reaction of As (III) with Sodium-Boron hydride to obtain the arsenic hydride (APAT, 2003).

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***Abstract number 293* – SPATIAL AND TEMPORAL CHANGES IN GROUNDWATER FLUX TO GAINING STREAMS**

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Seasonal and interannual variations in climate, particularly precipitation, have the potential to alter patterns of groundwater recharge, groundwater contributions to baseflow, and stream discharge in ways that are difficult to measure and predict. In this study, a variety of methods (stream discharge, streambed seepage, instream piezometry and streambed temperature) are used to quantify and compare changes in the groundwater flux to two gaining streams (Fishtrap and Bertrand Creeks) situated within 8 km of each other in the Lower Fraser Valley of British Columbia, Canada. Summer stream discharge (low flow period) is thought to be comprised of direct contributions from runoff and groundwater discharge, although proportions and controls are uncertain for each stream. Precipitation data indicate that total annual precipitation was 1316 mm in 2008, 1277 mm in 2009, and 1340 mm in 2010, while summer precipitation (June through August) was 241 mm, 112 mm and 4 mm in each year, respectively. Total annual stream discharge in Fishtrap Creek increased over the 2008 to 2010 period, from $2.2 \times 10^7 \text{ m}^3$, in 2008 to $2.3 \times 10^7 \text{ m}^3$ in 2009, to $3.2 \times 10^7 \text{ m}^3$ in 2010. The summer discharge in 2009 ($0.7 \times 10^7 \text{ m}^3$) was half of that measured in 2008 ($1.4 \times 10^7 \text{ m}^3$). In Bertrand Creek, summer discharge in 2009 was similarly half that of 2008 ($0.8 \times 10^7 \text{ m}^3$ in 2008 and $0.4 \times 10^7 \text{ m}^3$ in 2009). In 2010, the summer stream discharge in Fishtrap Creek was similar to 2008 amounts, despite the extremely low summer precipitation of 4 mm. Seepage meter measurements show an increase in flux into the streams in 2010 relative to the previous year, suggesting that the increase in summer discharge in 2010 may be a result of increased groundwater contribution to the stream. The changes in summer stream discharge in Fishtrap and Bertrand in 2009 and 2010, compared to 2008, suggest that these streams respond in a complex fashion to summer runoff and groundwater recharge from the prior winter period. Strategies to protect aquatic habitat during the sensitive low flow season must include a comprehensive interannual evaluation of the interaction between the precipitation, groundwater fluxes, and stream discharges at the watershed scale and throughout the annual cycle, not just during critical low flow periods.

***Abstract number 295* – COMPARISON OF LINEAR AND NON-LINEAR REGRESSION MODELS FOR DETERMINATION OF CHLOROPHYLL-A IN LAKE EYMIIR (IN ANKARA, TURKEY) USING QUICKBIRD 2 IMAGE**

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In this study, the distribution of chlorophyll-a in Lake Eymir is determined using remotely sensed data. For this purpose, a high-spatial resolution image obtained from QuickBird 2 satellite is used. Linear and non-linear regression models are used to map the remotely sensed multispectral data into concentrations. Performances of the models are compared. Lake Eymir is a small eutrophic lake that is located at 20 km south of Ankara. Since 1961, the lake is located within the campus area of the Middle East Technical University. Until 1990, it had been used as the primary water supply for campus residents. Starting from 1970s until 1995, discharge of untreated wastewater from neighboring vicinities to the lake gave rise to eutrophication problem. The lake and the surrounding areas of 245 km² were declared as “Special Environmental Protection Area” in 1990. In order to monitor and solve the resulting eutrophication problem, several studies were conducted. However, none of them were able to solve this problem completely. Besides, in the previous studies several parameters which may have impacted the surface chlorophyll-a concentrations were not monitored. In this study parameters that were not considered in previous studies were also considered to see their impact on modeling of the chlorophyll-a concentrations. In the context of the study, the satellite image was obtained in September 2009 from

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QuickBird 2. Reflectance values in different bands were derived using ITT ENVI software with FLAASH Atmospheric Correction model. Then, water samples were taken from 30 different points in the lake within 1 week of image acquisition. Coordinates of the sampling locations are recorded using a GPS receiver. Finally all data was analyzed using linear and non-linear regression models, by XLStat software. Regression model inputs were reflectance values for near-infrared, red, green and blue bands, turbidity, total suspended solids concentration, water column depth, air temperature, humidity and ratio of photosynthetically active radiance (0 m / 0.5 m). When the results of linear and non-linear regression models are compared, it was seen that the performances of non-linear and linear regression models were not significantly different. Calculated R2 values for non-linear and linear regression models were 0.819 and 0.797, respectively. Although R2 for the non-linear model was slightly better, it exhibited higher error in predicted chlorophyll-a concentrations. Results indicated that use of meteorological and other lake and quality related parameters, as well reflectance values, may improve the regression model outputs.

***Abstract number 299* – RESTORATION OF HABITAT AS ESSENTIAL FACTOR FOR IMPROVED FAUNA POPULATIONS – LONG TERM EXPERIENCE ON NORTH GERMAN LOWLAND BROOKS**

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Brooks and small rivers of the North German Lowland, caused by their geochemical background by the glacial ages, within the morane landscape once have been gravel streams. Their groundwater-fed origin and the high habitat variety, accompanying deciduous wood with roots and a high amount of dead wood giving three dimensional structures within the water column characterized these waters as productive summercool salmonid stretches – also important as spawning places for migrators from the rivers, e.g. sea trout, river and sea lamprey. Heavy construction work, hard maintenance over time and increased excessive land use during the last decades turned these once thriving biotopes into sluggish canals with moving sand. Engaged people tried to restore these waters, mostly against heavy pressure of land users and authorities. International knowledge of how to regain the vital functions, however, grew steadily. Now, in the time of the Water Framework Directive, the chance has come to restore habitats in a large scale. Long time experience, often gained in step-by-step activities, helps to take the most effective way, avoiding mistakes. Examples are given for rural and urban waters where the salmonid reaches have been restored. Trout, brook lamprey, stone loach and accompanying characteristic invertebrates reveal the positive results. Adopt-a-brook groups and engaged individuals co-operate with water authorities, land owners and maintenance organisations to further improve the situation. To stabilize the results on catchment level and in the time of climate change develop the necessary adaptations, however, strong efforts have to be taken within the total system. Stream corridors with deciduous trees as buffer to avoid the entrance of erosive materials, pesticides and nutrients as well as re-gaining the characteristics of the summercool stream are the inevitable basis. Altering present day subsidies for agriculture, adaptation of river maintenance to the goals and consequent action of water authorities are needed.

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Abstract number 301 – REMOTE SENSING ESTIMATES OF EVAPOTRANSPIRATION TO ANALYZE THE GROUNDWATER INFLUX AND ECOLOGICAL WATER DEMAND FOR A GROUNDWATER-DEPENDENT WETLAND

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In water limited semi-arid regions, wetlands located in lowlands are mostly groundwater dependent ecosystems fed by the regional groundwater discharges. In the last decades, the increase of groundwater consumption for agricultural purposes caused significant depletion of groundwater resources and thereby drying out of many wetlands. The arid to semi-arid Konya closed basin located in central Anatolia region of Turkey presents a typical case, where a severe groundwater head decline due to increasing pressures by irrigated agricultural activities caused drying of numerous wetlands in the lowlands of the basin. This study uses remote sensing based estimates of evapotranspiration for the downstream wetlands in the Konya closed basin to analyze the dynamics of the regional groundwater discharge and ecological water demand by the groundwater dependent ecosystem. To achieve this, the spatio-temporal distribution of evapotranspiration calculated by a surface energy balance model (SEBS) was combined with a regional groundwater model and time-series of vegetation provided as remote sensing product.

Abstract number 302 – SUBSUPERFICIAL RECHARGE TO EMERGENT WETLANDS BY IRRIGATION OF WINTER WHEAT CROPS IN MEXICO

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The All-American Canal in USA diverts water from Colorado River in Imperial Dam, to the county and agricultural valley of the same name, parallel to the international border between USA-Mexico, has favored high seepage rates of water to the ground, crossing through dunes and Aeolian deposits in Andrade Mesa. Wetlands in Mexico formed due to groundwater mound in the aquifer from this source, are threatened by the replacement of a parallel concrete lined channel instead. To determine recharge patterns and directions of groundwater flow towards wetlands, by sub-superficial inflows of groundwater from return waters of agricultural irrigation we physically measured by means of a small piezometric net, considering the fluctuations in water table levels that shows significant contribution to groundwater storage from irrigated cultivated areas, exposed in increments of piezometric levels during winter season. Nevertheless permanent reduction in the storage of the aquifer by the end of seepage rates exists, the irrigation can make this wetlands survive as long as the same rate and irrigation practices continues.

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***Abstract number 305* – GROUNDWATER DEPENDENT ECOSYSTEMS (GDEs) IN THE GRAN SASSO CARBONATE FRACTURED AQUIFER (CENTRAL ITALY): HYDROGEOLOGICAL CHARACTERIZATION USING SPRING MEIOFAUNA**

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With growing interest for ecological sustainability of groundwater exploitation, groundwater-dependent ecosystems (GDEs) are becoming a key –focus in multidisciplinary research, integrating hydrogeology, biogeochemistry and groundwater ecology. Among the GDEs, springs could be considered also subsurface groundwater-dependent ecosystems (SGDEs). Under an ecological perspective, springs are notorious for being multiple ecotones, incorporating terrestrial, semi-terrestrial and truly aquatic habitats; in the meanwhile, they are also groundwater/surface water ecotones, therefore shaping a heterogeneous mosaic of meiofaunal assemblages. Spring meiofauna properly may reflect the characteristics of an aquifer and may provide information on surface/subsurface hydrological exchanges and on groundwater flowpaths. The present contribution deals with meiofauna diversity assessment of springs at different elevation the Gran Sasso massif (Central Italy), specifically addressed to analyze crenostygial and interstitial habitats, i.e., the interface between groundwater and surface - water habitats in springs. Copepod assemblages were used as representatives of the whole spring meiofauna, being the Crustacea Copepoda the most species-rich group in the study area. Their potential as biological tracers has been tested for supporting hydrogeological and hydrochemical features of the springs. The Gran Sasso massif, corresponding to a National Park, is a carbonate fractured aquifer with well-defined boundaries and a total discharge of more than 18 m³/s. The major springs, characterized by high and steady discharge rates, are located at the boundaries of the aquifer and lie along no-flow and seepage limits defined by aquitards. The aquifer has a mean hydraulic gradient of 5–20 ‰ and is locally compartmentalized by faults that act as groundwater divides and/or low-permeability heterogeneities. Karst morphology, such as conduits and caves, is dominant in recharge areas, vadose and epikarst zones, while it is rare in discharge areas, owing to fast emplacement of Quaternary clastic deposits. Springs of each group can be distinguished in terms of discharge, physical-chemical parameters and water isotopes values, but rarely by main ion content, which is commonly Ca-HCO₃ based. Because of tectonic pattern and recent geological evolution, different groundwater flowpaths can be hypothesized, distinguishing regional springs by perched springs, and fast-flow springs by base-flow springs. Ecological conditions at the spring sites, mainly by small-scale analyses of meiofaunal copepods, result to be useful to confirm or modify the groundwater conceptual model derived by hydrogeological data. In addition, after the Mw=6.3 earthquake of 2009, April 6, which directly affected L'Aquila city and the Gran Sasso aquifer, consistent clues of changes in groundwater hydrodynamics have been recorded both by hydrogeological and meiofaunal field observations.

***Abstract number 306* – DYNAMIC OF NITROGEN AT THE SCALE OF THE SEINE CATCHMENT (FRANCE) : USE OF ISOTOPIC BIOGEOCHEMISTRY**

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In order to get insights into the processes involved at regional scale in nitrate contamination of surface water by agriculture and ¹⁵N values of nitrate was δdenitrification in soils and riparian zones, the measured in water samples collected in small streams with differing watershed land use (forests, crops) and pedo-lithological context over the whole Seine catchment (chalk, limestones, tertiary Brie). Invariably, forested watersheds ¹⁵N-NO₃- values, δare characterized with low nitrates concentrations and low consistent with the isotopic composition of the organic nitrogen pool of forest soil which

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reflects the primary sources from which organic matter (and leached nitrates) are derived (atmospheric N fixation and atmospheric NO₃⁻ deposition) and a closed nitrogen cycle, without gas losses. Groundwaters from agricultural watersheds on the other hand, are characterized by high nitrate concentrations, with isotopic composition often much higher than that observed in forested watersheds, and close to that of the agricultural soil organic nitrogen pool of 15Nδthe respective pedo-lithological regions. As the latter is higher than the of most fertilizers used, it probably results from denitrification and or volatilization processes occurring in agricultural soils.

***Abstract number 307* – UNDERSTANDING WATER-AGRICULTURE-HUMAN INTERRELATIONS WITH AN ECOSYSTEM SERVICE APPROACH**

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Natural wetland area has been reduced by around 40% in China in the last century. Agricultural expansion is a main course of wetland degradation. In order to guarantee food security, agriculture has increased its provisioning services at the cost of reduction of provisioning, regulating, cultural and supporting services of wetland. Partly due to the agricultural expansion and wetland degradation, water scarcity becomes a major threat to China's sustainable development in many regions. Under this background, understanding agriculture-wetland-human interrelations becomes a key for China's future sustainable development. A framework is set up to describe how ecosystem service approach can help understand the interrelations among agriculture, water and human, particularly in the context of climate change and intensifying human activities. The relationships among direct/indirect drivers, ecosystem services of agriculture and wetland, and human well-being will also be discussed. The ecosystem service approach will be a valuable way to enhance human well-beings with a lower cost of natural degradation.

***Abstract number 308* – INTERSTITIAL PORE-WATER TEMPERATURE DYNAMICS ACROSS A POOL-RIFFLE-POOL SEQUENCE**

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Hyporheic habitat conditions are strongly controlled by the spatial patterns and temporal dynamics of physicochemical processes at the aquifer-river interface. In particular thermal properties and heat transport between groundwater and surface water can have a great impact on streambed habitats. This study uses high resolution observations of vertical hydraulic gradients and interstitial porewater temperatures to investigate spatial patterns and temporal dynamics of aquifer-river exchange fluxes and streambed thermal properties of a pool-riffle-pool sequence of a UK lowland river. The results of our investigations indicate that, although groundwater is dominantly up-welling in the research area, exchange flow patterns are strongly influenced by the streambed geomorphology. Advective heat flux caused by groundwater up-welling is shown to have a moderating impact on interstitial temperature

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patterns and partly compensates the impact of conduction of diurnal surface water temperature fluctuations into the streambed. Consequently, diurnal temperature oscillations, which are clearly pronounced in the top 10 cm of the streambed (up to 2 C), are reduced by 90% at depths below 20 cm. This study provides evidence that even in groundwater up-welling conditions, the spatially variable impact of heat conduction from the streambed surface can cause spatially heterogeneous interstitial habitat conditions with thermal properties differing significantly in a vertical (3 C temperature gradient at a length scale of 0.4 m) as well as longitudinal (0.75 C at 16 m) domain. These results not only enhance the understanding of thermal property patterns in lowland rivers but also bear implications for interstitial habitat ecohydrology, community structures and stability.

Abstract number 310 – PATTERNS, PROCESSES AND FUNCTIONS IN ECOHYDROLOGY: INTEGRATING LANDSCAPE ECOLOGICAL AND HYDROLOGICAL MODELS

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Understanding of landscape controls on the natural variability of ecological and hydrologic processes is an important ecohydrological research question. Quantitative landscape ecology, which aims at understanding the relationships of patterns, processes and functions in dynamic landscapes, may greatly contribute to this research effort by assisting the coupling of ecological and hydrological models. This contribution reviews currently emerging conceptual developments in ecohydrological research. It points out some common concepts and future research needs in ecology and hydrology in terms of pattern, process and function analysis and modelling. Complementary examples show how both disciplines can provide valuable information for each other. One example in my talk focuses on an integrated landscape model to investigate the ecological consequences and costs of different management regimes in semi-natural grasslands. The model integrates dynamic abiotic conditions, management (i.e. disturbance) regime and response of more than 50 characteristic plant and insect species by modelling the dynamics of relevant niche parameters as predictors for species distribution models.

Abstract number 311 – A PHYSICALLY-BASED APPROACH TO ASSESS THE IMPACT OF CLIMATE CHANGE ON CANADIAN WATER RESOURCES

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It is now generally accepted within the scientific community that the climate is changing, and that future climate change may have significant impact on water resources in both quantity and quality. Alterations of base flow to rivers due to changing subsurface flow patterns, fluctuations in the depth of the groundwater table and the water levels of lakes, and altered groundwater recharge/discharge patterns are examples of possible consequences of future climate change. Quantification of such impacts as driven by plausible climate-change scenarios is essential for policy makers. To date, there are numerous studies concerning this issue in the literature, but, to our knowledge, many are limited to a relatively small domain, usually up to a watershed or basin scale, and/or they fail to simulate the surface and subsurface flow regimes in a physically-based, fully-integrated manner. In this study, our physically-based model, HydroGeoSphere (HGS), is employed to simulate 2D surface water flow on the land surface together with 3D variably-saturated subsurface flow covering the entire Canadian landscape. Various numerical solution and mesh resolution issues are explored in view of the large computational effort required to handle 3D continental-scale simulations, and to accommodate the highly-complex and wide-ranging terrain over the Canadian land mass. The impact of long-term future climate change upon Canadian

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water resources is explored after calibration against historical meteorological, hydrological and hydrogeological data. In this study, we employ future climate predictions from NCAR's Community Climate System Model (CCSM) and the Canadian Regional Climate Model (CRCM) to drive the 3D HGS computations.

Abstract number 312 – THE PIANC “WORKING WITH NATURE” PHILOSOPHY FOR INTEGRATED WATERWAY PLANNING AND THE ESSENTIAL NEED OF HYDRO-ECOLOGICAL KNOWLEDGE

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As introduced by The World Association for Waterborne Transport Infrastructure PIANC in 2008, the Working with Nature Philosophy (WwN) promotes an integrated planning process for waterway related projects, infrastructural and constructional, which involves identifying and exploiting win-win solutions being acceptable to both project designers and all stakeholders (environmental, economical, societal) early in a project when flexibility is still possible (PIANC, 2008). When intending to realise waterway projects a transition from a conventional philosophy of “control” to one of “management” is needed. WwN means doing things in a different order: establish project objectives, understand the environment, engage stakeholders to identify possible win-win opportunities, prepare initial project design to benefit navigation and nature, and prepare final project design. Thus a sound understanding of the waterway environment and its hydro-ecological interrelations must serve as the essential basis for realising the WwN-Philosophy. An understanding of dynamics of ecosystems and especially of the interrelations between interference and ecological impact are absolutely necessary. The traditional way of implementing hydro-ecological knowledge in the planning process is to rely on professional expertise and opinion. This procedure often involves emotional discussions and fixing of contrary opinions and may lead to potential mistakes and delays in planning. Hydro-ecological science will help in solving this problem. Reliable and well-founded knowledge on processes and functional chains creates an objective base for taking decisions affecting impact on the hydro-ecological environment in waterway projects. At this point ecological modelling can serve as an effective and valuable tool to assist and support a planning according to the WwN-approach. Applying hydro-ecological knowledge and especially ecological modelling tools will help to achieve project objectives in an ecosystem context including concepts and ideas of involved stakeholders. Two examples of waterway projects in Germany will demonstrate approaches which can be regarded as equivalent to the WwN Philosophy: construction of a flood spillway at the Lower Rhine, optional constructional measures counteracting river bed erosion at the Middle Elbe.

**Abstract number 313 – HYDROLOGICAL CONTROLS ON VEGETATION COMMUNITIES IN UK
DUNE SLACKS**

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In the UK, our conceptual understanding of hydrological influences on dune slack vegetation is largely based on short-term datasets and old studies (e.g. Ranwell, 1959). Until recently there have been few attempts to link UK dune slack vegetation classifications to our understanding of hydrological regimes in a systematic way, and there remain major knowledge gaps (Davy et al., 2010). Here we report the first attempt to define key hydrological and ecological parameters for all five UK dune slack communities, based on permanent vegetation quadrats, a combination of long-running water-level measurements and spatial and hind-cast modelling of water table parameters, and soil samples. Measurements were concentrated at one west-coast site: Newborough Warren which contains examples of all five slack communities, but representative communities were also sampled at other sites to assess between-site variability. New piezometers were established adjacent to permanent quadrats, repeat surveyed since 1987. New vegetation quadrats were established adjacent to existing piezometers, the oldest monitored ~monthly since 1985. The site has a network of dataloggers recording at hourly intervals. A water balance model was established for the site based on the longest records of hydrological data and calibrated spatially using the extended network of more recent data. Using this model, a range of water table parameters summarising extremes, inter- and intra-annual variation, moisture and drought SEVs were calculated for each vegetation quadrat, whose elevations were established +/- 1cm using DGPS. Vegetation recording and soil sampling and limited water chemistry and trace gas emissions sampling were conducted in 2010. Relationships between hydrological parameters, environmental parameters and vegetation community types were established using classification and ordination techniques, using Monte-Carlo approaches to test significance of individual parameters in explaining vegetation patterns. We quantify the extent to which hydrological regimes explain broad differences between selected vegetation community types, and highlight other factors which need investigating in greater detail. We also quantify the sensitivity of selected species to hydrological parameters. Davy AJ, Hiscock KM, Jones MLM, Low R, Robins NS, Stratford C. 2010 Protecting the plant communities and rare species of dune wetland systems : ecohydrological guidelines for wet dune habitats. Phase 2. Bristol, UK, Environment Agency, 113pp. Ranwell DS 1959. Newborough Warren, Anglesey 1. The dune system and dune slack habitat. *J. Ecol.* 47 : 571-601.

Abstract number 316 – TRACE ELEMENT AND ENVIRONMENTAL ISOTOPE GEOCHEMISTRY ANALYSIS IN AN ARID AREA: A CASE STUDY FROM THE LOWER PART OF WADI SIHAM BASIN, TIHAMA COASTAL PLAIN, REPUBLIC OF YEMEN

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Trace element and isotope analysis were carried out in the study area in order to understand the recharge mechanism, identify degree of mixing and sources of water salinity. Fifteen representative water samples were subjected to trace element analysis for Mn, Fe, Br, Ba, B, F, V, and minor SiO₂. Three distinct zones one each for limestone-, alluvial- and thermal spring samples have been demarcated on the basis of the Cl vs. Br/Cl plots. It has been shown that the plots for alluvial aquifer fall between the plots of thermal springs and limestone aquifer waters, thereby suggesting the mixing of two end member waters. Three fields have been demarcated also with the help of the plots of nitrate vs. Br/Cl ratio viz. lower field representing thermal spring waters, middle field the water from alluvial aquifer, and upper field the water from limestone aquifer also support the mixing phenomenon. In addition, 11 representative water samples covering entire range of salinity and also sample from Red Sea were collected and analyzed for stable isotope concentration (Deuterium 2H and Oxygen 18O). The stable isotope geochemistry data revealed that: 1. The plots of samples for thermal springs and limestone aquifer fall on Meteoric Water Line (MWL) and overlap with the RECHARGE ZONE i.e. (Foothill Domain). 2. The plots for the samples collected from coastal domain and Red sea fall on Evaporation Line and coincide with the DISCHARGE ZONE i.e. (Coastal Domain). 3. On the other hand, the samples collected from alluvial aquifer in the central domain are located between the evaporation line and MWL i.e. on the Mixing line indicating transitional phase between fresh water rich in lighter isotope and evaporative water containing heavier isotopes. These plots overlap with the STORAGE ZONE i.e. (Central Domain). The trace elements and isotopic data indicated that: 1. The study area has been divided into 3 zones, Recharge, Discharge and Storage zones 2. The rain water has been modified due to contribution of thermal spring water, evaporation process and sea water intrusion.

Abstract number 318 – RIPARIAN ECOSYSTEMS AND GROUNDWATER RECHARGE ALONG THE TARIM RIVER, XINJIANG, CHINA

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In the Tarim Basin, located in Xinjiang, NW-China, as well as in the Aral Sea Basin, the riparian ecosystems are the most productive ecosystems and harbour the highest biodiversity. The Tarim Basin covers about 1 Mio. km² and most of its area belongs to the Taklamakan Desert. The annual precipitation does not exceed 50 mm. The Tarim River with a total length of 1321 km flows from the Tianshan Mountains along the northern rim of the Taklamakan Desert. As a loosing stream in our investigation area it sustains forests, wetlands, and shrub vegetation as riparian ecosystems. Most plant species are adapted to grow deep roots in order to secure access to the groundwater. Therefore, the groundwater recharge from the river and the resulting depth to groundwater table, respectively, are decisive for the survival of those riparian ecosystems. Within this study, the recharge from the Tarim

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River into the underlying aquifer was modelled along a representative transect. Different scenarios with respect to the underlying geologic formations and differing river discharges were analyzed. Furthermore, the vegetation distribution in relationship to the groundwater depths will be presented.

Abstract number 320 – PUBLIC POLICY IN GROUNDWATER: FAR FROM THE RHETORIC, CLOSER TO THE REALITY

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The absence of a Water Act and the lack of underground water policy in Colombia lead the authorities to creating stagnation in the development of the country, increasing uncertainty in the scientific communities, discouraging national private industry initiatives. It also tends to generate potential conflicts between neighboring municipalities and departments. Logically, this situation creates benefits only for investors who do not know the importance of water, specifically groundwater. For several years some Colombian government agencies have sought to establish clear criteria for the extraction of water from aquifers for industrial, agricultural, public service and other uses. This article is based on hydrogeological studies and construction of groundwater wells in several areas of Colombia. In addition, a review of the results from several National Development Plans which showed and the failure of government agencies related to natural resources. Finally, I analyzed public policies of water that the local, departmental, and central governments have tried to be implemented; I did it through personal political analysis studies numerous years ago. The environmental agencies of control, created from the Political Constitution of Colombia of 1991, called Regional Autonomous Corporations for each administrative division of the country, have not been able to establish clearly the mandates of the Constitution. The executive and legislative powers are limited to write documents called CONPES. However, during the political campaigns of the last ten years the people have heard promises for Water legislation. Today, a Water Act does not appear. The problem exists and the Water Act does not exist. As a result, it is necessary to establish a design, promotion, and implementation of water's public policies, which will be clear, specific, concrete, and easy to measure in order to protect groundwater resources, communities, and authorities as well. Those resources are at risk to be privatized in the Water Departmental Plans as a local model plan of the uncertain development system because the local plans are not connected to each other. The privatization of groundwater in large tracts of land habited by people of many municipalities is a high risk for Colombian communities, especially after a very long armed conflict. Moreover, privatization of groundwater can lead to the extension of illicit crops negative causing social effects. Social effects are known as serious level of concern for consumer countries. As recommendations, public education policies of water through the creation of the University of Water will educate people. The distribution, use and protection of water through the creation of a specialized agency of the government should improve the living conditions of Colombians.

ABSTRACT NUMBER 324 – NEW DELTAIC LANDSCAPE FORMATION IN LARGE RESERVOIRS

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River flow regulation with large reservoir is carried out in many regions of the world. The direct effect of reservoirs on the environment has been already studied in many aspects. Recently much attention was paid to the processes of environmental degradation in deltas of regulated rivers. Nevertheless, an important aspect of the interaction of water reservoirs and rivers was not yet investigated. This aspect - deltaic landscapes formation at the emptying of rivers into basins. Previously, this process was considered from the standpoint of the reservoirs siltation. However, it is more varied and substantial. In fact, new deltas with hydromorphic landscapes and peculiar mode of surface and groundwater,

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vegetation and soil cover are formed in the reservoirs. It is these processes; that we investigated in the Dnieper cascade of reservoirs (Ukraine), the Kapchagay reservoir on the Ili River (Kazakhstan). But these processes occur in many reservoirs in the world. Using Landsat satellite images for the period 1985-2010 and ground-based studies with a GPS-receiver application showed that deltaic landscapes formation in the Dnieper cascade is the fastest in the first (Kiev) reservoir. At the top of this reservoir, the active formation of new islands (new land resources) takes place, and downstream shallow water area is heavily overgrown with aquatic vegetation (*Phragmites australis*, *Typha angustifolia*, *Scirpus lacustris*). In recent years, aquatic vegetation with floating leaves (*Nymphaea alba*, *Nuphar lutea*, *Trapa natans*) is quickly spread there. The average rate of increase in the area of hydromorphic landscapes in the period 1985-2005 was 100-200 ha here. But in 2006-2010 this value exceeds 1000 hectares per year. This process creates significant problems for navigation, fisheries, water quality, water supply and other industries. At the same time, it improved a recreational use of areas, and made a biodiversity in the region richer. In the second - Kanev - reservoir natural processes of hydromorphic landscapes formation are complemented by massive new lands (more than 800 hectares) inwash and summer houses construction. These artificial and natural processes have led together to an increase in the area of hydromorphic landscapes to 1126 ha for the period 1992-2009 years. Very fast increase of hydromorphic landscapes area was revealed in the upper part of the Kremenchug reservoir during the period of 1988-2009 as well. It has increased by 3,272 ha. A new delta formation in large (28.1 km³) Kapchagay reservoir on the Ili River (Kazakhstan) was investigated for 40 years. The sediment runoff accumulation (11 million tonnes per year) have led to the formation of hydromorphic landscapes in the area of 6497 hectares. Feature of this delta is formation here saline soils. Plant cover consists here of annual halophytes: *Suaeda crassifolia*, *S. prostrata*, *Climacoptera brachiata*, *C. obtusifolia*, *Camphorosma brachiata*, *C. monspeliacum*, *Aeluropus litoralis*, etc. Increasing the territory of the delta due to the sediment accumulation leads to waterlogging and salinization of southern shores landscapes. Salt content in groundwater of that territory becomes more and it contributes to the toxic salts accumulation in soils.

Abstract number 326 – IMPACT OF OVERLYING VELOCITY AND SEDIMENT MORPHOLOGY ON NITRIFICATION IN BENTHIC BIOFILMS

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The effects of overlying velocity and sediment morphology on nitrification rates were tested in a recirculating flume system. In addition, we also tested how sediment morphology affected the diversity, abundance and activity of ammonia oxidizing bacteria (AOB). The flume system has a 260 cm long and 29 cm wide working channel, which was packed with 5 cm of clean silica sand arranged into a dune shape structures (bedforms). Bedform heights were approximately 2 cm, while water depth was maintained at 7 cm. An initial microbial seed, scraped from the bed of Habsor River (Israel) was grown into a benthic biofilm under constant flow conditions and feeding with ammonium. The diversity of AOB, determined by denaturing gradient gel electrophoresis (DGGE) analysis, showed a shift in the community from a dominance of *Nitrosomonas* species in the initially seeded population to a dominance of *Nitrospira* species in the stream bed, regardless of the changes in flow conditions. The *amoA* gene copy numbers (the key enzyme in ammonia oxidation), which were estimated by the qPCR technology, was not homogeneous along the bedform structure and did not correlate with nitrification potential. However, ammonium removal increased monotonically when flow was changed from laminar to turbulent conditions, but it did not change with velocity under laminar flow conditions. This pattern was observed regardless of the biofilm characteristics (biomass or AOB abundance), indicating that ammonium removal was strongly controlled by mass transfer processes. Nitrate accumulation rates revealed that most of the ammonium removal was due to nitrification, while denitrification and assimilation in the system was minimal. Nitrification activity was spatially distributed as a result of

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physicochemical conditions, with the highest nitrification activity found at the upstream section of the bedforms, and at the upper most section of the biofilm (data obtained by microscale distribution of oxygen and pH with microelectrodes). The results emphasize the importance of the linkage between the physical conditions and the biogeochemical processes in the environment. We clearly show that different flow and sediment conditions can promote specific microbial activity, such as nitrification. This understanding will aid in the design of stream restoration schemes seeking to enhance the removal of excess nitrogen as a crucial step in aquatic ecosystems management.

***Abstract number 327* – EFFECTS OF HUMAN ACTIVITIES ON ECO-SYSTEM OF KALAR KAHAR, NUMMAL AND KHAN PUR LAKES IN PAKISTAN**

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Kalar Kahar, Namal and Khanpur are fresh water lakes located close to highly populated areas of Pakistan. These lakes receive recharge mostly from rainfall during monsoon season and provide residence to millions of migratory birds from November to February who comes from central Asia and Russia. Over the past few decades due to tremendous increase in the population, tourism and mining activities in the surrounding areas of these lakes, the eco environment of these lakes is threatened not only to the migratory birds but also unhygienic environment for local population and tourists. This study is focused to find out the status of these lakes in terms of water quality and the causes responsible for damaging eco environment of these lakes and then proposing various rehabilitation measures. The results indicate that the physical and biological quality of water from Kalar Kahar and Khanpur Lakes is greatly degraded due to the sewage pollution however the Namal Lake is comparatively still safe and partly influenced. The chemical quality of these lakes is also alarming due to the increasing trend of the contaminants. The chemical quality of the lake water varies greatly with the season which is probably due to the dilution process caused by the monsoon heavy rainfalls. The sediments pollution in these lakes has greatly reduced the total storage capacity of these lakes which has disturbed the eco system of these lakes. It is also creating hindrance in safe boating facility for tourists especially during the dry season. Suggestions for rehabilitation of eco environment of these lakes are also being proposed.

***Abstract number 328* – GROUNDWATER DEPENDENT TERRESTRIAL ECOSYSTEMS WITHIN THE EUROPEAN GROUNDWATER POLICY FRAMEWORK**

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The European Water Framework Directive – WFD (2000/60/EC) and the “Daughter” Directive Groundwater - GWD (2006/118/EC) are the main pillars for the European groundwater policy concerning management and protection of groundwater. These two Directives are complemented by a set of sectoral Directives contributing to the protection of groundwater e.g. Nitrates Directive, Plant Protection Products Directive, Landfill Directive. However, the WFD does not only address the needs for protecting, enhancing and restoring all waters across Europe. Moreover, it specifies receptors which might be affected either by impacts on water quantity or on water quality. For groundwater in particular “groundwater dependent terrestrial ecosystems” (GWDTE) are defined as a relevant receptor in different Articles. Art. 1: 'The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which: – (a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;' Art. 4 specifies the environmental objectives. More details are given in Annex V for both, groundwater

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quantity and groundwater quality issues – “good status implies: no significant damage to terrestrial ecosystems which depend directly on the groundwater body”. Consequently status assessment for groundwater bodies has to consider the status of GWDTE and the impact of anthropogenic alterations in GW quantity and quality on them. To support the implementation of the WFD and GWD and to contribute to a harmonised approach across Europe, guidance documents were elaborated under the Common Implementation Strategy (CIS). For example: Guidance N° 12 “The role of wetlands in the WFD” provides definitions for “wetlands” and criteria for the practical approach to identify terrestrial ecosystems which could be significantly damaged by anthropogenic alterations to groundwater level or quality. Guidance N° 18 “Guidance on groundwater status and trend assessment” establishes frameworks for assessing both chemical and quantitative status of groundwater – considering the provisions for groundwater dependent terrestrial ecosystems. To support the elaboration of the second RBMPs an exchange of best practice and lessons learnt was initiated by the CIS Working Group Groundwater. Complementary the link to research has been established and the interdisciplinary cooperation between hydro(geo)logists and ecologists will be enhanced.

Abstract number 334 – HYDROECOLOGICAL PROCESSES AND FUNCTIONING OF GROUNDWATER DEPENDENT ECOSYSTEMS

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Groundwater dependent ecosystem are a vital yet poorly understood component of the natural environment. In many cases groundwater form an important but so far quite unknown contribution to these ecosystems. The presentation will focus on hydrology of different systems along with conceptual models on the role of groundwater. Different methods will be presented to assess the role of ground water in these ecosystems. Also the groundwater directive will be discussed and how ecosystems can be assessed in relation to ground water resources. The sites to be presented include different type of wetlands such as mires and lagoons, small lakes, rivers and springs.

Abstract number 335 – CLIMATE CHANGE AND ECOLOGICAL SYSTEMS: A FRAMEWORK FOR THE UNDERSTANDING OF SOCIO-HYDROLOGICAL DYNAMICS

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A functioning ecological system results in ecosystem goods and services which are of direct value to human beings. Ecosystem services are the conditions and processes which sustain and fulfill human life, and maintain biodiversity and the production of ecosystem goods. However, human actions affect ecological systems and the services they provide through various activities, such as land use, water use, pollution and climate change. Climate change is perhaps one of the most important sustainable development challenges that threaten to undo many of the development efforts being made while working to reach the targets set for the Millennium Development Goals. Understanding the provision of ecosystem services and how they change under different scenarios of climate and biophysical conditions could assist in bringing the issue of ecosystem services into decision making process. Similarly, the impacts of land use change on ecosystems and biodiversity have received considerable attention from ecologists and hydrologists alike. Land use change in a catchment can impact on water supply by altering hydrological processes, such as infiltration, groundwater recharge, base flow and direct runoff. In the past a variety of models were used for predicting land-use changes. Recently the focus has shifted away from using mathematically oriented models to agent-based modelling (ABM) approach to simulate

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land use scenarios. The agent-based perspective, with regard to land-use cover change, is centred on the general nature and rules of land-use decision making by individuals. A framework of analysis is being developed to investigate the possibility of incorporating the human dimension of land use decision into a hydrological model in order to assess the impact of future land use scenario on the ecological system in general and water resources in particular.

***Abstract number 336*– RAINFALL COMPLEX PATTERN TREND VIA MULTIFRACTAL ANALYSIS**

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Although today one can find a lot of hydrologic models (maths and physical models) there are a lot of uncertainties in hydrologic modelling in gauged catchment and even more so in ungauged catchment. According to the scientific literature there are some prevalence limitations in hydrologic modelling in relation to questions of scale, nonlinearity and uniqueness of place. The mentioned above suggest to look through alternative tools to describe (or modelling) physical (or geophysical) processes, one of them possibly based on the geometrical composition of observed data. Rainfall, as one of the highly complex geophysical processes, exhibits a multifractal structure in its description. The multifractal patterns identification of rainfall observed data records suggest the estimation of nonlinear statistical attributes designed for this purpose, such as the multifractal spectra. This statistical tool has been applied to nonlinear analysis of time series in order to despite its structure as also to achieve a rebuilding (or predicting) model. This research surveys the implementation benefits to use multifractal analysis on daily rainfall time series. These time series belong to some rainfall gauges located on Surba's river basin at Duitama (Boyacá, Colombia). Some previously analysis exhibit some trends which are leading to interpret possible local climatic pattern. Future analysis look for characterizing morphological attributes joint to multifractal attributes in order to get a better hydrological comprehension at ungauged catchment.

***Abstract number 339* – EFFECTS OF SOIL SALINISATION ON THE EARTHWORM *EISENIA ANDREI*: LIFE CYCLE TRAITS AND HISTOCHEMICAL BIOMARKERS**

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Salinisation is the process that leads to an excessive increase of water-soluble salts in the soil, and one of the most widespread soil degradation processes. Along the Adriatic Coast of the Emilia-Romagna region in Italy, our area of interest, soil salinisation is enhanced by salt water seepage, caused among others by subsidence and drainage. Salt prevents, limits or disturbs the normal metabolism and nutrient uptake of plants and other soil biota. Biological effects on plants, in particular crop species, are widely studied because of the socio-economical consequences of agricultural soil loss. Impacts on soil fauna are less known, in spite of its importance in determining soil fertility. Salinity might cause a decreased resistance of organisms to other stressors, eventually leading to synergistic effects. Here we report the results of a laboratory experiment that is intended as a first step of an ongoing study on the interactive effects of soil salinity and pesticide contamination on the earthworm *Eisenia andrei*. A natural silty soil was collected in the field, dried, grounded and sieved through a 2 mm mesh, to eliminate skeleton. Glass containers (223x121 mm, h: 77 mm) were used as experimental chambers; in each container 500 g of dry soil were mixed with 150 ml of spiking solution (NaCl dissolved in distilled water). A control treatment (distilled water) and five NaCl concentrations ranging from 0.1 to 12 g/L were prepared. Each treatment was replicated in two containers. Ten adult worms for each container were incubated in the experimental soils at controlled environmental conditions (20°C, 400-800 lux, 16 h light/8 h dark). After 28 days of

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exposure, three life cycle endpoints were assessed: survival, growth, and reproduction (number of laid cocoons). In addition, three histochemical biomarker were determined: lysosomal membrane stability (neutral red retention assay), lipofuscin and neutral lipid accumulation. Soil salinity had significant adverse effects on all the life cycle endpoints, and it was possible to obtain preliminary estimates of effective median concentration (survival: 10 ± 1 g/L, growth: 8 ± 2 g/L, reproduction: 4 g/L). Soil salinisation did not alter the response of the biomarkers analysed in the present work. Although the biomarker sensitivity to pollutants is reported higher than that of life cycle endpoints, it appears they are not impaired by salinity and may be used for future investigations on polluted salinised soils. As an overall, our study indicates that adverse effects on earthworms are possible at levels of soil salinisation still compatible with agricultural land use, even in the absence of other stressors.

***Abstract number 340* – GROUNDWATER DEPENDENT RIPARIAN ZONES IN AN AFRICAN SAVANNA: WHO IS USING WHAT WATER AND WHEN?**

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An initial assessment of groundwater dependency in the Kruger park, South Africa, identified springs, terrestrial fault zones, permanent pools in seasonal rivers and riparian zones as important habitats reliant on groundwater within the savanna landscape. A riparian zone, and neighbouring non-riparian mopane bush area, on the Shingwedzi river were equipped with detailed monitoring equipment to assess patterns of water by the different tree species. Rainfall, temperature, soil moisture, groundwater levels and sap flow in *Colophospermum mopane* (Mopane trees), *Xanthocercis zambesiaca* (Nyala tree) and *Lonchocarpus capassa* (Apple-leaf tree) were monitored over a year period. In addition, net ET and carbon fluxes were measured for one week in the wet season and for one week in the dry season. We wanted to find out: Which plants are accessing groundwater? Does access to groundwater maintain primary productivity during the dry season? What are the relative rates of carbon and water uptake in the groundwater-linked riparian zone and rain-fed mopane-grassland? This multi-disciplinary assessment of the relationships between different plant species and different water sources in a seasonally, water limited environment, showed how primary productivity is maintained in the dry season with access to groundwater and how different tree species respond differently to increasing soil moisture in the rainy-season. This work gives insight to the complexity of plant-water interactions and challenges ecohydrology to simultaneously take a holistic approach, whilst focussing on key exchanges to link carbon and water cycles.

***Abstract number 342* – IMPACT OF CLIMATE CHANGE ON THE RAISED BOG WATER BALANCE IN WESTERN SIBERIA**

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Bogs that occupy vast areas of the Western Siberia play the role of the powerful regional climatic factor, thereby facilitating the spatial redistribution of thermal energy resources. The examination of moisture accumulation and consumption processes in river basins will allow to estimate modern processes of climatic and hydrological condition changes in the Western Siberia and define the influence of progressive bog formation on changes of land and underground drainage. Examinations of water balance were carried out on the territory of raised bog within the area of small water-logged basin of river Klyuch in the north-eastern part of the Vasyugan bog. The determinations of water balance components were carried out separately for every dominant types of the raised bog biogeocenoses: high riam, low

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riam and sedge-sphagnum swamp. By results of performed investigations it was noted that differences in the water balance of biogeocoenoses are defined by the vegetation structure, which defines the process of moisture accumulation in the bog peat deposit. The accumulation of atmospheric precipitation is observed in a more forested pine-shrub-sphagnum biogeocenosis with high pines, however in conditions of intensive water evacuation, a minimum level of moisture accumulation is observed considering the powerful active layer. The less forested lower riam is characterized with smaller snow cover water equivalent, but with the more intensive level of annual evaporation reaching up to 414 mm, relatively high discharge module and the level of waters -1 cm in relation to the average surface level. Constantly high levels of bog waters, which are 3 cm higher of the average surface level, evaporation on an average of 405 mm and moisture accumulation in a peat deposit are characteristic of the open area of sedge-sphagnum bog. The statistical analysis of the long-term changing of water balance elements allowed to mark the decrease of overall moistening in April-May, the gradual increase of evaporation in the autumn period, growth of duration of transitional autumn-winter period and the corresponding minimizing of moisture content in snow cover in November-December. As a result, the hydrological regime redistribution, which is characterized by the definite flow decrease in November and December, April-June and increase in August-September is observed in the considered region. Nevertheless, annual characteristics of water balance remain statistically unchanged. Generally, favorable conditions for the development of bog formation and peat accumulation processes owing to excessive moistening in the warm period of year will be invariable in the nearest and midterm prospect.

Abstract number 343 – USING THE DRENAFEM MODEL FOR SIMULATION SUBSURFACE DRAINAGE IN BAIXO VOUGA LAGOON

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The Baixo Vouga Lagoon is located at the end of the Vouga River basin and has an area of 4600 ha. Presents extensive and broad valleys of low elevation, often subject to flooding. Its water regime is also influenced by the sea, through the effect of the tides. Often the seawater enters the estuaries, and climbing the dikes and invade agricultural fields. A deterministic numerical model based on finite element method was used to simulate the variable water table, and made their comparison with data obtained on site. The drain selected is the 89th located in the drainage portion 31, which lies at an average depth of 0.7 m, with a distance between drains of 25 m, a slope of 0.001 m m⁻¹ and a length of 250 m. This is a drain on PVC corrugated, wrapped in geotextile, installed in 1986. In 38 consecutive days were carried out measurements of the flow (q) and the hydraulic head between the drain (hr) and half distance between drains (hm), resulting in the determination of hm hr and the arithmetic mean of these observations. The difference in the peak of rainfall between the observed and simulated values, is that the observations are daily and do not detect such small variations, the model, to discretize the time by 0.05 days at most, can simulate, and the concentration of rain for periods of 4 hours. The fact that the Baixo Vouga Lagoon system to be working with non-ideal drains, dramatically complicates the comparison, given the difficulty in simulating the input resistance. Improvements in the agreement of observed and simulated results can only be achieved through processes of attempts before a reliable calibration of the behavior of the drain. The difficulty expressed in simulating the actual conditions in the field not off due to numerical methods because they provide important practical conclusions regarding the behavior of subsurface drainage system.

***Abstract number 345* – ASSESSMENT OF THE GROUNDWATER ECOSYSTEM**

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The role of organisms in the groundwater ecosystem for the global turnover of materials and energy is not known. Estimations that 6-40% of the bacterial biomass of the earth is living subterranean, show that the biomass of this ecosystem has great importance. The EC groundwater directive (2006/118/EC) demands "Research should be conducted to provide better criteria for ensuring groundwater ecosystem quality". An assessment of the groundwater ecosystem has to refer to main and can only refer to microorganisms. Investigations to detect indicator organisms like crustaceans or nematods in groundwater for an assessment of biocoenosis can only be used in groundwater areas under aerobic conditions. There are additional problems in the sample technique with nets or tube pumps in the well. The conditions in the well water are different from the environment. It is necessary to use a sampling technique that collects organisms of the representative groundwater area. This is easier for microorganisms, because one can use a radial pump with high through flow according to the DIN/ISO. The groundwater microbiocoenosis in the area of nine German landfills are characterised by DGGE-Fingerprints (Kilb, 1999, Eschweiler, 1999). Parallel the emissions from the landfills into the groundwater are determined. The fingerprints of bacteria in groundwater influenced by landfill emissions differ, dependent from the concentrations of the emissions, significantly from those of the not influenced ones (Struppe 2006). It was possible to define a threshold of non-toxic emissions, which causes significant differences in the groundwater ecosystem. To define not influenced groundwater, the background concentrations have to be detected. This is done by adding the 84,1 %-Perzentiles of the groundwater main ions (Na, K, Ca, Mg, Fe, Mn, HCO₃, NO₃, NH₄, Cl, SO₄, TOC) of numerous groundwater (Schleyer und Kerndoff, 1992). The sum is 860 mg/L. So groundwater with concentrations of groundwater main ions <800 mg/L are defined as not influenced (neutral wells). It can be shown that in groundwater with concentrations of main ions below 900 mg/L in clusterdendrograms of the DGGE-Fingerprints are added to the neutral wells. If the concentrations of main ions are higher than 1200 mg/L the changes in the groundwater microbiocoenosis compared to those of the neutral wells are so significant that the wells are separated in clusterdendrograms. These changes in assembles of groundwater microorganisms can cause in two effects. First there are toxic effects of other components in the emissions, which lead to a decrease of bacterial diversity and amount. Second there are adaptations of the bacterial settlement to the emissions, which lead to an increase of bacterial amounts, caused by better nutrition situation downstream of landfills. Quantifications of bacteria at the investigated landfills show that both effects can be observed. A significant change of groundwater biocoenosis caused by non toxic landfill emissions is possible. This is of great importance for the assessment of groundwater biocoenosis. The outlined investigation could be improved by using DNA-microarrays and is a field proved measure for the description of the groundwater ecosystem quality.

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Abstract number 348 – WHEN MODELLING BIODEGRADATION ON THE MICRO SCALE, DEGRADER COLONY DISTRIBUTION DOES MATTER

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Groundwater contaminant biodegradation relies on the complex interplay of the microbial community and its environment. Biodegradation, which may be enhanced by engineering, is thus a phenomenon emerging from the adaptive actions of individual cells and organisms. The capacity to predict the success of in situ bioremediation depends on our ability to understand, simulate, and finally predict the interactions of the various complex and heterogeneous ecosystem processes and functions. It is widely accepted that biodegradation is influenced by bioavailability (degrader must meet contaminant), scale-dependent mixing, competition for resources, and predation. However, a sound concept linking the behaviour of individual degrader cells and the performance of bioremediation is still lacking. In particular, it is unknown to which extent the distribution of low numbers of cells in a heterogeneous groundwater environment is affecting biodegradation at the various spatial and temporal scales. Numerical reactive transport models have become established evaluation tools for the quantitative description of contaminant biodegradation in groundwater, but so far, for biological functions, they rely on empirical observations and meanfield-averaging assumptions. They also lack concepts for the micro-scale descriptions that are needed to explain biological functions where and how they actually occur. In turn, individual-based modelling concepts have been developed and successfully applied for the description of single cells or cell communities, but the applicability of these concepts is limited to micro-scale environments. Our aim is to close the gap between the description of individual cells and their behaviour within specific micro-environments and biodegradation in groundwater at the macro-scale. We have developed a quantitative model to study the impact of single cell processes and micro-scale heterogeneities on biodegradation in contaminated aquifers on the pore level, using COMSOL® coupled to an individual-based model. We studied acetate degradation in interplay between total biomass (varying from pristine conditions, i.e. 100,000 sessile & planktonic cells/cm³ aquifer, i.e. water & sediment, to eutrophic conditions, i.e. 10,000,000 cells/cm³), cell distribution (biomass homogeneously distributed, or clustered in two colonies with varying distance), and two flows (average groundwater flow: 0.9 m/d, slower or micro pore flow: 0.1 m/d). First results indicated that degradation varied most (from 13 to 18 %) among biomass distributions for slightly eutrophic situations (1,000,000 cells/cm³) at average groundwater flow (0.9 m/d), while at slower flow (0.1 m/d), degradation varied most (from 28 to 59 %) for pristine situation biomass distributions (100,000 cells/cm³). Depending on how biomass distribution is simulated, micro-scale models will yield very different values for degradation.

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***Abstract number 349* – TRANSFORMING RELATIONSHIP AMONG SURFACE WATER ,
PRECIPITATION AND GROUNDWATER ALONG FENHE RIVER IN TAIYUAN BASIN, CHINA**

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With analyzing geochemical characteristics of surface water and groundwater including isotope information, a research work was carried out to investigate transforming relationship among surface water, precipitation and groundwater along Fenhe River in Taiyuan Basin. The results indicated that the recharge source of mainstream in Fenhe comprised of groundwater and precipitation, but the ratios of two sources changed along the river. The ratios of groundwater and precipitation in the upstream and the downstream are the ratio of 93 to 7 and ratio of 24 to 76, respectively. The groundwater was the main source of recharge in the upstream but the ratio decreased in downstream, where the main source of recharge alternated into precipitation. The data shows that the ecological condition in the upstream areas along Fenhe river is better than the areas in the downstream.

***Abstract number 355* – WATER HYDROGEN AND OXYGEN ISOTOPE COMPOSITION AND SPRING
ISOTOPE INFORMATION IN THE TEA DITCH OF ANXIAN, CHINA**

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This paper studies isotopic composition in the Chayuan Gou of Anxian area. The results showed that the water body δD is between -68‰ ~ -54‰ , $\delta^{18}O$ in between -11‰ ~ -8‰ ; Sample put above global rainfall line and these show the groundwater and surface water originated in the meteoric waters of supply; S^{15} isotopic composition of spring water showed that the groundwater come from different two type groundwater mixing, the mixing ratio of 3:2.

***Abstract number 361* – ANALYSIS OF THE RIPARIAN VEGETATION DYNAMICS THROUGH THE
RIPFLOW MODEL. CLIMATE CHANGE SCENARIOS IN THREE EUROPEAN COUNTRIES**

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The RIPFLOW model is a useful tool for the simulation of riparian vegetation distribution in space and time. This model simulates the vegetation succession or retrogression in response of physical parameters. Beside its scientific value, this is a practical tool to tackle water management issues and restoration projects results uncertainties. RIPFLOW has been applied in the Alpine region and in Mediterranean semiarid environments with satisfying results. The study sites are Terde, Ribeira and Drau. Terde is a natural stretch of the Mijares River within the Júcar River Basin District (Spain). Ribeira is also a natural stretch located in the unregulated course of the Odelouca River basin (Portugal). The Austrian site lies along the upper course of the Drau River and it is a free flowing reach which has been restored 10 years ago. Two climate change scenarios were analyzed for each study site. In the climate change scenarios set up the hydrometeorological series were adapted to consider the monthly variations expected by the HadCM3-PROMES regional climate model for Spain and HadCM3 for Portugal. We selected SRES A2 and SRES B2 as the more probable pessimistic and optimistic emission scenarios respectively, both for the same 2070-2100 period. The analysis of those scenarios required the

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comparison with the reference period results (1960-1990). The Austrian partner applied instead the GCMECHAM5 climate model, using the results of scenario A1B as optimistic and A2 as pessimistic climate change options. The reference period was the same as the described for the Mediterranean sites. The results from the climate change scenarios analysis were coherent in both Mediterranean study sites, Terde and Ribeira. Both scenarios showed a river channel widening with substantial decrease of the early succession phases, leading to species lost, aging of the remaining riparian vegetation and spreading of upland forest inwards the river. This trend was more pronounced in the worst scenario, suggesting that extreme climatic change will promote the disappearance of pioneer or young succession stages of the riparian woodlands in Mediterranean rivers. The simulations of the Austrian case study highlight a stationary percentage composition of the older succession phases which are not heavily affected even by large floods. On the other hand, the younger succession phases abundance fluctuate in response of the flow variations determined by the climate change scenarios. In addition, those scenarios produced a generalized reduction on evapotranspiration rates in the stretches, harder during dry years and for the pessimistic scenario. Although there were important differences between scenarios results, they were lower as expected in spite of the great variations between hydrological inputs of each scenario definition all over the simulation periods.

***Abstract number 363* – HYDROLOGIC LONG-TERM MONITORING NETWORK. ICTS-DONANA NATIONAL PARK**

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Doñana Biological Station (EBD) provides the scientific community a unique study area for its size and biodiversity of Doñana Biological Reserve (RBD). It includes four major ecosystems: beach, dunes, scrub and marsh, this being the habitat of a large number of endemic species and be legally protected by restricting access to technicians and researchers. The term Singular Scientific and Technological Installation (in Spanish, ICTS) refers to that installation that is unique or exceptional in Spain, whose investment or maintenance cost is relatively high with regards to the R&D investment budgets in the area where its activity is included, and which are unique in their nature. These aims mean to develop the equipment of sensors that allow to arrange of measures detailed in the medium and long term to be able to observe trends and biological alerts; storage system and remotely, freely and cost free access, from anywhere and in real time, and available Information for all. The hydrological station network aims at making available to the scientific community and managers of the Doñana Natural Area (END), continuous data on the main parameters involved in monitoring water quality, flowstream, and groundwater level. The network is divided into two subnetworks, one of surface water and other groundwater. Sensor and site selection are guided by the purpose of monitoring and the data objectives, whether for those stations whose information refers to the regional operation of the system, aquifer, watershed runoff and surface flows, or to specific research projects. The most used water-quality sensors in monitoring installations in the area are temperature, conductivity, DO, pH, turbidity, Nitrate, Ammonium, Chlo and Phycocyanine. At some stations flow is also measured, or just flow, and at groundwater stations level is measured and is planned to measure some basic quality parameters. All ICTS hydrological stations listed as part of the automation network and infrastructure measures in ICTS Doñana Biological Reserve, meeting all the maintenance and communication protocols and technical requirements, from installation of the sensors, to remote access to the system of consultation and data mining via the web developed with this goal. The modernization and accessibility of the hydrological sensor network and related communications equipment, allows for the continuous opening of new external users and has the advantage of reducing the number of trips through the Park, given the large amount of real time information and generated automatically.

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***Abstract number 366* – MITIGATION OPPORTUNITIES FOR OBSTRUCTED RIVER REACHES BY COMBINING RES-E AND WFD OBJECTIVES**

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Project-Title: Hydroelectrical Potential On Existing Lateral Structures in Austria, Hypo-last Abstract: Further integration between the Renewable Energy Directive (RES-E) and the Water Framework Directive (WFD) at different levels and scales is recognized as an important requirement to address hydro-morphological pressures on river ecosystems. The WFD risk assessments in 2005 showed that hydro-morphological pressures and impacts are one of the most important risks of failing to achieve WFD objectives. For already deteriorated aquatic ecosystems, there could be opportunities for “win-win” outcomes if the development of small hydropower projects is designed to improve the river continuum and to create, protect or rehabilitate aquatic habitats. The Hypo-Last Project aims to integrate the objectives of both the RES and WFD Directives by identifying and analysing existing lateral structures (defunct weirs, ground ramps etc.) for small hydropower potential and concomitant river continuum restoration. A win-win situation for both the river hydro-ecology and the small hydropower sector is possible. Ecological mitigation can be funded and implemented by state of the art small hydropower units that utilize existing lateral structures obstructing the river continuum. The scientific challenge of the project was in the joint use of a variety of very diverse morphological, hydrological, ecological, infrastructural and socio-economical data. The main steps were the definition and set-up of a comprehensive database, the derivation of site-specific hydrological information from the hydrological water balance model, the classification of the lateral structures according to the project objectives and the evaluation of representative sites. The results can be used for strategic decision making concerning the Austrian energy and climate policy in the federal as well as in the province governments. At the same time the study output is detailed enough to be used as a guideline for the pre-selection of small hydropower project sites. The rehabilitation of rivers impacted by existing and defunct infrastructure can be achieved through integration of the RES and WFD Directives. The Hypo-Last project is a practical example of an investigation of the possibilities.

***Abstract number 367* – CONCEPTUAL MODEL OF GREENHOUSE GAS EMISSIONS FROM HYDROELECTRIC RESERVOIR IN TROPICAL AREAS**

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Like most manmade projects, hydropower dams have multiple effects on the environment that have been studied in some depth over the past two decades. Among their most important effects are potential changes in water movement, flowing much slower than in the original river. This slower flowing favors the appearance of phytoplankton as nutrients increase, with anoxic water replacing oxidative water and generating anaerobic conditions. Although research during the late 1990s highlighted the problems caused by hydropower dams emitting greenhouse gases, crucial aspects of this issue still remain unresolved. Some of these biogenic gases cause global warming, including methane, carbon dioxide and nitrous oxide. In order to draw up an accurate assessment of the net emissions caused by hydropower dams, significant improvements are needed in carbon budgets and studies of representative hydropower dams located in tropical, boreal, arid, semi arid and temperate climates. This paper has the objective to show main interactions between landscape, hidrology and fluxes of GHGs gases from reservoirs in a form of conceptual model of process.

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Abstract number 368 – LONG-TERM PERSISTENCE OF STREAM NITRATE CONCENTRATIONS (MEMORY EFFECT) INFERRED FROM SPECTRAL ANALYSIS AND DETRENDED FLUCTUATION ANALYSIS

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Previous research in agricultural catchments showed that past inputs of nitrate continue to influence present observations and future characteristics of nitrate concentrations in stream water for a long period of time. This persistence manifests itself as a ‘memory effect’ with a prolonged response of stream water nitrate levels to reductions of nitrate inputs on the catchment scale. The question we attempt to resolve is whether such a memory-effect also exists in mountainous catchments with snow-melt dominated runoff regime. We analyzed long-term records (~ 20 years) of nitrate-nitrogen concentrations measured in stream at three stations on the upper Váh River (Slovakia). Applying spectral analysis and Detrended Fluctuation Analysis (DFA), we found that there is a varying degree of persistence between the three analyzed sites. With increasing catchment area, the fluctuation scaling exponents generally increased from 0.77 to 0.93 (fluctuation exponents above 0.5 are usually considered as a proof of persistence, while values close to 0.5 indicate ‘white’ uncorrelated noise). The nitrate-nitrogen signals temporally scaled as a power-law function of frequency (1/f noise) with a strong annual seasonality. This increase in persistence might be attributable to the catchment areas upstream the sampling sites. These results have important implications for water quality management. In areas where reduction of nitrate in surface waters is imposed by legislation and regulatory measures, i.e. two catchments with different persistence properties may not respond to the same reduction of sources of nitrogen at the same rate.

Abstract number 369 – COMPARISON OF THE NUTRIENTS REMOVAL EFFICIENCY OF AROUND DONAX VERSUS PHRAGMITES AUSTRALIS

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Reed beds have found application in the treatment of domestic, industrial and agricultural waters. Although in the literature reed beds are often classified as constructed wetlands, they tend to be more highly engineered systems with a well-defined gravel matrix structure akin to a trickling filter. They are able to nitrify ammonium compounds as a first step towards reducing the concentrations of ammonia and ammonium in the treated effluent. Reed beds have been used for more than 20 years to treat wastewaters such as local domestic sewage, airport runway runoff and some kind of industrial effluents. Reed beds operating with subsurface flow may be divided into two categories—horizontal and vertical. Tidal flow systems are a variant of the latter type, in which the bed is alternately filled with wastewater and then drained. Vertical-flow reed beds gave the best overall performance compared with horizontal beds. However, combination of vertical–horizontal flow offered some advantages for total nitrogen removal. The main advantages of using reed beds are the high efficiency of treatment and the low cost of operation. This work deals with the estimation of the effect of two different kinds of reeds (*Arundo Donax* and *Phragmites Australis*) for a retention time of three days on the efficiency of removing nutrients from ground water. The reed beds plant was constructed in the outside area of the Laboratory of Environmental Technologies of NTUA and groundwater with high concentrations of nutrients (nitrogen and phosphorous) was used as an influent in the reed beds plant. The plant consisted of 6 channels of 20 m in length, 2 m in width and 1m in height and a larger tank of 8 m × 13 m × 1m. Each channel was filled with gravel where two kinds of reeds had been planted in 25 cm depth. These were

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Arundo Donax and *Phragmites Australis*. During the 10 months of the experimental procedure, from March to November, the groundwater feeding was constant about 180 L/h for each channel, in order to maintain the retention time at three days. Every week, 2 samples from the effluent of each channel were collected. Each sample was analyzed for total phosphorus and total Kjeldahl nitrogen. All measurements of the collected samples were carried out according to the Standard Methods for the Examination of Water and Wastewater. The statistical analysis of the results was carried out utilizing the techniques given by Taylor. Conclusively, the use of *Phragmites* is more effective than *Arundo* for both TKN reduction and TP reduction. Furthermore, the treatment of groundwater by reed beds is quite effective.

***Abstract number 373* – WELCOME ADDRESS – SPECIAL SESSION ON UPSCALING FROM INDIVIDUAL ECOSYSTEMS TO GROUNDWATER BODIES IN THE LIGHT OF THE WATER FRAMEWORK DIRECTIVE IMPLEMENTATION**

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One of the aspects of the European Union's Water Framework Directive (WFD) adopted in 2000 concerns the achievement of 'good groundwater status' by 2015. This objective covers both the quantitative status (balance between groundwater recharge and abstraction) and the chemical status which has been subject to specific requirements established by the "daughter" Groundwater Directive 2006/118/EC. Among the various criteria related to the good status objective, the interaction of groundwater with associated surface water and dependent terrestrial ecosystems is one of the key evaluation components. Considering that this objective applies to groundwater bodies (defined as reporting units) delineated before 2006, many EU Member States are encountering difficulties in implementing provisions related to impacts on ecosystems. These imply that the quantitative status should be such that surface waters and terrestrial ecosystems that are groundwater-dependent, are not significantly affected by changes in groundwater flow. Furthermore, for the chemical status, the WFD requires that the concentrations of pollutants in groundwater are such that they do not endanger environmental objectives for associated surface waters or lead to a significant diminution of the ecological or chemical quality of such surface water bodies, and that they do not raise to significant damage to terrestrial ecosystems. In this respect, the knowledge of groundwater-ecosystems (aquatic or terrestrial) interactions is paramount to enable a proper evaluation of good chemical status, including in the definition of groundwater quality standards (threshold values) by the Member States. However, the regulatory framework does not provide details on how these interactions should be determined and even less on how this could be done at groundwater body level. The special session will provide examples on how the scientific community is tackling this issue with efforts to scale knowledge gathered at ecosystem level up to the groundwater body level. The session is also about strengthening operational links among the scientific and policy communities, ensuring that scientific progress will flow into the policy implementation and review process in the context of the current WFD river basin management planning cycle.

***Abstract number 375* – DETERMINATION OF MICRYSTINS IN WATER**

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Microcystins are hepatotoxins produced by cyanobacteria (blue-green algae) which occur in water bodies with high eutrophication especially those with a slow flow rate or those that are stagnant in warm climates. Mammalian exposure to these compounds has been associated with deleterious effects and in high dosage cases, deaths of animals has been reported. The metabolic profile of HepG2 cells is closely

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related to that of hepatocytes and therefore serves as a good model due to their human origin. Proton nuclear magnetic resonance spectroscopy (^1H NMR) and direct injection mass spectrometry (DIMS) were used to analyse media extracts from the cells and data obtained was reduced by chemometric methods. The use of principal component analysis (PCA) enabled achievement of a visual distinction between the metabolic profiles of samples exposed to microcystins, control samples (unexposed), and those which were exposed to acetaminophen (positive control).

Abstract number 376 – ALUMINIUM SPECIATION IN NATURAL WATER HETEROGENEOUS SYSTEMS

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Abstract: The presence of aluminium in natural waters is of major concern at present due to the potential threat for the health of a number of species, including humans. In natural water aluminium exists in different forms depending on the concentrations of various other species, organic matter, the types of minerals, the pH etc. The aluminium species in the system natural water - gibbsite is considered in this work. The main approaches for estimating of the individual concentrations of the aluminium species involve the use of reliable thermodynamic data, together with experimental measurements of free or total concentrations of major components. The new type of diagrams based on graphical and computerised methods, which quantitatively describe the distribution of soluble and insoluble, inorganic and organic, monomeric and polymeric aluminium species in heterogeneous aquatic systems is presented. This approach utilizes thermodynamic relationships coupled with original mass balance constraints, where the mineral phases are explicitly expressed. The factors influencing the distribution and concentrations of soluble and insoluble aluminium species in aquatic systems were analysed. The developed new type of diagrams may be used to interpret data obtained within the framework of water quality monitoring programs. **Keywords:** gibbsite, diagram of distribution, thermodynamic stability.

Abstract number 377 – PHOSPHORUS DYNAMICS FOR THE RIVER PRUT

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Seasonal and spatial dynamics of phosphorus forms in waters, particulate materials and bottom sediments of the river Prut (Republic of Moldova) was elucidated. The scheme for the determination of phosphorus forms in waters and particulate materials according to the World Health Organization classification was evaluated. Additionally, this scheme was tested for the estimation of phosphorus content in bottom sediments. The supplemented scheme allows the analysis of the phosphorus forms for the entire system “water – particulate materials – bottom sediments”, extending possibilities for interpretation of phosphorus dynamics in natural waters. On the basis of obtained data, waters of Prut River should be attributed to the I-II classes of quality according to the Romanian standards. The eutrophication level of the Prut River should be qualified to the oligotrophic-mesotrophic level of eutrophication according to the UE directives. **Keywords:** phosphorus forms, particulate materials, bottom sediments.

Abstract number 400 – CONSIDERATION OF THE VEGETATION LAYER IN HYDROLOGICAL MODELLING

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In most of the hydrological models the properties of the top soil layer, such as infiltration capacity and water storage, are considered. The vegetation layer is usually parameterised with respect to its interception; in some models the root zone is considered by its water abstraction capacity as a function of root depth which is a plant and age specific parameter. The objective of this paper is to analyse additional parameters which are dependent on the vegetation cover considering the herb, the shrub and the tree layer. For illustration some examples are given: in mid to high alpine regions *Carex* from the family of Cyperaceae may change the surface runoff and infiltration capacity. Having reached their mature state the plants cover densely the soil surface and reduce infiltration and simultaneously increase surface runoff. The surface roughness is also strongly dependent on the herb and shrub layer and of course, on land use activities. Also, the macro pore density is driven by plant activities. The change in runoff was investigated in an Austrian catchment where the forested area has increased substantially over the last hundred years and where simultaneously a change in the tree composition had taken place. In the lower altitudinal zones mixed forest stands (deciduous and coniferous) developed while in the higher zones the coniferous trees dominated. By the help of a spatially distributed hydrological model time series of runoff were simulated over a period of about 100 years. It could be demonstrated that the changes in the plant cover had beneficial effects on flood peaks. Dependent on the tree layer the soil water utilisation ranged from 50 cm to a few meters and thus the water storage capacity of the soil layer became more effective during high intensity rainfall events. Frequent flood events were reduced up to 30 % in the flood peak and events with a return period of about 10 years were reduced by 15 %. In extreme events, characterised by a 100 years flood, the mitigation effect was still 8-12 %. It can be concluded that surface roughness, infiltration capacity and soil water abstraction by the vegetation layer deserve explicit integration into hydrological models.

Abstract number 444 – THE ROLE OF GULLY EROSION AT CATCHMENT SCALE

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Soil erosion is one of the most significant land degradation processes on agricultural areas in Hungary. 25% of the total area of Hungary (more than one-third of agricultural land) is affected by water erosion, 16% by wind erosion. The role of gully erosion has been recognized only lately. The hilly countries of Hungary are mainly covered by unconsolidated sediments, mainly by loess. Loess covered areas are prone to erosion and mass movements. The paper provides an analysis of environmental conditions of gully development in Hungary. The role of gully erosion in total soil loss at catchment scale is shown on the example of the Tetves catchment (120 km², subcatchment of Lake Balaton catchment). A completely filled up sediment reservoir can be found at the catchment outlet. An attempt is made to determine the share of the material removed by gully erosion, based on the analysis of the sediment accumulated in the reservoir. If there is more topsoil in the reservoir then the role of sheet erosion is more important in the catchment, while more subsoil in the reservoir points to considerable gully erosion activity. Humus content and Caesium-137 activity were used as indicators of the topsoil. Gully erosion activity was investigated in the whole catchment in 1968, 1984 and 2004 using maps, air photos and field survey. The results show that approximately half of the deposited sediments came from the “subsoil” layer pointing to the important role of gully erosion. The main conclusion is that the Caesium-137 method proved to be very well applicable to identify sediments originating for gully erosion activity. For policy makers it is suggested that land use planning should ensure a minimum risk of gully erosion with special

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