Using SDP to optimize conjunctive use of surface and groundwater in China

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Hydrological processes in a changing environment: Coping with uncertainties

Exploring hydrological model sensitivity to change by automatic differentiation

R. R. P. van Nooijen[1], A. G. Kolechkina[2]

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Abstract:
How to study of the effects of a changing environment on models of hydrological processes or computer optimization of operating procedures? One answer would be to apply or extend the traditional techniques for sensitivity analysis. This involves exploration of the solution space of an optimization problem. Either the calibration problem of finding the "best fit" of the model to the data or the optimization problem of finding the "optimal design" or "optimal operating procedure" for a water resource system. Traditionally this exploration is done by random sampling. A less used technique is automatic differentiation. This method provides the gradient of the solution with respect to certain chosen parameters for a very limited additional computational effort. However, there are two questions: firstly whether this can be done with limited human effort, that is without writing two different programs (one for the original problem and one for the problem with added automatic differentiation) and secondly whether the additional computational cost is indeed limited. We will explore this question for a simplified parameter determination problem.

Assessment of design flood characteristics for ungauged permafrost basin

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Abstract:
Development and construction in remote poorly gauged regions of Eastern Siberia require reliable estimation of future possible hydrological extremes. The applicability of traditional statistical methods to the assessment of maximum flood characteristics in permafrost basin under changing environmental conditions is questionable. Three different approaches to estimate maximum flood discharges for the design of the Kanku hydropower plant in ungauged Timpton River basin (Eastern Siberia) were used, namely probable maximum flood (PMF), deterministic-stochastic modelling and conventional probability analysis. Deterministic-stochastic approach consists of process-based Hydrograph model and stochastic weather generator. The Hydrograph model parameters relate to observable properties of soil and vegetation, therefore application of the model does not require calibration. The stochastic weather generator provides simulated meteorological input for the Hydrograph model (daily precipitation, average temperatures, and relative humidity at different points within river basin) taking into account temporal and spatial correlations between meteorological elements and characteristics of their annual variability according to historical observations or climate change scenarios. The Timpton River outlet at Kanku (26700 km^2) has no discharge measurements. The Hydrograph model was validated against flow data in two gauges upstream and downstream. Validated model was applied to studied basin using the ensemble of stochastically generated sets of meteorological input corresponding to different scenarios of climate change. Resulting probabilistic curves of maximum floods were compared to those developed on the base of statistical analysis and estimated according to PMF approach.

Future projections of extreme precipitation using Advanced Weather Generator (AWE-GEN) over Peninsular Malaysia

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Abstract:
In this paper, one of the weather generators' method known as AWE-GEN, has been tested to four stations representing the north, south, west, and east part of Peninsular Malaysia using observations available from 1975-2005. In order to take the uncertainties into account, an ensemble of multi-model were used in this study such as GFDL-CM3, IS-CM5A-LR, MIROC5, MRI-CGCM3 and NorESM1-M which were obtained from the dataset compiled in the World Climate Research Programme's (WCRP's), Coupled Model Intercomparison Project phase 5 (CMIP5). The projections of extreme precipitation were based on the RCP 6.0 scenario (2081 and 2100). The hourly extreme precipitation for the western and northern regions are well simulated but is somewhat underestimated for the eastern and southern regions. However, the 24-h aggregation periods of extreme precipitation is well simulated in all regions while the extremes of wet spell durations are generally well captured by the model. The performance of GCM models varies significantly in all regions. Almost all regions have shown high variability of monthly precipitation for both observed and future periods. The extreme precipitation for both 1-h and 24-h seems to increase in future while extreme of wet spells will remain unchanged, up to the return periods of 10-40 years.

Adige river in Trento, 1892: a first flood risk map?

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Abstract :
For the determination of the flood risk hydrologist and hydraulic engineers focuse their attention mainly to the estimation of physical factors determining the flood hazard, while economists and experts of social sciences deal mainly with the estimation of vulnerability and exposure. The fact that flood zoning involves both hydrological and socio-economic aspects, however, was clear already in the XIX century when the impact of floods on inundated areas started to appear in flood maps, for instance in the UK and in Italy. Maps of areas 'liable to flood' were published in the mid 19th century in the UK, (Duncan Reed, personal communication), and a 'flood risk' map for the Adige river in Trento, Italy, published in 1892, takes into account in detail both hazard intensity in terms of velocity and depth, frequency of occurrence, vulnerability and economic costs for flood protection with river embankments. This map, which will be presented, is likely to be the rediscovered here as the first flood risk map for an Italian river and, possibly, worldwide. Risk levels were divided in three categories and seven sub-categories, depending on flood water depth, velocity, frequency and damage costs. It is interesting to notice the fact that at that time the map was used to share the cost of levees' reparation and enhancement after the severe September 1882 flood as a function of the estimated level of protection of the respective areas against the flood risk. Flood protection costs were shared between the central Austro-Ungarian government which ruled the region at that time, the regional government, the railway company and private owners. This shows how already at that time the economic assessment of structural flood protections was based on objective and rational cost-benefit criteria and that hydraulic risk mapping was perceived by the society as fundamental for the design of flood protection systems.

Identification of low flow parameters using hydrological model in selected mountainous basins in Japan

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Abstract:
About 70% of land area in Japan is mountainous area and provides water resources to the remaining 30% of the areas, where agricultural, industrial and urban activities are held. Projection of impacts of climate change on water resources to local level would provide useful information to decision makers in formulating policies for climate change adaptation. In particular, low flow is highly related with occurrence of drought and thus, accurate estimation of low flow is very important for the evaluation of climate change impacts on water resources. This study focuses on the equation to represent nonlinear relations between storage and discharge, and investigates the optimal parameters to represent low flow. The storage-discharge equation is represented as $Q = Au^N Sg^N$, where Au is the fractal recession constant and N is the storage exponent constant. We carried out the investigations by applying hourly hydrological model presented by Fujimura et al. (IAHS Publ., 355) to two basins in Japan. One basin is the Sameura Dam basin located in the western Japan and another basin is the Shirakawa Dam basin located in the eastern Japan. We selected these two basins because climate and geological condition of these two basins are very different and thus it its suit for examining how the estimated parameters are different according to climate and geological conditions. The period of data is the 20 years for the Sameura Dam basin and is the 9 years for the Shirakawa Dam basin. We prepared 7,900 sets of the 2-parameters in storage-discharge equation, and examined the sensitivity of the 2-parameters to the calculation of low flow. The result suggested optimal combination of 2-parameters can be represented by exponential equations of Au and N. Considering the parameter identifications were performed for climatologically and geologically different basins, the obtained exponential equations could be also applied for other places in the world.

Water budget comparison of global climate models and experimental data in Onça Creek basin, Brazil

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Abstract:
Groundwater is an important term of the hydrological cycle and accounts for 35% of human needs in a global scale. As a result of potential aquifers overexploitation associated with climate change, groundwater levels might experience drastic drops. Although there are efforts to include groundwater dynamics in global climate models (GCM), its influence is still not taken into full account into GCMs water budgets. In order to assess the role of groundwater in the water balance, we compared the water budget calculated from experimental data of a basin in São Paulo state, Brazil, with a water budget using climate scenarios derived from 10 GCMs. We used the delta factor approach to downscale the model's temperature and precipitation for a control period from 1970 to 2000, calculating evapotranspiration by the Thornthwaite method for two representative soil uses found in the Onça Creek basin. Runoff and interception were estimated based on experimental data for both culture types (sugar cane and pasture). The experimental data shows that there is enough available water for percolation, indicating that recharge cannot be ignored in the water balance. As the GCMs ignore subsurface flow, the excess surface water is supposed to be redistributed among the other water budget components. This fact leads to the possibility of the models to overestimate the other components to compensate for the ignored recharge component.

Where does blue water go in semi-arid area of northern China under changing environments?

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Abstract:
River flow regimes in the semi-arid region of northern China show a decreasing trend in terms of quantity. River runoff (i.e., blue water) reduction within the Laohahe catchment and the source area of the Liaohe River Basin, manifest aridity that widely exists in northern China. According to the water balance equation, during the past half-century, observed streamflow records in the Laohahe catchment show that blue water is redirected to the green water flow (i.e., evapotranspiration) on annual and decadal time-scales, whereas precipitation does not vary much. Human activities and land use/cover changes are the fundamental reasons for such runoff change. In the studied catchment, extensive land reclamation for agriculture, water withdrawal from streams, and abstraction from aquifers for irrigation are the direct and main causes leading to the decrease in observed blue water. These factors further justify that a land-use decision is also a decision about water. Therefore, there is a need for an integrated modeling framework to intrinsically link climate, hydrological, and agricultural models with social and economic analyses.

Estimation of hydrological response of a small Mediterranean watershed to fire by data analysis and modelling approach

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Abstract:
Though the problem of changing environment is widely discussed in hydrological community most of hydrological model still rely on the hypothesis of stationarity. The aim of presented study is developing a tool to cope with non-stationary conditions based on process-based hydrological model. The study object is the Rimbaud watershed (1.46 km^2) which was destroyed by fire in August 1990. It is located in France and characterized by Mediterranean climate. The Hydrograph model used in the study has such an advantage that observable properties of a basin are used as the model parameters without calibration. Abrupt change of land cover properties due to the fire and their succession afterwards could be described explicitly by dynamic set of the model parameters. The tasks of the study include the detection of fire-induced changes of land cover and hydrological regime, the development of dynamic set of the model parameters and the validation of developed parameterization in post-fire conditions of the Rimbaud watershed. Neither conventional statistical analysis nor hydrological modelling with fixed parameters detected any significant change in hydrological regime of the Rimbaud watershed after the fire in 1990 on daily temporal scale. The assessment of the fire effects on discharge using hourly data and development of dynamic set of the model parameters are still in progress. The results of the application of dynamic set of parameters to post fire conditions will be presented. If validated, the approach is supposed to be an effective tool to assess and predict runoff characteristics and basin variable states in non-stationary conditions in past and future.

Water Management and Productivity in Planted Forests

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Abstract:
As climate variability endangers water security in many parts of the world, carbon sequestration of sustainable building products makes plantation forestry important. High plant water use efficiency is generally associated with lower plant productivity, so an explicit balance in resources is necessary to maximize water yield or tree growth. This balance requires understanding and predicting plant water use under different soil, climate, and planting conditions, as well as a mechanism to account for trade-offs in ecosystem services.
Several strategies for reducing the water use of forests have been published, ranging from policy guidelines for planting and species selection to site-specific management techniques such as thinning and site layout, but there is little research tying these to operational forestry. This work combines an overview of these proposed strategies with application to plantation management. Using data from silvicultural and biofuel feedstock research and industrial ownership patterns in the southeastern US, proposed water management tools are evaluated against known treatment responses to estimate water yield, forest productivity, and economic outcomes. Ecosystem impacts are considered qualitatively and related to water use metrics. This work is an attempt to measure and compare important variables that forest managers, policy makers, and the public could use to make sound decisions about plantations and water use.

Climate and socio-economic changes and their impacts on future water management at the regional scale. A case study in the dry inner-alpine zone of Switzerland

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Abstract:
The national research program NRP 61 "Sustainable Water Management" aimed at providing a basis for sustainable water management in Switzerland. As part of this research program the effects of climate and socio-economic changes on water availability, water use and water management were investigated in the Crans-Montana-Sierre region, situated in the dry inner-alpine Valais (project MontanAqua). The project followed an inter- and trans-disciplinary approach which involved stakeholders throughout the entire project. The current water situation was assessed with quantitative and qualitative methods (dense hydro-meteorological measurements, tracer experiments, statistical analyses, interviews). Future water management was modeled based on existing regional climate change scenarios and socio-economic scenarios developed in close collaboration with stakeholders. The findings of MontanAqua can be summarized into five key-messages: (1) Socio-economic changes should have a greater impact on the water situation in 2050 than climate change. A territorial development that limits water needs is then recommended. This requires important changes of current water- and land-management practices; (2) Water resources available nowadays and in 2050 are generally sufficient to meet water demands. However, local and seasonal (e.g. second half of summer) shortages are to be expected; (3) Water issues are primarily regional management problems. We advocate for better cooperation between the eleven municipalities of the region and the establishment of a demand management strategy; (4) Inter-communal measures on infrastructures can help to ensure sustainable water supply, but only if they are integrated into ambitious institutional reforms; (5) To achieve a sustainable regional water management, improved data management and transparency is needed.

Response of Tuzla Lake Ecosystem in Turkey to Irrigation and Climate Variability

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Abstract:
Tuzla Lake is an important saline playa lake located in the Palas Basin in Turkey. In this study, we investigated the effects of climate variability and irrigated agriculture on the hydrology and water quality of Tuzla Lake and propose measures for its protection from natural and anthropogenic impacts. Changes in the hydrologic characteristics of Tuzla Lake were determined by analysis of hydrologic and climatic data series and satellite images. Water quality at Tuzla Lake was evaluated based on measurements of several water quality parameters (total phosphorus (TP), total suspended solids (TSS), and total nitrogen (TN), Chlorophyll-a (Chl-a)). The analysis showed that water levels and extents at Tuzla Lake showed strong fluctuations in the seasonal and annual timescales. Both climatic factors as well as extensive use of groundwater in agriculture were responsible for these variations. Average annual value for TP, TSS, TN and Chl-a were determined to be 149 µg/l, 2957 mg/l, 10.83 mg/l and 34.5 µg/l, respectively. Chl-a, nitrogen and phosphorus concentrations indicated that the lake is eutrophic and significant amount of pollution is transported to lake from agricultural areas. For protection of Tuzla Lake ecosystem, the natural water regime should be protected and expansion of irrigated agricultural in the basin should be controlled.

A model of river bank deformations under simultaneous effect of the waves from hydropower plant and warming

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Abstract:
Arctic regions are very sensitive to the global climate change and hydrological systems in these regions are sensitive to the rising temperature. Banks of the rivers and reservoirs located in the permafrost zone to a considerable extent are composed of the frozen soil and the underground ice. This structure of the banks makes the abrasion processes even more pronounced. The laboratory experiments and field observations showed that thermoerosion plays a significant role in the deformation of the banks composed of permafrost with the inclusion of layers of ice. Sometimes the effect of thermoerosion is greater than the one of the mechanical erosion. A mathematical model of the river bed deformations in permafrost areas is presented. The deformations are caused by the influence of waves from hydropower plant under increase of the ambient temperature. The model system consists of an unsteady hydrodynamic module, a thermal module and a bed-deformation module. The hydrodynamic module is based on the two-dimensional shallow water equations. The bed-deformation module is based on the sediment mass balance conditions. The thermal module is based on the Stefan equation, which defines the "water-ice" boundary movement. We present two applications of the model in which the bed deformation is calculated for the alluvial channels with melting bed under the influences of waves of different duration and intensity. We compared the model predictions with the laboratory data and generally obtained a good agreement between the two.

Uncertainty in hydrological signatures

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Abstract:
Information about the characteristics of the runoff processes in a catchment is essential for most hydrological analyses, modelling and water-management applications. Such information derived from observed data is known as a hydrological or diagnostic signature, and have been used in a variety of studies for, e.g., change detection, catchment classification, model-structural identification, and model calibration. Different sources of uncertainty in the observed data – including measurement error and representativeness as well as errors relating to data processing and management – propagate to the values of the derived signatures and reduce their information content. Subjective choices in the method used to calculate the signatures create a further source of uncertainty. The aim of this study was to contribute to the community's awareness and knowledge of observational uncertainty in hydrological signatures, including typical sources, magnitude and methods for its assessment. We first reviewed the sources and nature of uncertainties relevant to the calculation of different signatures based on rainfall and flow data. We then proposed a generally applicable method to calculate these uncertainties based on Monte Carlo sampling and demonstrated it for a number of commonly used signatures including thresholds in rainfall-runoff response, recession analysis and basic descriptive signatures such as total runoff ratio, and high/low flow statistics. The study was made for two data-rich catchments, the 135 km^2 Brue catchment in the UK and the 50 km^2 Mahurangi catchment in New Zealand that are both densely monitored. The resulting uncertainties were compared across the different signatures and catchments to understand how the uncertainties may change with the sources of the uncertainty in the observed data and the active runoff processes. Finally we considered whether the uncertainties found would change the interpretation of the signatures to give information about catchment response.

Hydrological simulations driven by RCM climate scenarios at the basin scale in the Po river in Italy

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Abstract:
River discharges are the main expression of the hydrological cycle and are the results of climate natural variability. The signal of climate changes occurrence raises the question of how it will impact on river flow and on their extreme manifestations, e.g. floods and droughts. This question can be addressed through numerical simulations spanning from past (1971) to future (2100) under different climate change scenarios. In this work, we concentrate the attention on the capability of a modeling chain to reproduce observed discharge of the Po river over the period 1971-2000. The modeling chain includes climate and hydrological/hydraulic models and its performances are evaluated through indices based on the flow-duration curve. Climate dataset used are (1) high resolution observed climate dataset; and from COSMO-CLM regional climate model driven by (2) perfect boundary condition, ERA40 Reanalysis, and (3) by the global climate model (GCM) CMCC-CM, for the 1971-2000 period. The hydrological/hydraulic components are simulated through a physically based distributed model (TOPKAPI) and a water balance model at basin scale (RIBASIM). The aim of these first simulations is to quantify the uncertainties introduced by each component of the modelling chain and their propagations. The estimation of the overall uncertainty is relevant to correctly understand the future river flow regimes. Results show how bias correction algorithms can help in reducing the overall uncertainty associated to the different stages of the modeling chain.

Impact assessment on hydrologic conditions due to climate change over Asian regions

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Abstract:
Water is an essential resource for human lives because water is used for various purposes such as the municipal, industrial, agricultural, and environmental water, etc. Unfortunately the changes in hydrological process due to climate change are expected to cause the changes in water resources spatially and temporally. Thus, the purpose of this study is to evaluate the climate change impact assessment on hydrologic conditions over Asian regions. The coupled results of climate change impact and local climate characteristics were suggested on each climate zone of Asian monsoon regions. For analysis of the current hydrologic conditions, a hydrological model was constructed by using the observed climate and hydrological data and topographical data (DEM, land use and soil characteristics). The hydrologic components of water cycle were evaluated during the past historical period and those for the future periods were projected by using future climate change scenarios. The results reveal that the annual average runoff will be increased approximately 10-20% for 2080s except for some climate regions (Cs, Ds). It also shows that the monthly average runoffs during November to March will decrease about -3~-28% for 2080s in the winter dry region (Aw, Cw, Cf) and those during April to October will decrease about -16~-41% for 2080s in the summer dry region (Cs, Ds). In addition, it can be found that the monthly average runoff in the summer runoff concentration regions (Aw, Cw, Cf, Dw) will greatly increase during the summer season. Therefore, the risks for drought in arid regions and for flood in wet regions are increased over the Asian region in the future.

Analysis of flood downstream from the Nangbeto dam on the Mono River (Togo and Benin, West Africa)

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Abstract:
The analysis of flood risk downstream the hydroelectric dam of Nangbeto in the Mono River considered several factor such as the inter-annual rainfall and streamflow variability from 1955 to 1999, population vulnerability, hydrological modification and impacts downstream in Togo and Benin countries from 1987 (year of construction of the dam). The analysis of the mean annual discharge revealed no tendency, showing thus that changing in land use, increasing of impervious areas and even functioning of the hydroelectric dam have not modified significantly manner the river flow rate. Apart from the return to improvement in rainfall as far back as the 1980 years end, increase in anthropogenic pressure and demographic explosion have best explained the magnitude and frequency of flooding downstream from Nangbeto hydroelectric dam. The soil degradation, floodplain deforestation, increasing in number of human settlements in the river boundary amplify the population vulnerability of faced with flooding.

Trends in extreme temperature and precipitation in Muscat, Oman

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Abstract:
Climate change is likely to affect the frequency and intensity of weather events resulting in more frequent and intensive disasters such as flash floods and persistent droughts. In Oman, changes in precipitation and temperature have already begun to be detected, although a comprehensive analysis to determine long-term trends has yet to be conducted. We analyze daily precipitation and temperature records in Muscat, the capital city of Oman, mainly focusing on extreme events. A set of climate indices, defined in the RClimDex software package, were derived from the longest available daily series (precipitation over the period 1977-2011 and temperature over the period 1986-2011). Results showed significant changes in temperature extremes associated with cooling. Annual maximum value of daily maximum temperature (TX), on average, decreased by 1°C (0.42°C/10 yr). Similarly, the annual minimum value of daily minimum temperature (TN) decreased by 1.5°C (0.61°C/10 yr), which, on average, cooled at a faster rate than the maximum temperature. Consequently, the annual count of days when TX > 45°C (98th percentile) decreased from 8 to 3 by 5 days. Similarly, the annual count of days when TN < 15°C (2nd percentile) increased from 5 to 15 by 10 days. Annual total precipitation averaged over the period 1977-2011 is 80 mm, which has increased at an average rate of 6 mm/10 yr (statistically weak trend with p-value = 0.6). Even though, no significant long-term trend occurred in precipitation totals, there is a reasonably significant trend of annual maximum 1-day precipitation (p-value = 0.14). When the General Extreme Value (GEV) probability distribution is fitted to annual maxima, a coefficient of skewness of 0.55 was calculated over the period 1995-2011, which approximate to 10 fold the coefficient of the period 1977-1994 (0.06). Results showed significant change in extreme precipitation to have become more intense, especially in last decade.

Methodology to determine a storm water flow to support decision-making: case of the Ben Chaabane region (Blida. Algeria)

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Abstract:
The objective of this work is methodological; in order to determine the storm water flow to be used by a decision management system while not any gauging station is available. Only rain gauging stations have been used to study short duration rainfalls. The proposed methodology is based upon hydrologic modeling using the HEC HMS software developed by the Hydrologic Engineering Center (HEC, Corps of Engineering U.S. Army, 2000), consisting of a production function derived from the SCS-CN (Soil Conservation Service Curve Number) and of a transfer function based on the synthetic unit hydrograph method. This methodology has been applied to the Ben Chaabane region (Blida Wilaya, Algeria) which is prone to flooding.

Long term prediction of large rivers discharge based on helioclimatological data

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Abstract:
The source of all the energy in the climate system of the Earth is radiation from the Sun, which provides energy for heating of the land, ocean, and the atmosphere overlies the surface of its. All of these interact to produce regional and local alteration of climate around the surface of the Earth. Our study (200 weather stations) shows that the Sun activity is responsible for temperature change. The same correlations were found for many rivers runoff. There is a significant positive relationship between solar activity and river runoff the rivers Mississippi, Missouri, Rhine and Songhua Jiang. The correlation between solar activity and rivers runoff is higher than 0,7. An increase of solar activity does actually increase these large rivers discharge. This positive relationship is actually conventional. When the Sun has many sunspots it gives more energy, more energy makes its way to Earth, and our planet will warm, warm air increases the evaporation process, and leads to intensification of hydrological cycle. Surprisingly, the rivers Amazonas, Amur, Danube, Parana and Yangtze show a steady trend of decreasing rivers runoff and these negative trends occur due to the high solar activity. For example: discharge of the Amazon River (Obidos) and solar activity over the period of 1933-1996 can be described by following equation: Q = -15,6W + 6538, r-0, 98, where Q-discharge of the River Amazonas, W-sunspots. Strong correlation we also found between runoffs of the Amazonas, the Amur and the Danube – rivers flowing in sub-latitudinal direction. The study show the solar activity affect on hydrological process in different way for rivers with diverse geographical locations. Analysis of dynamics of water inflow to World Ocean (1921-1985) shows long term increase of rivers discharge in ocean. This also connected with high solar activity in the last century. In accordance with NASA forecasting the next two solar cycles will be below average in intensity. This actually will decrease the water inflow to ocean and will lead to accumulation of water in form of ice on continents.

Assessment of the intrinsic vulnerability of agricultural land to water and nitrogen losses: case studies in Italy and Greece

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Abstract:
Two case studies were considered for the application of a set of indices (LOS) in order to classify the intrinsic vulnerability of agricultural land to water and nitrogen losses. The first case concerned a lowland region in the Po River Delta (Province of Ferrara, Emilia-Romagna Region, Northern Italy) where two areas were identified to be more vulnerable to water and nitrogen losses: the coastal dunes and the neighborhood of riverbanks and paleochannels. The second case concerned an upland region in the Sarigkiol basin (Western Macedonia, Greece) where two areas were identified as the most vulnerable: a district with high slopes and the upper part of the alluvial plain. For the Ferrara Province, from here onward indicated with FP, the mean annual water and nitrogen losses were 314±37.2 mm and 20.4±7.0 kg N ha^{-1}, respectively, while for Sarigkiol Basin, from here onward indicated with SB, were 290.4±51.6 mm and 20.3±2.5 kg N ha^{-1}, respectively. The minimum transit time of water and N species in the vadose zone varies significantly between FP (21.2±18.5 days) and SB (185±147 days). LOS indices application for the two cases showed their ability to represent adequately the intrinsic vulnerability both in lowland and upland regions. Moreover LOS indices showed their advantage, with respect to other indices, since their objective physical and statistical background was used in assessing the relative pollution potential of surface and groundwater, unbinding the results from site specificity and therefore gives the possibility to compare results among different regions. Finally, both cases showed that nitrogen losses were proportional to water losses. This leads to consider that a good water balance is a prerequisite to understand nitrate fate in the subsurface and therefore that it is crucial to take into account seasonality as key factor.

Parametric uncertainty or hydrological changes?

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Abstract:
The model calibration, maximizing a likelihood function, is the way of hydrologists for searching also a physical interpretation of complex interactions acting within a basin. Actually, it can be frequently noticed how model calibration performed on a given time window may converge to a point in the parameter space that could be distant from another obtainable calibrating the model in the same basin but considering a different time window. Is that attributable to parametric uncertainty? Or the trajectory in the parametric space relates about a slow hydrological basin change? In order to dispel this doubt in this work several model calibrations have been performed in different time windows. The hydrological model used here is the EHSM (EcoHydrological Streamflow Model), a conceptual lumped model for simulating daily streamflow with seven parameters, which summarize soil, vegetation and hydrological catchment properties. The case study is the Oreto catchment, which is located in the northern of Sicily, Italy. This basin has an area of 112 km2 and an annual mean precipitation of approximately 1000 mm. The climate is Mediterranean with hot dry summers and rainy winter seasons from October to April. The hydrological response of this basin is dominated by long dry seasons and following wetting-up periods. This basin has the longest hydrological data series available in Sicily, from 01/01/1924 to 31/12/1999. The optimal parameter sets are assessed by Monte Carlo simulations considering 14 subseries of 10 years, each spaced 5 years from another, within the entire available dataset. This moving window calibration procedure allowed to draw a path in the optimal parameters space, which may be interpreted as a proxy of hydrological basin evolution. In this light, this work is an attempt to relate parameters variability to land use changes, such as urbanization and abandonment of agricultural land

Evaluation of the effects of underlying surface change on catchment hydrological response using the HEC-HMS model

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Abstract:
Due to the rapid population growth and urbanization, the Dongwan catchment with a drainage area of 2856 km^2, which is located in the Henan Province, has been subjected to considerable land-use changes since 1990s. Distributed or semi-distributed models have been widely used in catchment hydrological modeling, along with the rapid development of computer and GIS technologies. The objective of this study is to assess the impact of underlying surface change on catchment hydrological response using the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), which is a distributed hydrological model. Specifically, twenty-one flood events were selected for calibrating and validating the model parameters. The satisfactory results show that the HEC-HMS model can be used to simulate the rainfall-runoff response in the Dongwan catchment. In light of the analyses of simulation results, it is shown that the flood peaks and runoff yields after 1990 moderately decrease in comparison with that before 1990 at the same precipitation level. It is also indicated that the underlying surface change leads to the increased flood storage capacity after 1990 in this region.

A modeling framework to project future climate change impacts on streamflow variability and extremes in the West River basin, China

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Abstract:
In this study, a hydrological modeling framework was introduced to assess the climate change impacts on future river flow in the West River basin, China, especially on streamflow variability and extremes. The modeling framework includes a delta-change method with the quantile-mapping technique to construct future climate forcings on the basis of the observed meteorological data and the downscaled climate model outputs. This method is able to retain the signals of extreme weather events, as predicted by climate models, in the constructed future forcing scenarios. Fed with the historical and future forcing data, a large-scale hydrologic model (the variable infiltration capacity model) was executed for streamflow simulations and projections at daily time scales. A bootstrapping resample approach was used as an indirect alternative to test the equality of means, standard deviations and the coefficients of variation for the baseline and future streamflow time series. The bootstrapping method was also applied to assess the future changes in flood return levels and the associated uncertainties resulting from the limited size of annual extreme flow samples. The case study in the West River basin of China confirms that the introduced modeling framework is an efficient effective tool to quantify streamflow variability and extremes in response to future climate change.

Reservoir siltation under changing climate: a Mediterranean case study

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Abstract:
In order to ensure the sustainable managements of reservoirs, future reservoir operation planning must take into account the hydrological change. This change, which is composed by both human induced effects and natural variability, is likely to modify reservoir operation rules, reservoir capacity, sedimentation, etc. Within this framework, the main goal of this study is to evaluate the impact of climate change on reservoir siltation in Mediterranean environments. This was done by using a physically based distributed hydrological and sedimentological model (TETIS) coupled with climatological scenarios obtained by a regional circulation model (ARPEGE). This study was applied to the Ésera River catchment (Southern Central Pyrenees, Spain), a highly erodible Mediterranean catchment drained by a large reservoir. Due to the lack of sediment records, the sedimentological sub-model of TETIS was calibrated and validated by reconstructing the depositional history of the reservoir by means of several bathymetries. Then, it was used to simulate three climatological scenarios (reference climate, SRES A2 and SRES B2 scenarios) representing different possible climatic future evolutions. The results of all scenarios were compared in order to assess the impact of climate change on water resources and sediment transport, with an especial focus on reservoir sedimentation. The results show that reservoir useful life is expected to increase by 60% under A2 scenario, while it is not expected to change significantly under B2 scenario. This is because under B2 scenario the increase in rainfall torrentiality is expected to compensate the decrease in soil moisture. The erosion and sediment transport are expected to become more vigorous, i.e. more concentrated in a few large events, whose occurrence or absence could considerably change the total soil erosion and sediment yield of this Mediterranean catchment.

Variational Data Assimilation with YAO platform for hydrological forecasting

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Abstract:
In this study a data assimilation based on Variational assimilation was implemented with HBV model by the mean of YAO platform of University Pierre and Marie Curie (France). The principle of the Variational assimilation is to consider the model state variables and/or model parameters as control variables and optimise them by minimizing a cost function measuring the disagreement between observations and model simulations. The Variational assimilation is used for the calibration of the HBV hydrological model. In this case the 14 model parameters are considered as control variables and optimised by minimizing the Nash criterion as cost function. Results are compared to those obtained by the well known powerful optimisation algorithm SCE-UA. To draw the calibration, parameters were divided into different sensitivity groups. A multistep calibration strategy was implemented beginning by the calibration of the most sensitive parameters and ending by the less sensitive. A second application of Variational assimilation was dedicated to hydrological forecasting. In this case four state variables of the HBV model (those related to water levels in rooting tanks and to soil water content in the water balance tank) are considered as control variables. They were updated through the 4-D VAR procedure using hourly discharge incoming information. Three basins that belong under different climate: Sejnène from Tunisia, Ardèche and Serein from France are studied. Very good comparison is obtained with SCE-UA results in terms of Nash performance. A high level of forecasting accuracy was obtained allowing one to two days anticipation of floods.

Climate change and its impacts on water resources in the Northwest China

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Abstract:
The arid region of Northwest China is a special natural unit, with a unique landscape characterized by mountain-oasis-desert ecosystems. It approximately covers one fourth of the nation's entire land area. Water, largely originated from the mountain areas, has been a most critical factor to drive the energy and mass circulation in this region, which responds sensitively to the global climate change. This report discusses various aspects in water resources research, which includes: (1) The temperature increased obviously in Northwest China, and the increasing rate of temperature in the mountain areas was the largest, compared with period before1990s, showing an increase of 57.7%, followed by that in the oasis and desert areas. The winter temperature change was the most important factor affecting the rising annual air temperature, and mainly caused by changes in the Siberian High. The precipitation exhibited a general upward tendency, however, precipitation in desert areas showed inconspicuous change, and it was noteworthy that since 2000, about 35% sites of precipitation had decreasing trend in this region, especially concentrated in the Tianshan Mountains. Besides, pan and potential evaporation in this region exhibited an obvious decreasing trend until early 1990s, however, the downward trend reversed in 1993. (2) Runoff was affected by changes in precipitation and air temperature and increased significantly. The glacier meltwater was an important water resource of runoff in the arid northwest of China, the warming accelerated glaciers melting, and the melting inflection points of glaciers were found, the runoff recharge from glaciers had great change. Besides, there was a positive significant relation between summer run-off and 0°C level height; the digital filtering method was used to separate baseflow from surface flow, and found that baseflow of the Tarim river increased considerably.

Determination of nonstationarity of applied hydrometeorological characteristics in Russia under modern climate change

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Abstract:
In conditions of modern climate change the problem is formulated on the need to test the stability of the designed hydometeorological characteristics, which are used for different projects. For this purpose, the specialized archives of applied climatic characteristics over the Russia area have been developed for the data on air temperature and precipitation, that are used in building climatology and hydrology. Spatial distribution of stations, data bases and list of applied climatic characteristics are discussed. Simple and effective statistical methods are suggested for assessing of climate change, based on the basic properties of the climate system, such as equilibrium and nonequilibrium of climate response. As a result, three competing models had applied: stationary model, a linear trend model and a model of step changes, each of them reflects the different physical properties of the climate dynamics. Aim of application of different models to assess both efficiency and the statistical significance of nonstationary models with respect to the stationary. The aim of research was an identify areas in Russia where the changes of applied climatic characteristics are already occurring or may occur in the near future. The methods of research include: evaluation of the quality, uniformity and reliability of the original information; development of methods and models for climate change detection in time series of observations; building spatial interpolation models; revealing climatic risk zones with significant trends of increasing or reduce the applied climate characteristics; construction of statistical spatial models for climate risk zones.
As a result, climatic risk zones have been identified for each applied characteristic and spatial modes have been developed in these zones. The most unstable characteristic was an annual air temperature and temperature of cold season, the most stable one – maximum precipitations and maximum runoff.

Methods and software for planning and design in hydrology and water resources systems

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Abstract:
Hydrological information consumers generally are not interested in the observations but the results of their processing, such as the parameters of the distribution function and design hydrological characteristics and often not even in the gauged sites and in the sites of the design or in estuaries, where the observations unavailable (ungauged sites). However, to get the designed values in the ungauged site we have to first perform calculations at many points in the territory where these observations take place. To solve these problems was developed Rulebook on defining the basic design hydrological characteristics (SP 33-101-2003), software and information systems "Hydrocomputations" and "Hydrological GIS of Russia".
The software "Hydrocomputations" as program complex (PC) is intended to define the design hydrological characteristics in the presence and lack of observational data. It includes database for management of hydrological data and computational modules to provide the full range of hydrological calculations. The software "Hydrocomputations" supplemented with a GIS module "Map", allowing to submit 7500 observation sites on a digital map of Russia and implement the interface between the map and the perennial series of basic hydrological characteristics in regional databases in order to obtain samples of points on a territorial basis. New software and information product "Hydrological GIS Russia" is designed to determine the design hydrological characteristics in the ungauged sites and implements as standard features of GIS (creation and editing digital geo-informational layers, work with raster and others), and calculations in ungauged sites by the methods of interpolation and hydrological analogy with the estimation of efficiency on independent information. The information part of the "Hydrological GIS of Russia" includes a basic electronic map of Russia, specialized digital layers of coordinate of gauged sites and centers of gravity of watersheds for the 26 hydrologic regions.

Climate change scenarios and its impact on water resources of Langtang Khola basin, Nepal

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Abstract:
General Circulation Models (GCMs) successfully simulate future climate variability and climate change on global scale, however poor spatial resolution confine their application for impact studies at regional or local level. The dynamically downscaled precipitation and temperature data were used for the future climate scenarios prediction for the period of 2000–2050s, under the Special Report on Emissions Scenarios (SRES) A2 and A1B scenarios. In addition, rating equation was develop from measured discharge and gauge (stage) height data. The generated precipitation and temperature data from downscale and rating equation was used to run the HBV-Light 3.0 conceptual rainfall-runoff model for the calibration and validation of the model gauge height was taken in the reference period (1988-2009). In the HBV-Light 3.0 a GAP optimization approach to calibration the observed stream flow. From the precipitation scenarios with SRES A2 and A1B emissions at Kyanging increase of precipitation during summer and spring, decrease during winter and autumn seasons. The model projected annual precipitation for 2050s of both A2 and A1B scenario are 716.4 mm and 703.6 mm respectively. Such precipitation projections indicate the future increase of precipitation in all season except the summer. There is increase in precipitation but decrease in discharge in summer for future due to less glacier melt. By the end of the 2050s simulation projects an increase maximum (min) discharge of 37.8 m3/s (13.9 m3/s) for A1B scenario and 36.2 m3/s (14.3 m3/s) for A2 scenario. Finally, the study aims to analyze the perception and prediction of systems against the climate change, its sustainable development and to examine how the predicted climate change will impact on water resources in Langtang Khola catchment.

Arid zones Floods in the South Western Algeria: study and protection with insufficient data

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Abstract:
Floods, this natural phenomenon, combined with unforeseeable climatic factors, take an exceptional character of gravity in arid zones. The city of El Bayadh, located at the South-west of Algeria, in the outlet of the Wadi El Bayadh catchment area, knows torrential floods with each rainfall event like those observed in October 2011, when important human and material damages were recorded. The significant rainfall made an overflow of El Bayadh Wadi, crossing an important agglomeration, Main city of El Bayadh Wilaya (Department). The absence of the remarkable Wadi sections and the existence of negative slopes on the minor bed, generated easily flooded zones in several points throughout the Wadi profile. The adopted approach in absence of hydrometric data would be to propose a hydraulic calibration of the Wadi, adapted to the available source data.

Hydrological Simulation of Future Climate Scenario of Ganga Basin using Dynamically Downscaled input from WRF model

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Abstract:
Changes in temperature and precipitation alter the climatic conditions and subsequently hydrological and watershed processes in the long run. The effects of changes due to climatic variability on hydrological responses have been extensively carried out at watershed and river basin scales. Future climate scenario is best demonstrated by Global Climatic Models (GCM). The resolution of GCM is still too coarse to capture regional and local climate scenario to simulate hydrological processes at basin scale. Dynamical downscaling approach is employed in the present study to provide adequate spatial and temporal resolution to represent regional heterogeneity in atmospheric fields. Dynamic Downscaling of six hourly meteorological data from HadCM3 at 2.5° X 3.75° grids to generate three hourly model outputs at 25 X 25 km grids for the Ganga basin was successfully done using Weather Research and Forecasting (WRF) model with Advanced Research WRF (ARW) core. A physically based semi distributed Variable Infiltration Capacity (VIC) hydrological model was forced using downscaled atmospheric fields to simulate the hydrology of the Ganga river basin and analysis were carried out of the impact of climatic variability on hydrological regime. The simulated average rainfall for 2020 is in compliance with the average annual rainfall (1977-2006) over the entire Ganga basin with an overall decrease of 4%. The runoff for the year 2020 is estimated to be 257 mm while in the year 2006 the estimated runoff is 357 mm.Drop in the estimated runoff from the year 2006 to the year 2020 is found to be 100 mm averaged over the entire basin whereas, there is little difference between the values of obtained for evaporation for the two years with a decrease of about 7 mm in the year 2020. The present study shows that the year 2020 experiences an early onset of monsoon season and receives heavy rainfall of about 700 mm in the month of June itself.

Modelling approach of the rainfall erosivity index in sub-humid urban areas in northern Algeria.

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Abstract:
In this work, we present an approach of the storm water erosivity index modeling in urban and suburban areas, in sub-humide climat. Indeed, after each torrential downpourn these regions have floods laden sediment obstructing of storm water drainage. In absence of gaugings, there remains difficult to estimate soil loss, due to the aggressivity of storm water, torn off with the catchment area and deposited on the transportation roads. With the aim to estimate the amount of sediment that can be deposited on a stretch of road, adjacent to the study area, the erosivity index is determined from a count of 744 rain showers recorded over a period of 19 years. The Universal Soil Loss Equation (USLE) of Wischmeier and Smith is applied. From the hydrological point of view, this index has a consequent weight in the equation. It is based on the intensity of the rain starting the process of erosion in tablecloth. the Algerian North-West area, in full heart of Mitidja, vulnerable to the floods, with an erosion in visible tablecloth, is chosen as the study area. Functional relations are required between this factor and the explanatory variables (total annual rainfall and maximum intensities). A regression model, power type, is reached between the index from erosivity and accumulated precipitation. This model, very promising, makes it possible to bring a decision-making aid in absences of measurements, climate sub-humide, in the zones with predominance "erosion in tablecloth".

New characteristics of the maximal runoff in abandoned charcoal quarries. Case study: Motru's piedmont in Romania

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Abstract:
Motru's piedmont in Romania is a well-known coal basin that disposes of lignite lenses that occur from 2-7 m under the soil, down to tens of meters deep. The energy needs imposed the elimination of the soil and the implementation of quarry exploitations, which created a new landscape such as terraces, earth dams and steep slopes that disorganized the hydrographic basins and the natural discharge. The present article evaluates the new characteristics of the maximal runoff from the Rosiuta perimeter, where more than 100 m³ of soil, sand, clay and lignite were removed from a surface of around 800 ha, in some places the digging reaching 90 m of depth. This study is necessary for the estimation of new risks of flash flooding, much higher today than before, threatening the villages in the affected area. Because these are ungaged basins, both the scenario of maximal discharge before impact and the one after impact are realized through indirect, GIS-assisted methods. Noting that the heavy rainfall intensity didn't change in the last 25 years, since the works on the quarry started, the rational method was used. Examining maps drawn before impact and topographical relevees after impact, we used GIS functions to quantify the land use reality at the two moments; the resulting grid data being used to create the two scenarios. The increase of the maximum discharge on new surfaces – much more steep and lacking a protective soil and vegetation layer – is carefully detailed. The comparison between scenarios shows the increase rate in the risk of flash flooding, as well as the danger that menaces the neighboring settlements.

Probabilistic Runoff Simulations using Snow Cover Risk Maps in Middle Euphrates Basin, Turkey

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Abstract:
Mountainous Euphrates Basin in the eastern part of Turkey has large snow extent that contributes approximately 2/3 of the total annual volume of runoff during spring and early summer months. The location of important water structures in the downstream indicates the need for an operational forecast system, thus monitoring snow covered areas, constructing a snowmelt model and analyzing its effects in hydrological modeling is an important issue. Although remote sensing is a valuable tool for snow monitoring, it is a key factor to understand snow depletion characteristics for extended years and to combine it with operational applications. The aim of this study is to investigate spatial snow distribution and its contribution on hydrological modeling in a changing environment. The study is carried out for Middle Euphrates Basin in Turkey with an area of 5882 km^2 and an elevation range of 1500-3500 m. Cloud eliminated daily 500 m snow cover maps are derived using the MODIS satellite and probability of snow is defined for each pixel of the MODIS image during the snowmelt period (February-June) from 2001-2012. Thus, snow cover risk maps for each day are produced and snow cover depletions with respect to 6 probability classes are calculated. Afterwards, the Snowmelt Runoff Model (SRM) is utilized to obtain daily probabilistic runoff simulations for the 2013 snowmelt period using probabilistic snow depletion curves.

Estimation of Discharge in Rivers using neural network and multiple regression approaches. Case of the "Algerian Coastal" basin

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Abstract:
A quick and accurate determination of flow passing through a river section is fundamental for a large number of engineering applications, such as flood forecasting and real time water resources management. However, practically the great amount of discharge occurs during very brief flash floods, so getting gauging during these quick events is not easy. The rating curve remains the most frequently used method for continuous river discharge measurement. "Stage-discharge" is a time-dependent and very often they exhibit random fluctuations caused by modifying gauging cross sectional during the various flood, their relationship is not always unique. To overcome this difficulty, Water level-runoff model is proposed. The observed stage-discharge data of two hydrometrics stations in the "Algerian Coastal" basin are put to the test by an artificial neural network 'ANN' and by multiple regression 'MR'. The results are acceptable and show the significance of these approaches, particularly for extrapolation, when the intrusive methods are impossible to lead and the geometry of the bed is evolving.

Determination of the homogeneous groups using different fuzzy logic systems

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Abstract:
The lack of sufficient hydrological data in many situations is a threat to start new projects. Therefore, estimation of maximum discharge is an important task in order to design of hydraulic structures. Regional flood analysis is appropriate methods for flood estimation in areas without statistics data and determination of homogeneous regions is the most important step in it. In this paper, the application of fuzzy system for determining homogeneous regions is presented. The Urmia Lake basin in north-west of Iran, where it faces the climate change crisis was chosen for this study. The data was selected from a set of 19 available hydrometric stations with longer information and data period. The 9 physiographic characteristics were chosen as the most important parameters for this study. The fuzzy system was used with 2 inference systems of Mamdani and TSK, with triangular, Gaussian and Sigmoidal membership functions. The homogeneity accuracy was investigated using homogeneity test. Then, the homogeneous groups were compared using the error analysis method. The results showed that TSK system with Gaussian membership function and minimum error of MeQ100=0.03492 is the best method for determination of homogeneous groups.

SASSCAL research activities to assess land and climate change impacts on water resources in Southern Africa

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Abstract:
Given the ongoing land management and projected climate change, the overall challenge in sub-Saharan Africa is to secure water at sufficient quality and quantity for both, the stability of ecosystems with their functions and services as well as for human well-being. Funded by the German Ministry of Education and Research (BMBF), 88 research projects of the SASSCAL Initiative (www.sasscal.org) provide information and services allowing for a better understanding and assessment of the impact of climate and land management changes in five thematic areas (climate, water, agriculture, forestry and biodiversity). Water-related research activities aim to improve our knowledge on complex interactions and feedbacks between surface and groundwater dynamics as well as land surface processes in selected regions of the participating countries (Angola, Botswana, Namibia, South Africa and Zambia). The main objective of this joint and integrated research effort is to develop reliable hydrological and hydro-geological baseline data along with a set of analytical methods to strengthen research and management capacities of the regional water sector. This paper presents ongoing activities of the international SASSCAL research teams. Specifically addressed is the establishment of a weather stations network in Angola, Botswana and Zambia which will notably improve regional data availability. Also, case studies on flood monitoring using remote sensing, integrated hydrological modeling, surface-groundwater interactions and various hydrological process studies in different ecosystems, all at various spatial and temporal scales are introduced. The integration of these joint research efforts with findings from other thematic areas, e.g. in the field of optimized land management, deforestation and restoration, ecosystem stability and resilience, climate projections, food production and security, will allow for a better understanding and assessment of global change related environmental threats and resulting societal challenges in the Southern African region.

The potential and limits of different snow products for spatio-temporal snow cover assessments in Mediterranean high-altitude environments

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Abstract:
Snow and its spatial and temporal patterns are important for water management in the semi-arid eastern Mediterranean, since downstream regions of the Taurus Mountains are dependent on the timing of snowmelt discharge. Different snow products are appealing to overcome the lack of observations in high-altitude regions and analyze snow cover patterns. To better assess the quality of such products, simulated daily snow cover and EO-based snow cover products were compared for the Egribuk basin, Central Taurus Mountains, Turkey. Daily snow cover, depths, and snow water equivalent were derived from distributed hydrological modeling with the J2000 model. Furthermore, 8-day MODIS snow cover data (2002-2007) were utilized. All products were analyzed to determine the number of snow-covered days in relation to freezing days and temporal patterns, reflecting the effect of altitude on the percentage snow-covered area (SCA) along a topographic gradient at various time-steps. Monthly and 8-day spatial patterns of a single snow season were also examined. Both products show a good agreement when SCA peaks at all altitudes in February/March. In contrast, SCA differs notably during snow accumulation and ablation periods. The highest SCA inconsistencies are observed in the low and mid altitudes. The analysis suggests that the J2000 daily model does capture individual snow events, when the MODIS SCA estimates fail due to their temporal resolution and effects related to the acquisition time and inner-daily melt and re-freezing dynamics. In other cases, differences can be explained to insufficient model input data, primarily due to spatially limited precipitation and temperature data. Given this inconsistencies, we recommend a combined analysis of different snow products to provide reliable information on snow cover dynamics, especially for water management and climate change assessments in Mediterranean high-altitude environments.

Understanding and modelling hydrological dynamics for water resources management of the sub-arid Kara river basin (West Africa)

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Abstract:
Understanding and modelling hydrologic processes in sub-arid catchments which are often characterized by limited data is of importance for their sustainable water resources management. In this study, the distributed hydrological model J2000 is used to model the effects of climate and land use on hydrological processes in the Kara river basin, Togo and Benin. For the analysis and modelling of three tributaries, available time series of daily discharge and rainfall covering the period between 1977 and 1989 were checked regarding consistency and homogeneity and corrected using regression analysis. Initially, a catchment pre-analysis was carried out to investigate discharge and rainfall dynamics in three nested catchments. The pre-analysis showed that all catchments have similar runoff dynamics and the runoff generation processes, i.e. volume and timing, are controlled by catchment size, shape, topographic gradient and rainfall distribution. Utilizing the hydrological response units concept, the J2000 model was parameterized and run at daily step. Assessing the Nash-Sutcliffe efficiency (E) and the coefficient of determination (r2) as criteria, the model was calibrated against discharge data from two sites (Kara and N'Naboupi) for the period 1986-89 and validated with discharge from Kpesside (1980-84). With E ranging from 0.55 to 0.79 and r2 equal to 0.6 and 0.81, modelling results indicate that the J2000 model simulates discharge volume and timing for the given period adequately, but was also sufficiently validated for the Kpesside catchment (E: 0.55-0.61, r2: 0.62). It is also shown that combining catchment pre-analysis and J2000 modelling is efficient in reproducing the basin hydrology, but also that applying a calibrated process-driven model offers the potential to assess climate and land management impacts on water resources.

Performance comparison of ANN and a conceptual model in estimating runoff: A case study in Pavanje catchment, Karnataka, India

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Abstract:
Relationship between rainfall and runoff plays a significant role in generation of stramflows. The objective of this study was to compare the efficiency of artificial neural networks (ANN) in rainfall-runoff process simulation with Identification of unit Hydrographs and Components flows from Rainfall, Evaporation and Streamflow (IHACRES) model in a small catchment in Southern part of India. Eight years of data was used for performing the study. Daily rainfall, temperature and runoff datas were used for the study. The IHACRES model was calibrated for a period of 1232 days. Different input combinations were tried for developing ANN models. Correlation Coefficient (R2), Nash-Sutcliffe Efficiency (NSE) and Root Mean Square Error (RMSE) were used to assess the performance of the models. The results showed that the R2, RMSE and NSE values of ANN model are 0.869, 18.43 and 0.542 respectively. The R2, RMSE and NSE values of IHACRES model are 0.623, 27.67and 0.622 respectively. The comparison results show that the ANN has better performances in Simulation of Rainfall-Runoff process than IHACRES model. Also the ANN model with present day rainfall, previous day rainfall and maximum temperature as inputs showed better result than the models with other input combinations. The results can be used for future studies in the catchment.

Modelling extreme streamflows under non-stationary conditions in Ouémé river basin, Benin, West Africa

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Abstract:

Recently, many countries over West Africa have suffered catastrophic floods that affected thousands of people with loss of lives, and damages to properties. Within the context of global warming, the hypothesis of stationarity of observed data set required to perform classical flood frequency analysis is no longer valid. A statistical model to predict the probability and magnitude of flood in non-stationary condition is presented. The model uses a time-dependent and/or the covariates dependent Generalized Extreme Value distribution to fit the Annual Maximal discharge and is applied to five gauge stations of the Ouémé river basin in Benin Republic, West Africa. Different combinations of the model parameters which vary with respect to time and/or covariates Southern Oscillation Index were explored against the stationary model based on three criteria of goodness of fit. It is found that the non-stationary model is more adequate to explain a substantial amount of the variation in the data. The Mann-Kendall and Spearman's rho trend tests show that, at the 5% significance level, the trend observed in the Annual Maximum flood series is not statistically significant. An analysis of 25 and 50 year flood shows that considering the flood event as stationary lead to high uncertainties. This case study put to test the hypothesis of stationarity in estimating flood events and show the strong need to account for the change over time in the flood frequency analysis. This generalization of the classical model based on the hypothesis of stationarity and normality, allows the incorporation of climate change effect on the evolution of the distribution parameters and predictions to be made about the probability of the future occurrence of a particular flood event.

Vulnerability of two Mediterranean catchments to climatic and anthropogenic pressures – spatial and temporal evolution of water supply capacity over the past 40 years

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Abstract:

Over the past 40 years, climatic and anthropogenic pressures have been increasing in the Mediterranean region. According to projections of climatic and socio-economic changes, this area could experience higher water stress by 2050. In this context, integrated modelling approaches are needed to assess water allocation scenarios and assist decision-making for water resources planning. This study aims at developing a generic, multidisciplinary approach to model water supply capacity and its spatial and temporal variability over long time-periods. A common integrated modelling framework was applied over two Mediterranean basins with different physical and anthropogenic characteristics: the Hérault (France, 2500 km²) and the Ebro (Spain, 85000 km²) catchments. Water resources were evaluated using a conceptual hydrological model at a daily time step over a nearly 40-year period. River flow regulations were accounted for through a generic demand-driven reservoir management model applied to the largest dam in the Hérault basin and to the 11 major dams on the Ebro basin. Over both catchments, water demands were estimated from population and monthly unit water consumption data for the domestic sector and from irrigated area, crop and soil data and climatic forcing for irrigation. Finally, a ratio comparing water supply to water demands at strategic resource and demand nodes was computed at a 10-day time-step. Analysis of the variability of this ratio over space and time shows the evolution of the vulnerability of each catchment in terms of water supply capacity, taking into account climatic and anthropogenic pressures and the evolution of water management strategies over time. This study is a first step in exploring the sustainability of water management on two Mediterranean catchments by the medium term, under uncertain and non-stationary climatic and socio-economic scenarios.

Data and model uncertainties in flood-frequency estimation for an urban Swedish catchment

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Abstract:
Floods are extreme events that occur seldom, which means that there are relatively few data of weather and flow conditions during flooding episodes for characterisation of flood frequency. In addition, there are often practical difficulties associated with the measurement of discharge during floods. In this study we used a combination of monitoring and modelling to overcome the lack of reliable discharge data and be able to characterise the flooding problems in the highly urbanised Riseberga Creek catchment in eastern Malmö, Sweden. The study is part of a project, GreenClimeAdapt, in which local stakeholders and researchers work with finding and demonstrating solutions to the flooding problems in the catchment as well as adaptation to future change. A high-resolution acoustic doppler discharge gauge was installed in the creek and a hydrologic model was set up to extend this short record for estimation of flood frequency. Discharge uncertainty was estimated based on a stage-discharge analysis and accounted for in model calibration together with uncertainties in the model parameterisation. The model was first used to study the flow variability during the 16 years with available climate input data. Then it was driven with long-term climate realisations from a statistical weather generator to estimate flood frequency for present climate and scenarios for future climate changes through continuous simulation. The uncertainty in the modelled flood-frequency for present climate was found to be important, and could partly be reduced in the future using longer monitoring records containing more and higher flood episodes. The climate change scenarios are mainly useful for sensitivity analysis of different adaptation measures that can be taken to reduce the flooding problems, for which other concerns such as land-ownership are also highly important.

HYDROMORPHOLOGICAL ANALYSIS OF SABARMATI RIVER

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Abstract:
The study of the shape and form of a river and changes in these with respect to time is called river morphology. Effective management of a river can be possible by studying the channel morphology and sedimentation characteristics of that river. Under this research program the cross sectional data of Sabarmati River for 14 different stations has been obtained for current year 2012-13. This collected data is compared with the available data for same section in year 1997. The longitudinal and transverse meandering and change in slope of the river have been analyzed using the data comparison of the two different years. Calculation of the other parameters like velocity and discharge have been done using manning's formula for both the years and the change in those parameters over a period of 15 years have also been analyzed. A model has been prepared to calculate all the parameters mentioned above for unknown stations also. The future condition of the river after 30 years is also studied and the problems which are going to be encountered after 30 years have also been studied. The brief idea for solving these problems is also considered under this work. (WC=194)

Spatial Extension of Flood Event Data for Ungauged Small Watersheds

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Abstract:
For precise flood control, runoff data availability is substantial. However, developing countries have limited amount of runoff data especially, for the mid/small size watersheds. Thus, we developed a method which can extend available runoff data extensively for the ungauged small watersheds. A non-linear lumped concept model, Storage Function Method (SFM) was applied for the flood data extension on a selected watershed (Choongju Dam watershed, 6648Km2) located in the center of Korean Peninsula. The selected watershed was divided into 22 small watersheds for measuring the capability of spatial extension of runoff data. Twenty one flood events from 1991 to 2009 were selected for this trial. Choongju Dam is the final observation location for this watershed and has measured inflow data which can be used for optimization criteria of runoff data extension for other divided small watersheds. The model parameters consist of physical property and event based parameters. For 22 watersheds, physical property based parameters were fixed with empirical formula while event based parameters were optimized at each event. At the validation points of spatial flood data extension, the Nash-Sutcliffe Efficiencies (NSE) were over the model satisfaction (NSE>0.5). This result is showing the possibility of spatial data extension using a lumped concept model.

Regionalization of Flood Frequency using Hydrological Flood Simulations

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Abstract:
In general, flood frequency analysis can be categorized into two methods. First one is statistical method based on real flood data and the other one is rainfall-runoff method in terms of probability rainfall. For statistical method, sufficient amount of flood data with enough record length at several sites is required, however most of developing countries have limited amount of flood data. In this study, we extended spatially distributed flood data using a hydrological runoff model (i.e. Storage Function Method) to get adequate amount of flood data for ungauged sub-basins in a selected watershed. The study site was Choongju dam watershed divided into 22 small sub-basins and 25 years (1986-2010) flood data was spatially extended from observations. Based on these flood data, annual maximum series were generated and regional flood frequency analysis was performed. Regionalization on flood frequency for ungauged locations was studied using geomorphological factors of each sub-basin. The suggested method from this study can be applied on statistical method of flood frequency at sub-basins with insufficient flood data.

Assessment of Bayesian method for accuracy improvement of real-time drought prediction

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Abstract:
Drought is one of the crucial natural disasters in Korea. Therefore, the real-time drought outlook system was developed using long-term weather forecast information for early drought warning. The system is composed of 3 processes: Ensemble meteorological outlook using Unified Model (UM) based on the multi-initial conditons, the hydrological analysis from Land Surface Model and several drought indices computation processes. However the utilization of outlook information was rare due to the uncertainty of the outlook results. In this study, the Bayesian method as a statistical bias correction technique is applied and evaluated for the enhancement of the quality of drought outlook system. The prior distribution, the likelihood function and the posterior distribution from relationship between observed and UM data in Bayesian scheme are determined during hindcast period, and the corrected posterior data is estimated in real-time. The SPI (Standard Precipitation Index) is calculated from the UM outputs and posterior values, and the temporal and spatial analysis are performed for the accuracy evaluation. Overall the results showed that the application of Bayesian method provide higher accuracy for drought outlook information. Time series of posterior SPI was much improved than that of UM in comparison with observation, and regional drought conditions were simulated well. It reveals that the Bayesian method is viable to improve drought outlook in Korea.

Main factors for developing the time of concentration formula in Korean urban area

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Abstract:
The reliable hydrologic analysis techniques in urban area of the Republic of Korea are required, because the flood damage has recently increased in this region. When we usually conduct an event-oriented hydrologic analysis, one of the most important parameters is the time of concentration in basin. In Korea, the empirical formulas developed by Kirpich, Kraven(I) are being used to analyze the hydrologic simulation. However, those equations are developed on the natural streams and do not consider the characteristics of Korean urban basin. Due to the limitations, the development of time concentration formula considering characteristics of our urban area and stream is necessary. The purpose of this study is to select and analyze the main factors for developing time of concentration in our study area. In this study, Seoul and its suburb area are selected as our study area which is a representative typical urban area in Korea. The rainfall and runoff data are collected from the Han River Flood Control Office (HRFCO) and Seoul City. The characteristics of urban basin and stream such as basin area, impervious rate of the area, coefficient of roughness, link system, stream length and stream slope are computed by using GIS after collecting DEM, soil map and sewer drainage system data. The values of concentration time are decided from the observed runoff hydrograph after separating the effective rainfall and base runoff from rainfall-runoff data. Main factors for developing the formula are selected and analyzed conducting correlation analysis of the values of concentration time and some related basin and stream indices. We finally develop the time of concentration formula in Korean urban area using multiple regression analysis.

Impact assessment of temperature rise on glacier and meltwater fluctuation: Andean tropical glaciers, Bolivia

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Abstract:
Meltwater from glaciers is one of the main water resources for capital area of Bolivia. However, Andean tropical glaciers are rapidly shrinking during past some decades. We projected variation in glacier recession and meltwater to evaluate the sensitivity of Andean tropical glaciers to temperature rise. A mass balance and melt model was applied to Condoriri, Tuni and Huayna Potosi West glacier in Bolivia. Simulation period is 30 years from July, 2011. We produced four types of meteorological dataset for model input with observation and general circulation model: one assumes that current climate keep constant during 30 years and the others assume that temperature increase at the ratio of 0.02 to 0.04°C/year. As results of projection, study glaciers do not disappear and reach to equilibrium states of mass balance in the next three decades under current climate condition. Furthermore, three glaciers exist even under possible temperature rise. Glacial area decrease 55 to 68% and meltwater decrease 66 to 74% by the end of 2030's. Ablation area of glaciers decrease and accumulation area ratio to whole area is high. Huayna Potosi West glacier has higher uncertainty about the response of temperature rise than Tuni and Condoriri glacier. Annual melt reaches a peak in 2020's and decreases by the end of 2030's under the condition of temperature rise of 0.044°C/year. It is close to constant by the end of 2030's under the condition of temperature rise of 0.024°C/year. This is because the peak of altitudinal distribution of glacial area is higher than equilibrium line altitude for current climate condition. These results can contribute to adaptation of water resources management to glacier shrinking.

Estimation of Water Resources Availability in High-Elevation Scarcely-Gauged Watersheds and Its Impact on Mini-Hydro.

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Abstract:
The aim of the present study is to estimate water resources availability (WRA) and its impact on hydropower production in the Mangla basin. This basin, with almost 45% of the catchment in India, where data gathering is even more difficult, is situated in the north western snow and glacier-fed region (Himalayan range) of Pakistan. Streamflow forecasting has been performed by application of a GIS (Geographic Information System) based standard rainfall-runoff model (HEC-HMS) fed with observed and TRMM (Tropical Rainfall Measuring Mission) rainfall data. The calibration of the model was performed by dividing the watershed into two sub-basins: Jhelum river at Azad Pattan station and Poonch river at Kotli station with subsequent accumulation of their flows in Mangla Lake. Simulations were carried out at a daily time step, using different calibration windows of one and three years to optimize the model parameters (such as lag time, initial deficit, maximum deficit, constant loss, lapse rate, Px temperature, base temperature and degree day factor etc). In general, the HEC-HMS application has produced good results, with Nash-Sutcliffe (NS) coefficients larger than 0.71 in all calibration and vaidation datasets. The model performed less efficiently for WRA estimation at Mangla dam by flow accumulation of both basins, with 0.69 NS coefficient. The WRA was estimated at the dam site to analyze its impact on micro-hydro at the downstream canal (Upper Jhelum Canal). The gross mini-hydropower potential at twenty five (25) different locations along the Upper Jhelum Canal was found to be 407 and 221 GHW by using potential and kinetic energy relationship, demonstrating that micro-hydro power genration could be a beneficial addition for the energy sector of Pakistan.

Assessment of land use change on the streamflow using GIS, remote sensing and physically-based model: case study of Tapacurá catchment, Brazil

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Abstract:
This study aims to assess the impact of the land use changes between the 1967−1974 and 1997−2008 periods on the streamflow of Tapacurá catchment (Northeastern Brazil) using the Soil and Water Assessment Tool (SWAT) model. The land cover changes within the catchment were examined analyzing satellite images, soil maps, digital elevation models and by spatial analysis using GIS and remote sensing techniques. The SWAT model was calibrated and validated by comparing the model outputs with historic streamflow data for both periods. The land cover change analysis has shown that the agriculture and urban areas have increased, while the forest has decreased, according to the two land-cover maps. The results shows that the most sensitive parameters were found to be the base flow, Manning factor, time concentration and soil evaporation compensation factor, that affect the catchment hydrology. Calibration and validation of the model were performed on monthly basis, and streamflow simulation had a good level of accuracy for both periods. The obtained R^2 and Nash-Sutcliffe Efficiency values for each period were respectively 0.90 and 0.89 for calibration, and 0.95 and 0.94 for validation. The evaluation of the SWAT model response to the land cover has shown that the mean monthly flow, during the rainy seasons for 1967−1974, increased when compared to 1997−2008. This is mainly attributed to the land degradation (removing of forest to agriculture and sugarcane field), which in turn increased streamflow during wet seasons and reduced base flow during the dry seasons. The results also revealed that the streamflow spatial distribution for 1997−2008 showed high values in the sub-catchments due to the high concentration of rainfall, presence of impermeable soil and land cover that favoring the streamflow, as presented in the sub-catchments located near to the catchment outlet.

Discrete wavelet transform coupled with ANN for daily discharge forecasting into Três Marias reservoir

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Abstract:
This paper proposes the use of discrete wavelet transform (DWT) to remove the high-frequency components of the original signal (details), because the noises generally present in time series (e.g. streamflow records) may influence in the prediction quality and cleaner signals could be used as model inputs in order to improve the model performance. In order to deal with these issues, the application of methods to pre-process input data has been pointed out as an efficient alternative to improve the models performance. An example of such method is wavelet analysis, which has recently received much attention. Wavelet analysis provides useful decompositions of original time series in high and low frequency components, so that wavelet transformed data improves the ability of a forecasting model by capturing useful information at various resolution levels. The decomposition process can be iterated, with successive approximations being decomposed in turn, so that the original signal is broken down into many lower resolution components. The approximation (A) and detail (D) components can be obtained by a reconstruction procedure. Thus, the raw signal Q is formed by those components, i.e., Q = A1 + D1 or A1 = A2 + D2, and in the same way Q = A3 + D3 + D2 + D1. There are many basic wavelets that can be used in this type of transformation. In this paper, Daubechies wavelets may be seen from order 1 up to 10. These wavelets have no explicit expression, except for db1, Haar wavelet. Most of the dbN are not symmetric, and for some, the asymmetry is well pronounced. Regularity increases with order. The N index in dbN indicates the order, which in theory may vary from 1 to infinity. Among the Daubechies wavelets, the db10 was chosen to be used in the decomposition of the flow signal due to its more detailed format, which permits to better represent the series in study. Finally, the proposed technique is tested using river discharge records.

Hydrological Parameter Analysis Based on Similarity Theory and 3S Technology

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Abstract:
Parameters' identification is the most important step in the hydrological model establishment. But some of the hydrological model parameters are almost not determined directly through experimental observation, which are related to basins' features. How to effectively analyze the correlation between the parameters and basins' features, become the important content of hydrological model development. This research uses similarity theory and combines with 3S technology to analyse the hydrological model parameters. The results showed that the distances on the parameters of two similar basin are mostly small and close in the geometric space.

Research on the snowmelt runoff with climate changed effect in China

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Abstract:
A major proportion of discharge in the Juntanghu river basin is contributed by its snow river and glacier-fed catchments situated in northern mid-slope of Tianshan Mountain, Northwest China. It's very important to assessment the snowmelt runoff from these catchment (data scarce area) for water resources management. The Mann-Kendall trend test was based on the 50 years data(from 1961 to 2011) from ten weather stations of northern slope of Tianshan mountain. The Mann-Kendall trend test was validated by using Coefficient difference product curves. The soil and water assessment tools (SWAT) was selected to simulate the daily discharges and to study the climate change impact on these discharges in Juntanghu watershed (the snow and glacier-fed catchment of the Juntanghu River). The SWAT was verified against observed for inflow series of the Hongshan reservoir of the watershed during the period from 1995 to 2010 and generally performed well for Nash-Sutcliffe coefficient. The simulate results obtained suggest that the SWAT model can be efficiently used in the snow and glacier catchments of the Juntanghu river basin and extend to overall northern mid-slope of Tianshan Mountain. Moreover, The application of the SWAT model under different climate (precipitation ad average temperature) change scenarios show that watershed hydrological cycle would be altered under different climate change scenarios. The snowmelt runoff in spring is likely to ahead of time with the increase mean temperature under Scenarios. and the snowmelt runoff during from preliminary to interim stage has less influence facing with changed precipitation. This research suggests that the reservoirs (eg. Hongshan reservoirs) will be necessary for large flow storage to meet the need of the flood control, water supply, etc. The modeling results provide useful decision support for water resources management and flood control.

River-bed erosion due to changing boundary conditions: perfomance of a protective measure

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Abstract:
As it is known, natural or man-made changes along a river disturb the equilibrium of the alluvial stream which adjust itself to a new equilibrium condition. As an example, due to the introduction of man-made sediment barriers, the amount of sediment load entering in the downstream river reach is different from that going out and erosion processes occur downstream of the barrier itself. Both bed degradation and local scouring can occur at different spatial and temporal scales. The knowledge of the response of the alluvial stream to the imposed conditions is extremely important. Designers are often required to take into account the scouring process and to include adequate protective measures against the local scour. The design of the protective measures, in turn, needs the knowledge of flow velocity field and of geometrical characteristics (maximum depth and length) of scour transient profiles. In this paper, attention is paid to the effect of bio-engineering protective measures against the erosion processes. In particular, real flexible vegetation has been used as protective measure against erosion process downstream of a rigid bed.
The aim of the present work is to give a contribution for a better understanding on flow hydrodynamics downstream a hydraulic structure with and/without the protective measure. Analyses are based on experimental work carried out in a straight channel constructed at the laboratory of the Dipartimento di Ingegneria Civile, Ambientale, Aereospatiale, dei Materiali - Palermo's University (Italy). Detailed measures of flow velocity field inside the scour hole have been obtained through both a 2D LDA anemometer and an acoustic velocimeter profile (DOP 2000). Maps documenting the bed shear stress distribution are shown.

Hydrodynamic characterization of soils in areas with sugar cane and pineapple crops in a representative watershed of Northeast of Brazil

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Abstract:
Studies about the infiltration of water in the soil, based on hydraulic conductivity and retention curve, are important to simulate hydrological processes and pollution fluxes. Infiltration and soil hydrodynamic properties also play an important role on crop efficiency. This paper aims to present the hydrodynamic soil behavior and infiltration of the Gramame watershed, located at the Northeast of Brazil. This basin is representative of several other watersheds located on the coastal region of Brazilian Northeast, where the land use is mainly explored by sugar cane crops. The Gramame watershed has about 85 % of its area used for some type of crop. For this study, three different land uses and land cover were considered: sugar cane crop, pineapple crop and Rainy Forest, which is the native forest of this region. This last one was considered in order to evaluate the changes manmade activities. Only about 10 % of the watershed still have Rainy Forest. For this purpose the Beerkan method and the BEST program were used in order to get retention curves θ(h) and hydraulic conductivity K(θ). Five parameters based on the granulometry and infiltration tests were gotten. The results show that the highest values of hydraulic conductivity were obtained at points located in native vegetation. However, the hydraulic conductivity in the cane sugar crop area was higher than the Rainy Forest from a certain soil moisture boundary, maybe due to the tilling the surface layer of the cultivated area. It was concluded that even with the soil with covered with the Rainy Forest presented results similar to the cultivated areas, the lowest hydraulic conductivities were found in areas with crops (sugar cane and pineapple), proving that deforestation impacts the soil hydrodynamic characteristics.

Forty years of history of aridity in the Tensift Basin (Marrakech-Morocco)

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Abstract:
Morocco has, since many decades, followed up a monitoring of water resources at the scale of the watersheds. Its main goal was a self-sufficiency in water resources in the frame of a policy of resource mobilization that was (and still is) necessary to meet the water needs of several socio -economic sectors booming since the early sixties of the last century.
This monitoring process has enabled the development of many stations and measurement sites of hydro-climatological parameters to assess the evolution of water resources. In addition, it is in this spirit that within the Tensift basin (Region of Marrakech), managed by the Water Basin Agency of Tensift, the diagnostic is quickly made. Indeed, on an observation period of more than forty years, the various indices for assessing the evolution of hydrological and climatic conditions (de Martonne, UNEP indexes) suggest that the region of Tensift in particular and Morocco in general, has entered a phase of significant intensification of aridity.
Thus, temperatures become higher during the last two decades and, paradoxically, they increased in mountainous areas. Meanwhile, a remarkable decrease in precipitation was observed in the foothills of the High Atlas. Overall, during the past two decades, the Tensift basin (Center of Morocco) has known a substantial expansion of arid zones, possibly due to global warming and the observed decrease in rainfall.
An immediate consequence of this situation has been expressed, as a notable diminution of the runoff (in gauged sites), with a random occurrence in time and in intensity. The runoff is, then almost exclusively torrential with a devastating impact on infrastructures and a very low benefit on recharge of groundwater. Regular runoff (due to precipitation and snow melting) occurs rarely and sustains the flows in few rivers, and contribute in a very weak way in groundwater recherché at the level of the plain.

An L-moment approach to assess changes in regional flood frequency distributions in Austria

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Abstract:
This paper aims to better understand the effect of environmental and catchment changes on the statistical properties of regional flood frequency distributions. The database used consists of L-moment ratios of annual maximum flood discharges from Austria, involving a total of 493 catchments with more than 25 yr of record length. A set of morphologic and climatic attributes, including temperature, precipitation, elevation, and soil characteristics is presented, as potential controls on regional flood frequency distributions. By *trading space for time*, i.e. translating the observed differences in space in possible changes in time of the discussed catchment attributes, the main outcome of the purely data-based investigation performed on the database shows that a transition in the future towards warmer, more arid environments could lead to higher regional values of L-coefficient of variation, L-coefficient of skewness and L-coefficient of kurtosis. This has implications in statistical model choice, in particular by moving into more skewed and leptokurtic regional distributions. The results related to catchment elevation (and therefore correlation to snow-dominated regimes) and soil characteristics are less conclusive. The findings presented in this study constitute a preliminary assessment of how statistical properties of regional flood frequency distributions could change in the future, and offer an orientation on how to better manage *non-stationary* flood design values.

Regional prediction of basin-scale brown trout habitat suitability

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Abstract:
In this study we propose a novel method for the estimation of ecological indices describing the habitat suitability of brown trout (*salmo trutta*). Traditional hydrological tools are coupled with an innovative regional geostatistical technique, aiming at the prediction of the brown trout habitat suitability index where partial or totally ungauged conditions occur. Several methods for the assessment of ecological indices are already proposed by the scientific literature, nevertheless the possibility to exploit a geostatistical prediction model, such as Topological Kriging, has never been investigated before. In order to develop a regional habitat suitability model we used the habitat suitability curve, obtained from measured data of brown trout adult individuals collected in several river basins across the U.S.. A Top-kriging prediction model is then employed to assess the spatial correlation between upstream and downstream habitat suitability indices. The study area is the Metauro river basin, located in the central part of Italy (Marche region), for which both water depths and streamflows data were collected. The present analysis focuses on discharge values corresponding to 0.1-, 0.5-, 0.9-empirical quantiles derived from flow-duration curves available for 7 gauging stations located within the study area, for which three different suitability indices (i.e. ψ_{10}, ψ_{50} and ψ_{90}) are evaluated. The results encourage this preliminary analysis showing Nash & Sutcliffe efficiency respectively equal to 0.52, 0.65, and 0.69.

Analysis of the impact of gravel mining activities on the flood flow profile of the Po River

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Abstract:
Flood routing is a fundamental step in the application of flood forecasting models. The dynamics of the river flow profile of the Po river (Italy) induced by a given upstream flood hydrograph and a downstream boundary condition was studied for the 97 km river reach between the cross river sections of Cremona and Brescello. The purpose of the analysis is to assess the impact on the flood profile of impounding basins that were originated by gravel mining activities in the floodplains. The simulations have been made under conditions of unsteady flow and one-dimensional motion of the flood wave propagation using the Hec-Ras model. The calibration has been made by referring to the flood wave observed in October 2000 by referring to undisturbed and perturbed (by the mining activities) conditions. The impact of the impounding basins will cause a lowering of water levels nearly 20 cm upstream of the planned interventions. Hence the results show that there are not negative implication of the mining activity on the hydraulic risk.

Application of the TOPKAPI model to Santerno and Senio catchments

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Abstract:
The poster presents the calibration of the TOPKAPI model in the Santerno and Senio catchments, two sub-catchments of the Reno Basin, in Northern Italy. TOPKAPI (TOPographic Kinematic APproximation and Integration) is a fully-distributed physically-based hydrologic model that reproduces the behaviour of the main components of the hydrologic cycle: subsurface flow, overland flow, channel flow, infiltration, percolation, evapo-transpiration and snowmelt. The topography of the basin is described by a Digital Elevation Model (DEM), which subdivides the application domain by means of squared cells. Being a physically based model, the values of the parameters can be easily retrieved from digital elevation maps, soil type and land use maps in terms of measurable physical quantities such as slope, superficial roughness, soil permeability and soil depth. Model implementation and calibration has started from public information available on the web. Soil parameters have been derived from pedologic information provided by websites of Emilia-Romagna and Tuscany. Starting from these initial parameters, comparing observed and simulated streamflow and observing the model results in terms of state maps (referring to the main hydrologic quantities, such as soil moisture, evapo-transpiration, river flow, etc), many simulations have been executed in order to identify the set of parameters that best reproduce the observed streamflow. This has also allowed to deepen the interaction between soil saturation and outflows formation.

Comparative application of HyMOD and HBV rainfall-runoff models to two Italian catchments

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Abstract:
The HyMOD and HBV rainfall-runoff models are applied to two Italian catchments in order to compare their performances and to obtain indications on the dominating hydrological processes. The observation period for both catchments is 20 years long and the simulation is operated at daily time scale. The models have been run by using the software R (www.r-project.org) and parameters have been calibrated by referring to an observation period varying from 2 to 10 years. Validations performed over an observation period of 10 years by using data that were not employed in calibration.
The results show that the performances of HBV, which counts a higher number of parameters with respect to HyMOD, are more satisfactory when the model is calibrated on a sufficiently long observation period. When the calibration data-base is reduced, HyMOD provides less uncertain simulations.

Generation of synthetic river flow data by using stochastic models

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Abstract:
The purpose of the study is to calibrate a stochastic model on time series of river flow data for the purpose of generating synthetic hydrological variables. Using the R software (www.r-project.org), an autoregressive integrated moving average model is applied to a series of mean daily flows. Given that river flow data are non Gaussian, and affected by seasonality, the series is first transformed to resemble a normal distribution and it is deseasonalized. The function *arima*, included in R standard stats package, is used to estimate the model parameters. This step is repeated for different model orders, with a maximum value of 3. The *arima* function gives, as a result, a class object which contains estimated residuals, as well as estimated autoregressive and moving average parameters. Residuals checking are used to validate the model and check the best set of model orders. The results show that several different model orders may provide a satisfactory fit.

Assessment of the impact of hypothetical extreme floods in the Secchia River (Italy)

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Abstract:
The study aims at assessing the impact of extreme floods in the Secchia River Basin (Italy). In the first part of the work we analyze the flood event that occurred in the Secchia River during 18-28 December 2009, when a rainfall occurred with a return period that was not relevant (less than 5 years) which induced extreme hydrometric values downstream. The data that were collected and analyzed within this study were recorded by automatic stations, managed by the Protection Agency (ARPA) of the Emilia-Romagna administrative region. In the second part of the work a rainfall with higher return period is assumed to occur over the catchment and river flows are simulated by using a rainfall-runoff model by referring to several river cross sections. The purpose of the second part of the study is to check the allowance for freeboard for the levees in the downstream part of the river.

Is the frequency of severe rainstorms increasing in Emilia-Romagna (Italy)?

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Abstract:
There is a strengthening common perception that the frequency of hydrological extremes is dramatically increasing in several areas of the world, due to a combination of different causes, among which climate change is often described as the major factor. Over the past five years, the Emilia-Romagna administrative district has been affected by 83 severe rainstorms, which caused flooding, disruption to traffic, landslides and even loss of human lives in at least two cases: Sala Baganza June 11, 2011, and Rimini June 24, 2013. Has the frequency of severe rainstorms increased during the last two decades in Emilia-Romagna? To address this science question we perform a quantitative assessment of possible recent modifications occurred in the frequency regime of annual maximum rainfall depths associated with durations ranging from 1 hour to 24 hours. In particular, we statistically test at 5% significance level the null hypothesis H0: "The regional frequency model identified for Emilia-Romagna by Di Balsassarre et al. (HESS, 2006) on the basis of annual maxima collected from 1935 to 1989 is suitable for representing the frequency regime of hourly rainfall extremes observed between 1995 and 2012". Our preliminary investigations do not seem to support the above mentioned common perception, since the H0 hypothesis could not be rejected for 157 out of 166 recent annual sequences of hourly rainfall with at least 10 years of data. The number of cases in which H0 should not be rejected slightly decreases for longer durations (e.g. 113 out of 144 annual sequences with at least 10 annual maxima of 12-hour rainfall depth), for which, though, inter-site correlation severely impacts the power of statistical tests.

On the flood risk evolution along the Po River: simplified tools for a large scale and temporal analysis

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Abstract:
Climate change is often indicated as one of the most important factors controlling the increasing frequency with which, in Europe and other areas of the world, high damages are caused by floods. However, in many cases, the increasing of flood risk could be related to other factors, such as the evolution of the flood exposure on the flood-prone area (e.g. the uncontrolled expansion of urban and industrial settlements comports higher potential flood damages and losses). Starting from these considerations, we focus on the middle-lower portion of the River Po (Northern Italy) with the aim of shedding some light on the impact and relative importance of different factors controlling the flood risk. We analyse the evolution of the flood risk during the last half century from different perspectives: i) hydrological factors, analysing long streamflow data series at different gauging stations for the evaluation of significant trend on the river flow regime; ii) anthropogenic impacts, investigating land-use and demographic dynamics observed from 1950s in the catchment and in the flood-prone areas.
The study proposes simplified flood-vulnerability indices suitable for the representation of the flood risk evolution along the middle-lower portion of the River Po, assessing the importance of different factors contributing to the definition of flood risk. The results of the study represent important information that can be particularly useful to decision-makers in the definition of large-scale flood-risk mitigation strategies and development plans for the study area.

Quantifying the effects of storage thresholds on step changes in the flood frequency curve

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Abstract:
In the presented study the authors explore the effects of non linear catchment response related to storage thresholds. They have shown in previous work that such catchment behavior may lead to step changes in the flood frequency curve. In this study they explore the impacts of temporal and spatial changes in storage properties on the magnitude of the step change using the maximum of the second derivative (curvature) of the flood peaks with respect to their return period as a new measure for the magnitude of the step change. The results of the analysis apply to catchments where runoff is generated by the saturation excess mechanism and a clear separation between a permanently saturated region and a variably saturated region with spatially uniform storage deficits exists. They perform a sensitivity analysis with a stochastic rainfall model and a simple rainfall runoff model showing that the magnitude of the step change increases with increasing area of the variably saturated region and decreases with increasing temporal variability of antecedent soil storage. The return period where the step change occurs is very similar to the return period of the rainfall volume that is needed to exceed the storage threshold. They present diagrams that show the joint effects of spatial and temporal storage variability on the magnitude and return period of the step change. The diagrams may be useful for assessing whether step changes in the flood frequency curve are likely to occur in catchments where the runoff generation characteristics are similar as the ones examined in the study and the flood records are too short to indicate a step change.

May flood-poor periods be more dangerous than flood-rich periods?

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Abstract:
River flooding in floodplains may cause loss of lives and tremendous economic damages and, therefore, is rightly seen as a very negative event by the riverine communities involved. Occurrence of many floods in a row is, of course, even more frustrating and is rightly considered as an unbearable calamity. In many places in the world, it has been observed that extreme floods cluster in time into flood-poor and flood-rich periods consistent with the Hurst effect. If this is the case, when are the people more in danger? When should people be more concerned? In flood-poor or flood-rich periods?
By applying a socio-hydrology model we found out that, maybe counter-intuitively, flood-poor periods may be more dangerous than flood-rich periods. The model is a conceptualisation of a hypothetical setting of a city located in the proximity of a river, along whose floodplains a community evolves over time, making choices between flood management options. The most important feedbacks between the economic, political, technological and hydrological processes of the evolution of the community are represented in the model. In particular, the model also accounts, in a dynamic way, for the evolution of the the community awareness to flood risk. It is shown through examples that frequent flood events may result in moderate damages because they ensure that the perception of risk and, consequently, people preparedness remains high. Conversely, long periods without floods will serve to diminish awareness, since the memory of floods tends to be short (i.e., people tend to forget quickly), finally leading communities to take higher risks.

The Role of Predictive Uncertainty in the Operational Management of Reservoirs

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Abstract:
Most of the large reservoirs in the world are currently managed either on the basis of politically influenced empirical rules or on the basis of optimisation-based rules derived either via deterministic (linear and non-linear programming, dynamic programming, etc.) or stochastic (generally stochastic dynamic programming) approaches. The resulting deterministic or stochastic optimised operating rules are then operationally triggered on the basis of future inflows predictions, mostly provided by seasonal or shorter-term hydro-meteorological forecasts. Moreover, when a flood is bound to happen, the decision maker may become risk averted thus changing the primary objective from benefit optimisation to risk management. This implies making use of shorter-term (weekly, daily or even hourly) operational flood forecasting systems. Today, most of these forecast, although inherently highly uncertain, are frequently used as deterministic in the decision making process. This inevitably results in strongly sub-optimal management results, which could be definitely (and simply) improved by accounting for and incorporating the predictive uncertainty in the decision making process. Using a theoretical and extremely simplified case, based on the Aswan reservoir data, it will be shown why neglecting predictive uncertainty may lead to poorer reservoir management. Moreover, the effectiveness and the tangible benefits for using the measure of predictive uncertainty (the entire probability density) as opposed to the actual predicted value, will be demonstrated on the basis of the Lake Como management system, which is operational since 1997, as well as on the basis of a case study on the lake of Aswan.

Heat and dry island observed over Jakarta, Indonesia, in 2012

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Abstract:
Recently, Asian countries experience rapid urbanization. Population concentration to urban area extends artificial land cover, increases energy consumption, and causes various problems. Especially higher air temperature over urban area (heat island) degenerates residential environment, and affects human health. Therefore, investigation of the heat island over Asian Megacities is pressing issue. In Jakarta, the largest city in Indonesia and the second largest city in Asia, some studies tried to investigate the intensity and extension of heat island. These studies rely on quite few observation points (only 4 to 5 points) and physical based model. To figure out more realistic thermal environment in Jakarta, denser observation is needed. In this study, we carried out 7 additional fixed-point temperature and humidity observation in Jakarta from dry to pre-monsoon season (from 16 September to 18 October) in 2012. On a typical day in dry season, 16 September, air temperature was higher over densely urbanized area because of strong heating caused by artificial land cover and anthropogenic heat until 12 LST (local standard time) compared with sparsely urbanized area. After 12 LST, increase in air temperature was suppressed because sea breezes penetrated and carried cold air from Java Sea. In the night time, air temperature over densely urbanized area was clearly higher than suburban area because urban geometry prevented radiation cooling. In point of humidity, specific humidity was lower over densely urbanized area in the midmorning because evapotranspiration from vegetation was smaller than suburban area. Around noon, specific humidity also decreased inland suburban area because of the effects of densely urbanized area close to sea. In the afternoon, specific humidity increased from coastal area to inland area, because sea breezes carried water vapor from Java Sea to inland. Overall, the features of heat and dry island over Jakarta was revealed in this observation.

Transformation of the tidal waves in the estuary of the Amur River

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Abstract:
This study considers the water dynamics in the Amur River estuary. The impact of the tides on the regularities of the interface of the river and the sea is studied. The transformation mechanism of the river flow and tidal waves in the Amur River estuary is described. The interaction of the opposing flows is studied.

Analysis of the driving factors of the ecological health evolution in the Zhang weinan River Basin

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Abstract:
Based on the PSR model, this study made the health assessment of ecological conditions of Zhang weinan River basin in three eras (1980s, 1990s, 2000s) with sub basin as the unit. This study identified the main driving factors of human activities on the basis of analyzing the evolution trends of its ecological health and it also quantitatively determined the magnitude of the driving factors of landscape ecological health. The results show that, since the 1980s, the ecological health of Zhang weinan River Basin presents a trend of worse and slightly turning good. The main factors of human activities are urbanization, soil and water conservation and utilization of water resources, which affect the healthy development of the basin. Thereinto, urbanization and soil and water conservation have the positive effects on the ecological landscape pattern of the basin, with the rate of contribution about 26% and 35%. While to a certain extent the utilization of water resources affect the healthy development of ecological landscape of the basin, with the rate of contribution about -39%.

Observed meteorological dry and wet events in central Finland and associated climate teleconnection patterns: 1959-2009

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Abstract:
Extreme climatic events may severely influence our society and environment. Drought as one of main extreme events is natural water shortage resultant of decrease in amount of precipitation during a long time period, like a season or a year. It plays an important role in sustainable water resources planning and management by threating terrestrial ecosystem and different human activities such as agriculture, forestry and recreation. Using Standardized Precipitation Index (SPI), we analyzed variability of meteorological dry and wet events on different time scales (annual, seasonal and monthly) in central Finland during the period 1959-2009. For different SPI values (SPI12, SPI3 and SPI1), trends based on the Mann-Kendall non-parametric test and most significant relationships with the climate teleconnection patterns based on the Spearman correlation coefficient (rho) were determined. Analysis of SPI values indicated more frequent wet years, seasons and months over central Finland during the study period than the dry ones. The SPI12, SPI3 for winter and summer seasons, and SPI1 for July and December showed significant increasing trends ($p<0.05$), while the SPI1 for August showed more dry conditions in the recent years. The East Atlantic/West Russia (EA/WR) and the Scandinavia (SCA) patterns were the most effective teleconnections on variations of SPI values on different time scales.

Regional methods of hydrological computations for ungauged sites

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Abstract:
The methodological and theoretical issues of regional modeling associated with the two main opposing properties of hydrological characteristics: their continuity in space, which is expressed in the method of contouring, and their readability, stipulates the existence of homogeneous regions in which the creation of regional dependency. Given the disclosure of this "hydrological dualism" associated with different contribution of zonal and azonal factors that reflected in different structures of regional models. Given the structure of regional models , depending on the spatial properties of the hydrological characteristics and factors.
The analysis of methods of interpolation and hydrological analogy has been given. The methods of perpendicular and rays have been suggested to calculate the weighted interpolation coefficients and the technique of evaluating the effectiveness of methods for independent information. Examples of application of the proposed methods for various geographic areas have been shown. Methodology is suggested for the selection of effective analog synthesis and long-term observation series in unexplored paragraph assessing the effectiveness of an independent information. Examples of application of the proposed method are given. The general methodical sequence for construction of regional dependencies, including three stages is suggested. The methods are given for evaluating the effectiveness of the resulting regional model based on residual analysis and testing it on the dependent and independent information and conditions for extrapolation to very small watersheds that are usually required and the practical implementation
Examples of construction, assessment and application of regional dependency are given for maximum spring flood runoff and rainfall floods in various regions of Russia, north of Western Siberia, the central district of European part of Russia, Angara basin, Kaliningrad region, the Black Sea coast.

Modeling the shrub encroachment in a grasslands with a Cellular Automata

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Abstract:
Arid and semiarid grasslands of southwestern North America have changed dramatically over the last 150 years as a result of the shrub encroachment, i.e. the increase in density, cover and biomass of indigenous shrubby plants in grasslands. Numerous studies have documented the expansion of shrublands in the southwestern America Grasslands; in particular the encroachment of shrubs in American deserts has strongly occurred in the Chihuahuan deserts from 1860. The Sevilleta National Wildlife Refuge (SNWR), located in the northern Chihuahuan desert, shows a dramatic encroachment front of Larrea tridentata (shrub) into native desert grassland. This encroachment has been here simulated using an Ecohydrological Cellular Automata Model, CATGraSS.
CATGraSS is a spatially distributed model driven by spatially explicit irradiance and runs on a fine-resolution gridded domain. Plant competition is modeled by keeping track of mortality and establishment of plants, both calculated probabilistically based on soil moisture stress. For this study CATGraSS is improved with a stochastic fire and a grazing function, and its plant establishment algorithm is modified.
The model is implemented in a small area (7.3 km^2) in SNWR, characterized by two vegetation types: grass savanna and creosote bush shrub. The causes, here considered for the encroachment in this case study, are: the fire return period increase, the grazing increase, the seed dispersal caused by animals, the role of wind direction, the shrub-grass inhibition effect (i.e. allelopathy) and the plant type competition. The model is able to reproduce the encroachment occurred in the SNWR basin, simulating an increasing of the shrub from 2% in 1860 to 42% in 2010 (actual shrub percentage) highlighting among the most influent factors the reduced fire frequency and the increased grazing intensity.

Land use impacts on stream ecosystems – studied using Distributed Temperature Sensing (DTS) and hydrological modelling

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Abstract:
Water management in Denmark is challenged by high groundwater abstraction rates in and around urban and agricultural regions which are placing significant stress on stream ecosystems. In addition, the use of fertilizers and pesticides in agriculture is increasing water scarcity by polluting groundwater and leading to enhanced eutrophication in lakes and estuaries. Environmental regulations aiming at securing and protecting water resources and aquatic environments include strict nitrogen (N) norms in agriculture (=85 % of economical optimal) and land use change measures, such as the growing of catch crops and the establishment of stream buffer zones where agricultural activities are prohibited. In 2013, a new environmental law requires stream buffer zones to be expanded to 10 m, and pipe drains are currently being cut off to facilitate the development of wetlands in the stream buffer zones thereby increasing denitrification. Generally, environmental land use plans aim to increase both wetland and forest areas to reduce N loads. The impacts of such pollution mitigating land use strategies on hydrological processes influencing stream discharge and stream temperature are not well known. The current study combines Distributed Temperature Sensing (DTS) measurements and catchment hydrological modelling to investigate land use impacts on hydrological processes affecting stream temperature and stream flow in an agricultural catchment. The DTS system (a fiber-optical cable) was installed in a 1.8 km stream reach with sections of forest, agriculture and wetlands represented in the riperian zone, and stream temperature data were measured each meter and each three minutes during all seasons of the year. It is found that during summer low flow conditions, wetlands in the riperian zone significantly increase the stream temperature and may contribute to the development of unsuitable stream habitats. It is recommended that such impacts are further studied, and that alternative locations for the establishment of mini-wetlands are also explored.

Sediment matters in hydrological watersheds

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Abstract:
Rainfall and runoff induced erosion and sediment transport in hydrological watersheds are complex processes. This process has great importance in scientific research studies and engineering practice. The amount of sediment transported within the watershed is needed for hydrological and environmental problems. Sediment transport over a watershed can be estimated by time series analysis, empirical or mechanistic equations, monitoring, sampling, surveying, remote sensing or geographical information systems. As monitoring and sampling sediment transport process are costly and not easy to implement yet, modeling has become an alternating tool used for estimating sediment transport. Data-based empirical models as well as process-based hydrological models are available for this purpose, yet modelling is difficult and challenging. Challenges encountered in the modelling are the variability in the estimate of sediment calculated by each model, data requirement for the calibration of model parameters, complexity in the calibration and validation stages of the process-based models, uncertainty in the transport capacity approach used in model construction, etc. In this study, these challenges related to the modelling sediment matters are discussed with an emphasis on the process-based sediment transport models. A case study on Buyukcekmece dam reservoir in the greater municipality region of Istanbul, Turkey shows that order of magnitude different outputs are obtained when data-based models are used for estimating sediment transport in hydrological watersheds. Process-based models were paid particular attention on their microtopographical structure, parameterization and data requirement.

Model to assess the impacts of external drivers on the hydrology of the Ganges River Basin

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Abstract:
The objective of this study is to quantify the impacts of various external drivers on the hydrology of the Ganges River Basin (GRB). To accomplish this, the Soil and Water Assessment Tool (SWAT) is used to simulate hydrological flows. The GRB is divided into 1,864 sub-basins to capture all the tributaries. The SWAT model was setup using daily weather data for the period 1979-2010. The SWAT Calibration and Uncertainty Program (SWATCUP) was used to calibrate the model. The calibration period was selected as 1981-1990 with first two years as a warming up period. The calibrated model was validated for the period 1991–2000 by flow time series collected at different locations. The performance indicators show reasonable simulations for streamflow. The calibrated model was used to simulate the hydrological system of the GRB. Simulations were carried out for 30 years from 1981-2010. The preliminary simulations on annual water balance components showed that about 41% of the available water resources in the GRB contribute to evapotranspiration while the groundwater component is about 23% and the balance is leaving as surface runoff in the river. This model has been used to analyze the impacts of anticipated external drivers on hydrology of the GRB. These external drivers are: change in rainfall and temperature, increase of water use in the basin and the population growth. In comparison to the values in 1991, domestic water demand in the GRB is projected to increase by approximately 80% until 2030. Simulations using climate change data indicated that in 2030, the total groundwater recharge would be reduced by 8% while the increase of evapotranspiration will be about 17% compared to the 1991.The model setup is available for free from IWMI's modeling inventory.

Potential impacts of climatic variations on water availability and implications in water management in wetland dominated Andean environments

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Abstract:
In the highlands of the Andes in Bolivia, productive systems are basically dependent upon breeding of Southamerican camelids, whose nutrition depend almost exclusively on wetland vegetation, which in turn strongly depend on the availability of water in the Sajama basin. Considering the potential impacts of global environmental change on water availability, this research aims to evaluate such issue from a water balance perspective. For the analysis it is employed a semidistributed water balance model. In absence of agricultural activities, it is assumed that the main water user are the Andean wetlands within the study basin and that for such water user, the water demand can be adequately described by its calculated real evaporation. The analysis is carried out for three scenarios: present time (2005-2010) and a future time scenario (2046-2051), the later under predictions carried out by a stochastic mathematical model. The analysis is carried in a monthly basis. A global sensitivity analysis is carried out to evaluate the model predictive uncertainty. Results suggest that for a future scenario with unclear precipitation trends and an apparently evident future trend to raise for the water demand (i.e., the evapotranspiration), it is expected a decrease in the discharge frequency of occurence of about 14 L/s/km2. For the dry season, our study suggest a general increase in the frequency of occurence. For the transitional season, a mixed behavior is expected, with a decrease in the frequency of occurence of values lower than 2 L/s/km2 and an increase in the frequency of occurrence of values higher than the mentioned one. Later, in order to analyze variations of the potential impacts on the water demand, the sensibility analysis suggest that the user with higher demand is likely to displace the relevancy that precipitation has on the natural hydrological system.

The investigation of the biocenoses in the Karchaghbyur river biotope affected by the small hydropower plants

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Abstract:
Hydrobiological, hydrophysical and hydrological studies were implemented in the Karchaghbyur and Argichi rivers in October-December 2013.
The studies showed that the higher values of the quantitative and qualitative parameters of zooplankton in the Karchaghbyur river were registered in the site situated after the hydropower plant as this site of the river had lower velocity, and there were the thickets of higher plants. These conditions are favorable for the growth of zooplanktonic organisms. According to the observation sites situated before and after the hydropower plant, the quantitative and qualitative parameters of phytoplankton decreased which is explained by the pressure of zooplanktonic organisms as well as a change in thermal regime. In the observation site situated after the hydropower plant, where the representatives of the family Gammaridae prevailed quantitatively (> 96% of total biomass), the quantity and the biomass of benthic macroinvertebrates were higher than the quantitative parameters in the site situated before the hydropower plant which was conditioned by the existence of the thickets of macrophytes that had been formed due to the low velocity and the nutrient regime of the river and are preferable feed and habitat for the representatives of the family Gammaridae. The qualitative parameters of benthic macroinvertebrates decreased according to the observation sites situated before and after the hydropower plant which may have been conditioned by a decrease in dissolved oxygen level in the conditions of lower flow velocity and higher water temperature.
This work was supported by National Foundation of Science and Advanced Technologies, in frames of research project № YSSP-13-12.

Floods, droughts and water risks in a changing socio-hydrological context: Feedbacks between water resources and social systems

Methodologies for hydraulic hazard mapping in alluvial fan areas

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Abstract:
This paper discusses several criteria that can be introduced for the production of flood-related hazard maps currently used as a baseline for risk transfer, emergency management and land use planning. Hazard maps should convey to the stakeholders the physical meaning of hazard levels and contain the minimum number of subjectivity elements in order to produce reliable and sharable constraints. Specifically, this contribution is focused on hydraulic hazard mapping on alluvial fans, where floods often occurs as debris flows: in these settings, which suffer from growing levels of urbanization, hazard can be evaluated on the basis of geomorphic approaches or computed using numerical models. We argue that the numerical results provide the basis for rational and objective criteria, whilst geomorphic approaches should be used to define the main features of the event and to identify its boundary conditions. Most of the hydraulic hazard mapping criteria coded in National regulations are based on the direct use of the maximum values of flow depth and/or velocity only. Other approaches move from the evidences of several experimental studies about human and vehicles stability in a flood, that usually lead to inverse proportionality relationships of different complexity between water depth and velocity. In general thresholds values introduced by regulations appears as arbitrary and deprived of a physical justification. This paper presents the debris flow hazard criteria prescribed by the national regulations of Austria, Switzerland and Japan and compares them to a simple physically based model for human safety in a flood. The proposed approach verifies local human stability with respect to slipping failure under the effect of weight, drag, buoyancy and frictional forces. Finally, the resulting maps calculated for some Alpine debris flow events were quantitatively compared on the basis of the areal extension associated to each hazard level.

Changes in flood vulnerability, focused on private precautionary measures

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Abstract:
Flood risks emerge from extreme hydrological events and exposure of human activities. A large part of the observed upward trend in damage is assumed to be related to socio-economic factors, such as accumulation of assets and increasing vulnerability in flood-prone areas. There is a significant research gap in (semi-)quantitative studies on changes in vulnerability and its drivers.
This presentation will focus on the research question: How did flood vulnerability change in the past, focused on private precaution as one of the main determinants of vulnerability of private households.
To gain further insights into the long-term development of private flood mitigation measures, empirical data from flood-affected households in Germany are analyzed. Preliminary results show, that precautionary measures developed gradually over time among flood-prone households, with severe floods being important triggers for an accelerated implementation. Further drivers and their feedback mechanisms will be investigated to improve the knowledge about changes in flood vulnerability, which is important for improving flood risk analyses under changing conditions as well as for risk communication to further increase the level of preparedness of the flood-prone population.

Multi-model hydrologic prediction uncertainties analysis using parameter optimizing and Bayesian model averaging

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Abstract:
Modelling uncertainties (i.e. input errors, parameter uncertainties and model structural errors) inevitably exist in the hydrological prediction. Much attention has recently been focused on these, of which parameter optimizing and multi-model ensemble strategy are the two most popular methods to demonstrate the impacts of modelling uncertainties. This paper focuses on multi-model uncertainties analysis using parameter optimizing and Bayesian model averaging (BMA). The Xinanjiang model, Hybrid rainfall-runoff model and HyMod were applied to the Mishui Basin, south China, for daily streamflow simulation. The three models were firstly calibrated by two parameter optimization algorithms, namely, the Shuffled Complex Evolution (SCE-UA) and the Shuffled Complex Evolution Metropolis method (SCEM-UA); next, the simulation sets calculated from the three models were combined using BMA; finally, the prediction intervals for the signal model and merged simulations were estimated and compared. The results show that both the two parameter optimization algorithms generate good streamflow simulations, specifically the SCEM-UA can imply parameter uncertainty and give the parameters' posterior distribution. The BMA combination does not only improve the streamflow prediction precision, but also quantificationally give the uncertainty bounds for the simulation sets. The calculated 95% prediction interval from the merged simulations of SCEM-UA is excellent; while the calculated 95% prediction interval from the merged simulation of SCE-UA using monte carlo combination sampling is worse; however, it is still much better than that of corresponding singe model. These results suggest that considering the model parameters uncertainties and doing multi-model ensemble simulations are very practical for the streamflow prediction and flood forecast; from which we can generate more precision prediction and more reliable uncertainty bounds.

Changing Glacial Lakes and Associated Outburst Floods Risks in Nanda Devi Biosphere Reserve, Indian Himalaya

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Abstract:
Glacial lakes have increased in Himalayan region due to climate change during last century. Thesel lakes have been increasingly observed to breach out, leading to outburst floods (GLOFs) and debris flows. The GLOFs events cause huge loss to human society. Therefore, present study was undertaken to map glacial lakes, their increasing extent and associated damage potentials in Nanda Devi Biosphere Reserve (NDBR), Indian Himalaya. The glacial lakes were mapped on the recent Landsat TM5 satellite images (3-11-2009 and 6-11-2010) in combination with ASTER GDEM2 data. Major lakes were remapped on earlier MSS satellite images (15-11-1976 and 26-10-1979) to assess their changing characteristics, using change detection method. A few potential GLOFs sites have been studied for their damage potentials using site characteristics. Assessment of damage potential has been done in relation with previously occurred GLOFs. Five GPS aided field visits along with intense site photography were also made to different areas for verification of results. A total of 35 lakes were mapped, of which 17 are supra-glacial lakes, 5 cirque lakes, 4 lateral moraines-dammed, 3 end moraines-dammed and 6 other types of lakes. The altitude of lakes increases towards northern margins. As many as 14 lakes are located at more than 4500 m above msl. The size and damage potentials of glacial lakes have increased over the years. Unnamed lake on East Kamet glacier, Sitkeng, Geldhura and Hemkund has increased their area of 79952.2, 30430.9, 29543.9 and 27948.7 m2 respectively. Some lakes grew to the extent that they merged and formed a big lake. All of these are potential GLOFs and can cause severe damages to downstream. There are already many cases of GLOFs in NDBR that have caused severe damage to human society.

Past and future water demand under the combined impacts of anthropogenic and climatic changes: case study on two Mediterranean catchments

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Abstract:

Worldwide studies have shown that the Mediterranean region is one of the most vulnerable areas to water crisis due to an increase in temperature, a decrease in precipitation and growing human pressures. The Hérault (2,500 km², France) and the Ebro (85,000 km², Spain) catchments are representative of this context but differ in their physical and anthropogenic characteristics. Cumulated increases of population (Hérault +21%, Ebro +8%), irrigated areas (Ebro +29%), and industry observed in the recent past (1970-2009) point towards the necessity of considering the ability of these catchments to satisfy water needs. This evaluation in the recent past requires knowledge of the spatial, inter-annual and seasonal dynamics of water demands and of their main drivers (population distribution, crop types, irrigation practices, industrial sites, climatic conditions…) through a long-term historical reconstitution, and their inter-annual and seasonal variations. This work presents a method to integrate these key-variables in a conceptual modeling framework in order to estimate the evolution of water demands on each catchment. In the Hérault basin, domestic demands have largely increased since the 1970s and are characterized by a seasonal peak in summer. Agricultural demands have increased in the downstream sub-basins and decreased in the upstream ones where irrigated areas have decreased. In the Ebro basin, the increase in domestic water demands is slightly more moderate. In contrast, agricultural demands (87% of total water demand currently) highly increased mostly due to the expansion of irrigated areas (+22% in the 2000s), with a high seasonal variability. Future water demands were assessed for 2050 under the combined constraint of socio-economic and climate scenarios (downscaled from 9 IPCC-AR5 GCMs under RCP8.5). Results show that the impact of anthropogenic changes on total water demand (+6 to +25%) is more important than the impact of climate change (+7 to

How is climate science being used to inform water resource plans?

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Abstract:
Over the past 20 years, considerable effort has been invested in understanding and predicting the consequences of climate change for water resource systems. This has been justified as a response to the demand by water resource management agencies for information to incorporate in planning activities. Such investment suggests that climate science would be imbedded within current major planning activities. We investigated two significant water resource planning activities currently occurring in Mediterranean regions of the world: the Murray Darling Basin Rivers in Australia and the Sacramento-San Joaquin Bay Delta Rivers in the United States of America. In both regions, climate change is already altering water regimes and potentially has significant consequences for freshwater resources in the future. Both regions are important for agricultural production, environmental values, human populations and energy production resulting in complex planning environments in which multiple agencies and stakeholders are involved. Using a combination of detailed review of planning documents and interviews with key players and observers, we compared the two planning processes, focussing on the way in which climate science is being used to inform, or establish, sustainable limits to water extraction. Influence diagrams were created that identified the actual and potential use of climate science in both the technical and social components of planning. Contrasting approaches were evident: modelling played a larger role in the Australian case study, while stakeholders involvement was more prevalent in California. Neither made explicit use of climate science. The plans, and their implementation, must therefore be sufficiently adaptable as to incorporate climate science as they are implemented.

An Integrated Water Resources Management Strategy for Al-Ain City, UAE

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Abstract:
Al-Ain is the second largest city in the Emirate of Abu Dhabi and the third in the UAE. Its current population is about 650,000 inhabitants with an estimated annual growth of about 6%. Currently, desalination plants are the only source of drinking water in the city. The current average daily water supply to Al-Ain in is about 170 MIG (million imperial gallons); yielding a massive average per capita water consumption of about 1,200 liters per day. Recently, Abu Dhabi Urban Planning Council (UPC) released Al-Ain 2030 Plan. This plan contains vision of Al-Ain urban structure framework aiming to support the evolution of the city into a modern community. Although environmental sustainability was listed among its objectives, the plan, nonetheless, did not particularly demonstrate strategies to attain needed water resources in order to achieve its objectives. Water has always been the one necessary crucial commodity towards attaining sustainable development in any society. Projects suggested in this plan, over and above the expected natural population growth, will certainly put additional stress on the water resources in the city. With water use now being more than 25 times larger than its renewable water resources, Al-Ain city seems to be in urgent need for an integrated water resources management strategy towards achieving sustainable development. Therefore, the main aim of this paper is to develop an integrated water resources strategy for the city parallel to and supporting "Al-Ain 2030 Plan". This strategy will contain three main components; namely, a Water Demand Forecasting Model (WDFM), a Water Budget Model (WBM), and a Water Resources Optimization Model (WROM). The WDFM will estimate the future water demands in the city. The WBM will estimate all inflows and outflows to assess water resources sustainability in the city. The WROM will provide decision makers with the needed flexibility via implementing several management alternatives and conservation schemes.

Socio-hydrology of water scarcity in the United States – Mexico borderlands

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Abstract:
In complex social-ecological systems, human and physical processes mutually condition one another through co-adaptation at multiple scales from the local to the global. We modify a driver-response conceptual model of social-hydrological interactions by considering the degree to which each set of processes (human or physical) is simultaneously a driver and a response to global change. Processes that are mutually conditioned offer significant potential to adapt to demographic and economic change, on the one hand, and to climate, water resources, and ecosystems dynamics, on the other. By considering case material from the United States–Mexico border region, we characterize socio-hydrological interactions along a continuum from those acting exclusively as drivers to others reacting to change primarily as responses. We consider water resources to integrate multiple global change processes including climate change and variability, ecosystem resilience, and human water demands for a variety of purposes. We examine in detail two watersheds in the Arizona–Sonora borderlands representing a socio-hydrological systems. The Río Magdalena in Sonora is an illustrative case of smallholder agriculture and rural livelihoods engaged in adaption to water scarcity. Ambos Nogales relying on the binational Santa Cruz River and its associated aquifers is experiencing rapid urban growth. Here, human drivers of water scarcity raise concern for the medium- and longer-term implications of climate change. Adaption planning in Ambos Nogales is centered on infrastructure-based solutions including an inter-basin water transfer connection with the Río Magdalena, in which wastewater flows to riparian corridors pose a particular challenge for humans and the environment alike. Cross-border collaboration represents an important opportunity for adaptation. We summarize the analysis of both cases by raising conceptual questions for further enquiry and for adaptation and planning that are generic for the borderlands and beyond.

Irrigation beneficiary selection through Analytical Hierarchy Process

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Abstract:
Irrigation is an important element of the broader water resources management. This is particularly important in arid and semi-arid regions in order to ensure the food security. Like in many developing countries, Indian governmental agencies provide grants and subsidies to socially and economically weaker sections to support agriculture including developing irrigation facilities. One such system is *Ganga Kalyan* scheme being implemented in various parts of India. It involves providing government grants to poor to marginal farmers from socially weaker groups, referred to as backward classes. At present the selection process of the beneficiaries is carried out on an ad-hoc basis and at times the selection is carried purely by political factors. The present study focused on the development of an objective methodology to select the beneficiaries, who belong to socially weaker sections. We developed and tested a simple methodology by incorporating techno-socio-economic criteria through the use of Analytical Hierarchy Process (AHP) to select the beneficiaries of an irrigation development scheme meant for backward classes referred to as *Ganga Kalyan Yojana*. It involves a blend of socioeconomic and hydrologic criteria to evaluate the applicants and choose the beneficiaries based on the viability of the schemes. The AHP based approach is demonstrated using the data obtained from one of the blocks of Mysore District, in the state of Karnataka in southern India. The paper discusses the methodology and its testing process, and demonstrated its utility using the data collected from the Karnataka government agencies as well as through field surveys of beneficiaries.

Upping the social in socio-hydrology

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Abstract:
The new scientific decade 2013–2022 of IAHS on Change in Hydrology and Society “Panta Rhei” has a much needed emphasis on the social. However, the “socio-hydrology” that is beginning to emerge in the academic literature seems to be merely extending mathematical modeling methodology from hydrology to the realm of the social. We believe that reducing socio-hydrology to what can be modeled underestimates the true complexity of human-water interrelations. In particular, the political processes in which water resource problems originate, hydrological science is commissioned, conducted and used, and water management decisions are made need more emphasis. In this paper we focus on two ways in which the social could be enhanced in socio-hydrology: through connecting with the methods of the sociological and political sciences that have been analyzing human-water interrelations for decades; and through opening science up to civil society. We demonstrate with examples from our own research how interdisciplinary mixed methods and the plurality of perspectives in transdisciplinary collaboration can enhance both the practice of hydrological research and the solutions to water resource problems.

Conceptual analysis of water scarcity: towards an integrated approach crossing hydrology and social sciences

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Abstract:
Water scarcity differs from drought and aridity, as it is not exclusively a physical phenomenon. It refers to a lack of access to adequate quantities of water for human and environmental uses. Two distinct approaches are here presented to grasp processes leading to water scarcity. These studies focused on the agricultural sector in Spain, as it is the first European producer of fruits and vegetables. Moreover, it is one of the first countries to have been preoccupied by water scarcity issues, notably by setting up water management agencies. Water scarcity is first addressed from a hydrological perspective over the Ebro catchment in northern Spain (85 500km^2). An integrated framework modeling water resources and agricultural water demands is suggested. These main variables are confronted using a water allocation index in order to define water scarcity's current state and its evolution by the 2050 horizon. Although water allocation rules are considered, this approach lacks additional socio-economic information like the cost of the current system and its sustainability or its capacity to adapt. The second study explores the social dimension of water scarcity over the Campo de Dalías in Andalusia (330km^2). It is based on historiographical and institutional analysis of water use mode evolution over the last century. Unlike a-historical hydrological analyses, this social contingent approach emphasizes changes in water use rather than physical water shortage. Therefore, this paper highlights that water scarcity is a complex phenomenon that relies on water resources availability but also on water use and water management. Lacks expressed by each study can be overcome by a cross-fertilization of methods. Such integration aims at coupling synchronic results of the hydrological approach (comparative analysis of static pictures of current and future states) and diachronic understandings of social dynamics that shape the mode of water use. This is the subject of an ongoing research.

Ensemble scenarios for projection of runoff changes in the large Russian river basins in the 21st century

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Abstract:
The approach for the long-term scenario design of river runoff changes in the large Russian river basins in the first three decades of the 21st century includes two methods: a method of scenario estimations of runoff changes under probable climatic warming, which is based on generalization of the calculations made on the ensemble of global climatic models, and a method of alternative scenario estimations for water management complex transformation. The methodology described is based on the monthly water balance model of the RAS Institute of Geography. The range of probable climatic changes that is estimated by calculating deviations of climatic elements from their recent values is used as a climatic scenario. The calculations are made for the two scenarios with the most (A2) and least (B1) intensive rise of globally averaged air temperature. Simulation results obtained by using ten global climate models are employed. These were included in the IPCC program of the experiment "20C3M-20th Century Climate in Coupled Models" (Meehl et al., 2007). The climatic models were chosen from comparing the present-day observed and simulated climates (Kislov et al., 2008). The method for the long-term scenario projection of transformation of water management complex characteristics takes into account the available forecasts of population growth, indices of the development of the main economic sectors, and specific water consumption. Again, radical methods to prevent water resources deterioration are also taken into account. The results of the development of integrated scenarios are presented, with the Volga and the Don River basins taken as an example.

Developing Tools to Link Environmental Flows Science and its Practice in Sri Lanka

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Abstract:
The term "Environmental Flows (EF)" may be defined as "the quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems." It may be regarded as "water for nature" or "environmental demand" similar to crop water requirements, industrial or domestic water demand. The practice of EF is still limited to a few developed countries such as Australia, South Africa and the UK. In many developing countries EF is rarely considered in water resources planning and is often deemed "unimportant." Sri Lanka, being a developing country, is no exception to this general rule. Although the country underwent an extensive irrigation/water resources development phase during the 1960s through to the 1980s, the concept of EF was not/rarely considered. However, as Sri Lanka's water resources are being exploited more and more for human usage, ecologists, water practitioners and policymakers alike have realized the importance of EF in sustaining not only freshwater and estuarine ecosystems, but also their services to humans. Hence estimation of EF has been made mandatory in environmental impact assessments (EIAs) of all large development projects involving river regulation/water abstraction. Considering EF is especially vital under the rapid urbanization and infrastructure development phase that dawned after the end of the war in the North and the East of the country. This paper details simple tools (including a software package which is under development) and methods that may be used for coarse scale estimation of EF at/near monitored locations on major rivers of Sri Lanka, along with an example application to a location on river Mahaweli. It is hoped that these tools will help bridge the gap between EF science and its practice in Sri Lanka and other developing countries.

Analysis of flash flood scenarios in an urbanized catchment using a 2D hydraulic model

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Abstract:
In Italy, the growth of urbanization is increasing the flood risk due to minor water courses, especially in small and steep catchments where severe flash flood events can occur. The assessment of flash flood hazard calls for the application of new modelling tools, able to reproduce both the rainfall-runoff processes in the catchment, and the flow processes in the drainage network. Here, we propose the use of a simple 2D hydraulic model to analyse a flood scenario in a small valley within the city urban area of Bologna, in Italy. Historically, this area has been prone to severe flood events, the last occurring in 1932 and 1955. Since then, the urbanization of the lower portion of the catchment has significantly increased, while the natural stream bed has been partially replaced by a culvert. Therefore, the 2D hydraulic model was applied at catchment scale to simulate the possible effects of historical scenarios in the present catchment configuration. Rainfall and runoff data measured during recent rainfall events were used to calibrate model parameters. Model results show that the current culvert section would be insufficient to drain the runoff produced by intense rainfall events, with potential inundation of surrounding urban areas.

Individuation of rainfall triggering damaging hydrogeological events: a methodological approach applied to Calabria (Italy)

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Abstract:
The paper deals with Damaging Hydrogeological Events (DHEs), defined as episodes of severe weather conditions characterized by heavy rainfall, landslides, flooding, and sea storms. DHEs habitually cause economic and human-related damage, in both rural and urbanized sectors. Each type of phenomenon developing during DHEs is characterized by a proper dynamic and, according to the social and economic framework in which develops, it can cause different impacts. Despite during storms all these phenomena occur at the same time (or in a short while), often strongly amplifying damage and hinting emergency management, studies available in literature tend to analyze each type of phenomenon separately, supplying a fragmentary framework of either causes (rainfall) and effects (damage). For this paper, a database concerning DHEs which occurred in Calabria (southern Italy) in a 30-year period (1981-2010) has been updated and improved by in-depth historical research. Among the numerous DHE occurred in the study period, the focus is on the severest cases, in terms of economic damage and losses of life. For these cases, the systematic analysis of the available historical series of daily rainfall allowed the individuation of a series of typical rainfall-damage scenarios. The paper presents a methodological approach to both individuate and analyze the events. The performed analysis of collected data allows individuating complex rainfall thresholds (both daily and cumulative) that are able to trigger DHEs on the different regional sectors. The results can be fruitfully used for zonation of the study region according to the susceptibility to be affected by DHEs.

Phanta Rhei and the Hydrological Dilettante

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Abstract:
The late Professor Vit Klemeš in his provocative 1986 article published in Water Resources Research, argued that there was a lack of theoretical recognition for hydrology as a discipline in its own right, and criticised hydrologists for being “dilettantes who toy with the subject or study it lightly". In this paper, we argue that the past 25 years have seen significant advances in developing the conceptual and theoretical basis for hydrology as a discipline, that it is now well respected as a profession and it's teaching and training at undergraduate and post graduate levels is well established. We may not be a mature discipline, but we have certainly grown up!
However, the very real need to ensure the relevance of the discipline to address the massive changes facing society in the future (the anthropocene) as argued for by Wagner et al in 2010 and exemplified by the intention of the next hydrological decade i.e. Panta Rhei, also presents the risk that hydrologists will once again become dilettantes - perhaps not in their own discipline, but in others. We argue that if hydrologists are to make a meaningful contribution to future water resources management, then we need to do so from a position of disciplinary strength and not dilute our efforts by dabbling (becoming dilettantes) in other disciplines. Rather, hydrologists must recognise and respect the ethos, integrity and professionalism of disciplines that we may not have been often exposed to, and involve scientists and practitioners from those disciplines as collaborators in projects and on their teams in a truly transdisciplinary way, rather than develop “new” sciences and take on these responsibilities ourselves.

Floods hazards maps in Matucana Village under climate change scenarios

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Abstract:
Possible effects of climate change on floods magnitude y vulnerability are discussed in this document based on existing data and projected changes in precipitation until 2099. This methodology is applied to Matucana Village, which is vulnerable to floods and debris flows.
First, historical peak precipitation are fitted to a probabilistic distribution function and a probable maximum precipitation is estimated to different return period; according with data, Gumbel distribution was accepted. Then, percentage projected changes of precipitation are used to obtain projected maximum precipitation time series until 2099. After that, projected time series are used to estimate new probable maximum precipitation by considering the same probabilistic distribution function. Finally, peak flow hydrographs are estimated and hazard maps are plotted.
A first analysis shown that February is the wettest month and their projected changes were chosen to build the projected peak precipitation time series.
This application is possible because Matucana is located in a climatologically homogeneous basin.
Analysis was made using changes projected by the ECHAM4/OPYC3, HadCM3 and NCAR PCM models include in the IPCC Fourth Assessment Report because these have the highest spatial resolution. The interval defined by these models was considered like a variability interval and analysis considered three scenarios: mean scenario, with mean changes projected; and minimal and maximum scenarios, defined by the lowest and highest changes projected.
The final results suggest an important increase in magnitude and affected area by floods in the next 90 years under the A1FI emission scenario.

Assessing risks for integrated water resource management: coping with uncertainty and the human factor

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Abstract:
Integrated water resource management requires an accurate assessment of the risks associated to the different soil-use and water-allocation planning alternatives. Risk assessment in arid and semiarid areas must deal with the uncertainty associated to excess/scarcity extreme events occurrence and magnitude, together with the costs associated to their consequences. But the latter is very much dependent on the intervention of man on the territory; the previous actions already performed, devoted to increase water security (e.g. flood mitigation, reservoir storage increase, modernization of conduits and irrigation techniques), usually involve an indirect "call-effect", due to which the territory occupation or water use is increased following the enhanced protection achieved by such actions. This work shows representative examples of such situations in Mediterranean watersheds: flood and water demand in selected sites in Southern Spain are assessed by means of the stochastic simulation of extremes in the medium and short term, and the comparison of the final conclusions derived when human factor is/is not considered. The results show how not including this call-effect induced an underestimation of flood risk after protecting the floodplain, ranging between 15 and 60% when the human factor was not considered (from the adoption of the observed occupation increase rate in neighbouring areas) in a 15-yr planning horizon, which eventually was below the estimated risk associated to the decision of not protecting the area. Similarly, the water saving due to the shift towards highly efficient irrigation systems resulted in a scarcity risk increase up to a 38% when the observed trend of expanding the irrigated area as a result of the higher water efficiency was included in the simulations. The need of including this interaction in the decision-making assessment tools is highlighted from these results, especially when water availability is a socio-economical constraint.

Feedback between societal change and hydrological response in Wadi Natuf, a karstic mountainious watershed in the occupied Palestinian Westbank

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Abstract:
Runoff observations with high spatial and temporal resolution before, during and since the Intifada in the occupied Palestinian West Bank allow for new insights into the feedback between changing social systems and hydrological response under changing land forms. Lacking land control and infrastructure, movement restrictions and tight closure regimes, intensive settlement expansion and mushrooming unregulated solid waste dump-sites impact on runoff generation, groundwater recharge, flow patterns and rising water quality concerns. Long-term monitoring results from a 105 km2 Mediterranean climate catchment are presented. More research will strengthen these linkages. Short- to long-term technical protection measures are suggested. Changing socio-hydrological context of land sovereignty and equitable water rights remain paramount for addressing the chronic water crisis, establishing more symmetrical access and sustainable management of the shared water resources.

Human managed landscapes in transformation: potential water resource boundaries in a semiarid agricultural catchment of Burkina Faso

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Abstract:
Transforming landscapes for benefiting human wellbeing, economic development and environmental sustainability continues to alter natural water cycles resulting in adverse impacts at multiplier scales. The challenge to improve water resources management to deliver multiple benefits increases as demands for functions and provisions of water related services also increase. One particular rapid transformation is the development of agriculture in low income environments requiring high demand of water inputs tor agricultural production. We present an example of a typical transforming landscape in the semi-arid sub Saharan Africa context which is dominated by savannah and rainfed smallholder agriculture. The study area in Burkina Faso, is 1000 km2 catchment size, having significant rainfall and has undergone major land use change over the last 50 years due to human development. We use the Soil Water Assessment Tool (SWAT) and complementary livelihood assessments to explore changes in the water balance of the catchment over time and examine the potential to increase agricultural production through improvements to soil fertility and increased irrigation. We discuss broader implications on hydrological partitioning in terms of the potential livelihoods benefits from water–supported resilient food production for both income and food security; on water storage and availability; and the implications on water–related ecosystems functions and services. As a preliminary conclusion, we see development in dryland areas shifting water availability both spatially and temporally. Whilst these create local significant impacts, as yet, small or no significant impacts are found at the basin scale. The challenge therefore remains how to secure the water functions for environmental sustainability such as biodiversity habitat maintenance in the face of growing human demands: can we develop co-benefits in heavily transformed landscapes in these environments?

The Interplay between Human Population Dynamics and Flooding in Bangladesh: A Spatial Analysis

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Abstract:
In Bangladesh, socio-economic and hydrological processes are both extremely dynamic and interrelated. Human population patterns are often explained as a response, or adaptation strategy, to physical events, e.g. flooding, salt-water intrusion, and erosion. Meanwhile, many physical processes are exacerbated, or mitigated, by diverse human interventions, e.g. river diversion, levees, and polders. In this context, the paper describes an attempt to explore the interplay between floods and societies in Bangladeshi floodplains. In particular, we performed a spatially distributed analysis of the dynamic inter-link between the occurrence of extreme flooding events and the patterns of (formal and informal) human settlements, over the past 25 years. To this end, global datasets of population distribution data, such as the Gridded Population of the World, and flooding simulation results from inundation modelling, LISFLOOD-FP, were exploited. The outcomes of this work highlight the behavior of Bangladeshi floodplains as complex human-water systems and indicate the need to go beyond (potentially simplistic) narratives based on one-way cause-effects, e.g. climate change leading to migrations.

Understanding and improving water-society interactions under environmental change in a digital world

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Abstract:
To be able to understand, predict and manage water-society interactions under environmental change, there is a need to integrate the physical, social and digital aspects of catchment as integrative community science learning platforms. Falkenmark highlighted over a decade ago that the greatest water problem was the inability to link water, food and environmental security. This presentation will focus on providing a vision supported by examples from my research on what is required to improve our understanding and managing of cross-scale benefits and trade-offs between water and food security objectives. It is widely recognized that systems based integrative research are required. Modellers have key roles to lead and facilitate integrative research, as well as being technical experts. Facilitating understanding of problematic situations requires awareness and experience of relevant techniques. I will provide examples that include structured templates and soft systems methodology. Integrative research involves interdisciplinary teams of research and non-research experts and necessitates an understanding of optimizing multi-level supportive conditions for integrative research. Our ability to collect high temporal resolution data on multiple water variables is providing new process insight into the interactions between water and food security from the field to catchment scales. I will demonstrate this based on two research projects on temperate grassland systems in the UK. To be able to understand and improve water-society interactions in the 21st century demands utilizing digital technologies, including cyberinfastructure. Using the recent RCUK WikiRivers and Environmental Virtual Observatory (pilot) projects, the importance of integrating natural, social and computing science approaches to understand and improve water-society interactions will be demonstrated.

Variability of irrigation water use in a data-scarce region of North India

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Abstract:
The Green Revolution has transformed India from a famine-prone, drought-susceptible country into the worlds' third largest grain producer and one of the most intensively irrigated parts of the globe. This has been encouraged by successive governments whose policies have provided subsidised energy, seeds and fertilizer, and in many areas purchase guarantees for grain. This transformation however has had a significant impact on water resources in the region and, while there is a reasonable understanding of larger-scale regional effects, potential impacts of local variations in irrigation behaviour are not as well understood. Local-level understanding is key to identifying areas of water stress and to determining sustainable water use policies for the future. We analyse and present results from over 100 recently conducted farmer interviews in the data-scarce districts of Jalaun and Sitapur on the Gangetic Plains of Uttar Pradesh. Hotspots, where water resources are particularly at risk, are identified using variables such as volume and timing of water applied, energy source and costs incurred. Outputs are visualised and mapped using qualitative data analysis within a GIS framework. Large differences between districts emerge: for instance, in the region of Jalaun the availability of cheap canal water has counterintuitively enabled farmers to invest in more water-efficient technologies such as sprinklers, a practice not found in Sitapur, which depends almost exclusively on groundwater. Results are used to delineate the spatial variability in water use practices, along with farmer behaviour and decision making. Primary data are compared with socio-economic information taken from regionally produced statistical abstracts. The combined data are used to identify the main drivers that influence farmer decision-making, which is in turn leading to groundwater overdraught in many parts of North India.

Optimal integrated management of groundwater resources and irrigated agriculture in arid coastal regions

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Abstract:
Groundwater systems in arid coastal regions are particularly at risk due to limited potential for groundwater replenishment and increasing water demand, caused by continuously growing population. For ensuring a sustainable management of those regions, we developed a new simulation-based integrated water management system. The management system unites process modelling with artificial intelligence tools and evolutionary optimisation techniques for managing both water quality and water quantity of a strongly coupled groundwater-agriculture system. Due to the large number of decision variables, a decomposition approach is applied to separate the original large optimisation problem into smaller, independent optimisation problems which finally allow for faster and more reliable solutions. It consists of an analytical inner optimisation loop to achieve a most profitable agricultural production for a given amount of water and an outer simulation-based optimisation loop to find optimal groundwater abstraction pattern. Thereby, the behaviour of farms is described by crop-water-production functions and the aquifer response, inclusive seawater interface, is simulated by an artificial neural network. The methodology is applied exemplarily for the south Batinah region/Oman, which is affected by saltwater intrusion into a coastal aquifer system due to excessive groundwater withdrawal for irrigated agriculture. Due to contradicting objectives like profit-oriented agriculture vs. aquifer sustainability, a multi-objective optimisation is performed which can provide sustainable solutions for water and agricultural management over long-term periods at farm and regional scale in respect of water resources, environment, and socio-economic development.

Small watershed management as a tool of flood risk prevention

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Abstract:
According to the International Disaster Database (CRED 2009) frequency of extreme hydrological situations on a global scale is increasing continually. The most typical example of a natural risk for Europe is a flood – there is a decline in the number of victims, but a significant increase in economic damages. Decrease in the number of victims is caused by the application of current hydrological management that focuses its attention primarily on large rivers and elimination of the damages caused by major flood situations. The growing economic losses, however, are a manifestation of the increasing intensity of floods on small watercourses which are usually not sufficiently taken into account by the management approaches. The research of small streams should focus both on the study of the watercourse itself, his ecomorphological properties, and in particular the possibility of flood control measures and their effectiveness. An important part of society's access to sustainable development is also the evolution of knowledge about the river landscape area that is perceived as a significant component of global environmental security and resilience, thanks to its high compensatory potential for mitigation of environmental change. The findings discussed under this contribution are based on data obtained during implementation of the project "GeoRISK" (Geo-analysis of landscape level degradation and natural risks formation), which takes into account the above approaches on the example of several model sites – catchments of small streams in different parts of the Czech Republic. It is therefore the potential opportunities for practical application of field research knowledge in decision making processes within the national level of current water management.

Remediated Urbanism. How to make an environmentally and socially responsive waterfront through the minimization and remediation of contaminated stormwater.

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Abstract:
The consequences of increased urbanisation for deleterious hydrological outcomes, such as flooding and the production of contaminated stormwater, are widely understood. The construction of the contemporary waterfront is a well-recognised development trope that encapsulates these larger issues on one site. The production of this particular exemplar of urban development is skewed toward the spectacle while simultaneously anchored to a thirty-year-old real estate planning methodology. Contemporaneously with the production of this template is the elision of a series of environmental problems; sometimes as part of the existing site like contaminated soils, sometimes as the result of the construction process, like the increased discharge of contaminated stormwater. This paper explored the development of an alternative-planning regime that privileges the minimisation and remediation of stormwater. Using hydrological modeling software the author explores through the construction and testing of a sub catchment based model the hydrological consequences of a proposed waterfront development. In subsequent iterations the effect of various minimization and remediation regimes are measured. The consequences of this modeling work are explored in a series of speculative planning exercises where conventional Floor Area Ratio modeling of the building programme is modified to allow for the expected commercial return while the ground plane is reconfigured. The implications for new public space are explored, one in which the simulacra of traditional urban space are exchanged for the benefits of ecological restoration and remediation.

Socio-economic Effect on Socially Deprived Communities by Developing Drinking Water Quality Problems in Arid and Semi-arid Area of Central Rajasthan

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Abstract:
Rajasthan is well known for its Great Thar desert. Central Rajasthan has arid to semi-arid environmental. The area faces either scarcity of water or poor quality of drinking water. In some area water is transported from 2 km or more which consume time, energy and money. Rich people have their own sources which is restricted for use to other. Such conditions are affecting socially deprived community both socially and economically. Groundwater is major source of drinking water due to unavailability of surface water. There is a lack of groundwater quality knowledge to the community and data available are hard to understand by consumers. The CCME Water Quality Index is a tool to simplify water quality report by rating the water on quality standards. It provides meaningful summaries of overall water quality and trends, which is accessible to non-technical lay people. In the present study the objective is to examine the groundwater quality of 6 districts (viz. Ajmer, Bhilwara, Pali, Rajasamand, Nagaur and Jodhpur), centrally located to Rajasthan with arid and semi-arid conditions. CCME WQI is also evaluated to produce quality data in a form to be understood by community. 4369 groundwater source of 1680 villages from 6 districts (76,546 Km^2.) are collected and examined. Results are framed in Bureau of Indian Standards (BIS: 10500, 2012) and 2952 sources are unsafe for drinking. According to CCME WQI groundwater of 93 villages is poor, 343 villages are marginal and 369 villages are fair in quality. Toxicological studies of unsafe drinking water and their remedial measures are also discussed. A tentative correlation between prevailing water-borne diseases and quality parameter has also been shown.

Water Resources Management: A Traditional Technology and Communities are parts of Solution

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Abstract:
The state of Rajasthan, the largest State of the country has also one of the most critical status of water. Rajasthan with more than 10.4 % of the country's geographical area, supporting more than 5.5% of the human population & 18.70 % of the livestock has only 1.16 % of the total surface water available in the country. 2/3rd part of the State is a part of the Great Thar Desert and out of the total 142 desert blocks in the country, 85 blocks are in the State of Rajasthan. The per capita annual water availability in the State is about 780 cubic meter (Cum) against minimum requirement of 1000 Cum. It is feared that the availability would fall below 450 cum by the year 2050. Thus increasing population coupled with erratic rainfall further aggravates the water crisis.
This has been amply demonstrated by the successful experience of local communities in Alwar District in Rajasthan. It is possible to harvest and augment water resources through the construction of small water harvesting structures called Johads and the implementation of local water governance. Since 1985, 8,600 Johads have been built in 1,086 villages. This has resulted in the rise in water levels in the shallow aquifer, increase in the area under single and double crops, increase in forest cover and drinking water supply security. The water collected in a Johad during monsoon penetrates into the sub-soil. This recharges the ground water and improves the soil moisture in vast areas. The water in the Johad can be used directly for irrigation, drinking water by animals, and other domestic purposes. The other advantage of this structure is that it checks soil erosion, mitigates floods, and ensures water availability in wells or boreholes used for drinking water supply, even for several successive drought years. Also, during the dry season when the water gradually recedes in the Johad, the land inside the Johad itself becomes available for cultivation.

A probabilistic model for predicting seasonal rainfall in semi-arid lands of Northeast Brazil

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Abstract:
For most part of the Northeast region, Brazil, rainfall is relatively low, presenting significant inter-annual fluctuations, especially when compared to rainfall in other areas of Brazil. Moreover, evaporative rates, as the ones found in the Northeast semiarid are too high, reaching sometimes 2,800 mm annually. Owing to such a climatic character, very large areas in Northeast Brazil are subjected to recurrent droughts. This paper presents a methodology based on a model proposed by Silva for the prediction of seasonal rainfall in semiarid lands of Northeast region of Brazil. Seventy-two rain-gauge stations were employed, all of them distributed in three mesoregions of the study area. A rainy season (RS) with different subdivisions was established for each mesoregion. The Zi proportions - the ratio between the cumulative rainfall of the first RS period (Xi) and the rain that fell during the whole RS - were made to fit the Beta probabilistic model used for calculating the first and fourth *quintis* and the probability of rainfall above the climatologic average for the RS second period (Yi). The performance of the prognostic model for the period 1996 -2000 was evaluated.
In the period 1996 to 200 0, with rainfall above Yi average, the margin of error was less than 20%, except for the RS8 in 2000. In 1998 - a very dry year - the margin of error was over 20 %; this for the prognostic of a minimal total rainfall. The methodology adopted proved very accurate for forecasting droughts in Northeast of Brazil.

Water, a limiting factor for economic development in the Kandi region of Jammu, India: novel way to mitigate the problem for food security

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Abstract:
The Kandi region of Jammu is characterized by low mean annual precipitation values and water scarcity. The whole region is affected by droughts, lasting for 1 to 4 years with a return period of 2 to 3 years, on average. The consequences are economic losses, environmental degradation, desertification, soil impoverishment and social disorder. The region could not develop economically, water scarcity being one of the major factors. A field study was conducted to exploit existing soil moisture, for enhancement and conservation. After the rainy season, the soil moisture drops to about 4 to 6% during November, the time for sowing of winter crops. Indigenous plough, which does not inverts the soil but simply loosen it, was used for breaking the capillary movement of water and, thus, considerably reducing the soil moisture loss due to evaporation. The field was ploughed early in the morning, 2 to 3 hours before the sun-rise, keeping the furrows open to imbibe dew water. The soil furrows were closed properly before the sun-rise by a heavy leveller to avoid loss of soil moisture through evaporation. The ploughing operation was done 5 to 6 times during October for retaining sufficient moisture and improving physical condition of the soil for optimum germination of crop seeds. The study showed that at least 5 ploughings are necessary during October for optimum soil moisture conducive for seed germination. The soil moisture increase varied from 3% to 16% with the number of ploughings from 1 to 5, before sowing. The seed germination was above 90% at soil moisture of 16% and above; whereas the germination per cent was much below at lower ploughing rates. Optimum crop stand ensured two to three times higher crop yields compared to the yields obtained from plots where the ploughings were done only 2 to 3 times.

Water use and Sustainable Social-economic Development of Yulin city in Northwest China

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Abstract:
Understanding the nexus between water resources and economic development is very important to forecast future water demand as well as to manage water resources. A model has been proposed in this article to calculate economic elasticity of water use. The model has been applied in the Yulin city of China to assess the changes of water use in the city with economic development. The results show that the average economic elasticity of water use in Yulin city is 0.196. The study reveals that water use and economic elasticity of water in Yulin have declined over the time period 1990-2005 due to industrial structural adjustment and the introduction of innovative technologies and management. This indicates water demand management through optimization of industrial structure and water-saving technologies can improve water supply-demand balance to ensure continuous water supply growing economy for a long term.

Evaluation of the best fit distribution for partial duration series of daily rainfall in Madinah, West of Saudi Arabia

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Abstract:
Rainfall frequency analysis is still essential tools for most water related infrastructure design. It can be used to predict the frequency and magnitude of future rainfall events. This study involves with the rainfall analysis using partial duration series (PDS) in arid region at Madinah area, West of Saudi Arabia. The different statistical distribution tests will be used (i.e. Normal, Log Normal, Gumbel, Generalized Extreme Value, Pearson Type III, Log Pearson Type III) and the parameter of these distributions were estimated using L-moments methods for selection of the best fit statistical distribution. Also, different model selection criteria are applied such as Akaike Information Criterion (AIC) Corrected Akaike Information Criterion (AICc), Bayesian Information Criterion (BIC) andAnderson-Darling Criterion (ADC). The results showed that the advantage of Generalized Extreme Value for Madinah partial duration daily rainfall series as the best fit statistical distribution for Madinah Daily rainfall.

On the use of DPSIR model to two basins in the Northern of Algeria. Socio-economic pressions

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Abstract:
This research has an objective to determine the effective variables in socioeconomic category of Integrated Water Resources Management for Saf-Saf and Seybouse basins characterized by fast growing demand of urban and rural populations and the demand of economic sectors including industry and agriculture. In this paper, the artificial neural network models were used to model and predict the relationship between water resources mobilization and socioeconomic variables. The results indicate that the feed-forward multilayer perceptron models with back-propagation are useful tools to define and prioritize the most effective variable on water resources mobilization and use. The model evaluation shows that the correlation coefficients are more than 94 % for training, verification, and testing data. The model aims to link the water resources mobilization and driving forces variables with the objective to strengthen the Integrated Water Resources Management approach.

Effects of minor drainage networks on flood hazard evaluation

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Abstract:
Scientific literature reports a plethora of numerical tools of different complexity (e.g. 1D, 2D raster-based or full 2D models) for flood hazard and flood risk evaluation. The correct identification of the appropriate model still represents a key aspect in the overall flood hazard process even though the potentialities of these modelling instruments are emphasized by the availability of high computational resources and by the amount of high-resolution topographic data provided by recent survey techniques. In this context the present analysis investigates the effects of minor drainage networks on the estimation of flood hazard in a flood-prone area along the Enza river, close to the village of Sorbolo a Levante (RE, Northern Italy). By means of a full 2D hydraulic model (Telemac-2D), the effects of the drainage system is analyzed using three unstructured meshes with different degrees of complexity: 1) the minor drainage system allows the possibility to convey water outside the study area (REF); 2) the drainage system is reproduced only in terms of preferential flow-paths (REF-noFlow); 3) the drainage network is completely neglected (REF-noDN). The analysis points out that the maximum flood extent seems not to be influenced by the mesh schematization while water depths and the total volume are significantly related to the model schematization. Even if this analysis refers to a specific case study and further investigations are needed, it shows the fundamental role of the drainage network in controlling water depth distribution and the duration of the inundation, which should be accurately reproduced by numerical models.

Panta Rhei: an evolving scientific decade with a focus on water systems

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Abstract:
The paper presents an overview of the activity of Panta Rhei, the research decade launched in 2013 by the International Association of Hydrological Sciences. After one year of activity Panta Rhei already stimulated several initiatives and a worldwide involvement of researchers in hydrology and sister disciplines. Providing an overview of the status of Panta Rhei is essential to further promote the participation of scientists and the completion of its structure, that is currently being shaped by receiving Research Themes and Working Groups proposals from the community.

Understanding the dynamics of an agricultural community under water stress: The socio-hydrological system of the Ancient Maya

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Abstract:
Fine-tuning their way of life to the local environment has allowed many societies to rise over the course of history. Despite (or maybe due to) this highly specialized behavior, these societies have still been vulnerable and many of them have disappeared. One example are the ancient Maya who occupied the Maya Lowlands (parts of present day Mexico, Guatemala, Belize) from around 2000 BC to AD 800. Although many hypotheses exist on why the Maya Lowlands became depopulated in a relatively short period of time, the role of climate, especially the occurrence of several droughts, is increasingly acknowledged. This study aims to provide insight in the processes that occurred during the rise and fall of the Maya civilization through socio-hydrologic modeling. This is done through the application of a general, stylized model, built within the spirit of the Easter Island model by Brandner and Taylor. The model aims to capture the interactions between the hydrological and social system that give rise to the long-term dynamics. Advancement of technology employed in a smart way by the elite has allowed the Maya society to grow until unprecedented city states. At the same time, they approached the limits of the local carrying capacity, especially in the face of climate variability.

An assessment of future surface water levels of the Lake Chad and consequences on livelihoods

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Abstract:
The Lake Chad has once been on the largest Lakes in the world but has undergone a drastic reduction in size to less than one tenth of its original size as a result of climate variability and anthropogenic activities. The ultimate aim of this study is to assess the future surface water levels in the lake chad with respect to projected climate, specifically rainfall, river discharge and the impacts on the livelihoods . The assessment is based on precipitation model data of the IPCC's AR4 simulations and two EUWATCH project model data sets of discharge and Lake Chad surface storage. The results of the predictions indicate that there will mixture of increase and decrease in precipitation, river discharge and surface water level of the Lake Chad by 2050 but majority reveals reduction rate which will increase the impact on the basins livelihood defendants. This reduction is expected to negatively affect the livelihoods of the dependent communities thus, in the end, policy options are proposed to lessen this situation.

Does the Demand Responsive Approach (DRA) in Ghana's rural water delivery ensure improved functionality and equitability in a sustainable manner?

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Abstract:
A concern on adaptation to environmental change puts greater emphasis on the need to address water source sustainability. Demand Responsive Approach (DRA), adopted as a national policy for rural water delivery in Ghana is an attempt, within a decentralized programme to improve the efficiency of service supply and also to make *users take key decisions about the service they want and are willing and able to pay for* (Wedgwood, 2005). It was developed after the failure of supply-led approaches to increase sustainable water coverage (Wright, 1997). Currently, the DRA has become a cornerstone of government and donor water supply policies throughout the world. DRA is crucially referred to in Funding proposals, Country Action Plans and Implementation Manuals, and it is hard to find funding agencies that do not claim to be implementing DRA-based projects in developing countries (Breslin, 2005). The idea behind DRA is that, it ensures transparency and accountability and in the long term achieve sustainability since beneficiaries feel a sense of ownership towards the project. Sara and Katz (1998) reinforce the assumption that DRA significantly increases the sustainability of water supply projects. In the Shai – Osudoku District of Ghana, a purposive sampling method used in examining 200 households in four communities revealed that DRA based facilities adequately met their water requirements. Financial management which is crucial for the continuous functioning of the water facilities is a major setback. The approach does not address equity concerns thereby inhibiting those who cannot genuinely afford. The study recommends periodic financial management training to beneficiary communities for assured sustainability and also makes provision for the economically deprived.

Impact of human activities on groundwater quality Case of Tebessa area; NE Algeria

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Abstract:
Groundwater is exposed, more and more intensively, to deliberate discharges of polluting effluents, sewage or storm water runoff in urban areas. Near cities, the sources of groundwater contamination are numerous and are related to many urban activities. The urban water is a source of contamination of groundwater by their concentration in organic and inorganic constituents. However, their origins can be complex and include stormwater, wastewater leakage networks. Leachates of municipal waste, septic tank are considered as sources of contamination and carry pollutants that have major environmental impacts on water resources available.
In the Oued El Kebir basin in Tebessa, increased industrial and agricultural activities, and the alternative by-products of production or post-consumer waste, make groundwater resources vulnerable. The plan changes leading to changes in groundwater levels by pumping in urban areas can also lead to contamination of interconnected flows. The impact may be a hydrological from substantial exploitation of the resource has an action on the hydrodynamic behavior of the aquifer.
In this perspective, we try to examine the state of the groundwater resources of Tebessa plain, the last cut by the Oued El Kebir, which drains the wastewater from the entire urban area of the city and which location can contaminate groundwater.

Vulnerability assessment from SINTACS DRASTIC methods: The case of phreatic aquifer Bazer GueltZerga (North East Algerian)

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Abstract:
Groundwater is an important resource exploited for human consumption and for use in agricultural and industrial areas. These waters are often threatened by contamination by pollutants of various kinds: biological, chemical or physical. Prevention against groundwater pollution is an important step to which scientists agree more effort, particularly by studying the vulnerability of groundwater. The term vulnerability to pollution of an aquifer is defined as its inherent susceptibility to changes in the quality and quantity of groundwater in space and in time, because of the natural process and / or the anthropogenic activity. Bazer - GueltZerga the region has experienced considerable growth in agriculture, urban and industrial. This has increased the need for drinking water, irrigation and industry on the one hand and on the other hand, the water resources of the shallow aquifer that have been overexploited and polluted. This work was done in order to create maps of vulnerability to pollution by inorganic pollutants using the following parametric methods: the standard and the DRASTIC method SINTACS and assessment of vulnerability to pollution resources aquifer water surface area Bazer - Gelt Zerga.

Evaluation of Quantitative Precipitation Criterion (QPC) derivation for mountainous flash flood

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Abstract:
The damages from flash flood caused by torrential rains have increased in the world. Korea is also no exception from the damages. One of the typical remedies to reduce the damages is to develop a flash flood warning system. Because of complexity of the calculation process, it is difficult to secure the time for evacuation from the flood. In this study, we propose a method to derive the Quantitative Precipitation Criterion (QPC) for judging the mountainous flash flood. For the QPC derivation, geophysical and hydrological data for headwater basins in the mountainous regions are extracted. And then, Threshold Runoff (TR) and Flash Flood Guidance (FFG) are computed for the past historical rainfall events that cause flash flood in the mountainous regions. The ROC (Receiver Operating Characteristic) analysis is followed for finding QPC that represents the virtual rainfall providing the maximum value of ROC scores. The FFG, observed mean areal precipitation (MAP) and virtual rainfall (VR) with 1 mm increment are used for the computation of ROC scores. Finally, the QPCs are derived as a function of basin area and the relationship between precipitation and basin area (called P-A curve) is derived. The characteristics of P-A curve reveal that 42mm/hr rainfall is the threshold value for less than 40km2 watershed area and 32mm/hr rainfall is the value for 40~100km2 watershed area. To validate the adaptability of developed P-A curve, the observed rainfall data was used. This study is worth developing the quantitative criterion of flash floods in mountainous region.

Evaluation of urban flash flood forecast using flow nomograph & radar rainfall

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Abstract:
There has been developed many structural and non-structural measures to reduce the urban flood and flash flood damages. However, the damages from the flood caused by torrential rains have steadily increased due to the impacts of abnormal weather and urbanization. The enhancement of flood warning system and the use of high-resolution radar rainfall estimates are crucial for reducing the damages. Another essential point for the urban flash flood forecasting system is to secure the forecast lead time. The development of flow nomograph and its radar rainfall application can be a solution to overcome this problem. In this study, we will evaluate the urban flash flood forecasting model that composed of flow nomograph and radar rainfall estimates at the Cheonggye stream in Seoul, Korea. The Cheonggye stream is famous area for an urban restoration project in the world. Flow nomograph is a chart that represents various rainfall conditions (rainfall intensity and duration) causing flood at certain location of the river basin. To evaluate the applicability of radar rainfall in flow nomograph, the rainfalls are estimated from radar reflectivity data using Z-R relationship and adjusted the estimates using bias adjustment methods for improvement of the rainfall estimate accuracy. To validate the adaptability for the developed flow nomograph at various stations in the Cheonggye stream, the 10 rainfall events are selected and corresponding actual observed water level data are collected in this study. We concluded that the use of flow nomograph and radar rainfall estimate for the urban flash flood forecast is feasible in this study area.

Analysis of drought characteristics using the bivariate joint drought index

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Abstract:
Drought is one of the serious natural disasters along with the flood, which occurs in 2-3 year cycle in South Korea. The characteristics of drought are widespread and gradually developing. It is difficult to investigate the occurrence time, scale, scope of drought. Many researchers have quantitatively analyzed drought characteristics using the drought index. Drought index is an important factor for determining the characteristics of drought. However, there is a problem that has a different criteria and analysis methods. Furthermore, most of drought indices using the hydro and meteorological information do not properly represent the characteristics of drought in the particular region. In order to clearly show the characteristics of drought, it is necessary to use drought index considering two or more variables rather than the single variable. In this study, duration and severity of drought were calculated using bivariate joint drought index based on precipitation and soil moisture. After that, the bivariate frequency analysis considering severity and duration of drought was performed. The analysis of the regional drought characteristics at 59 weather observation stations in Korea was performed. The return period was calculated considering severity and duration. In addition, the quantitative return period obtained from this bivariate joint drought index was presented for the past observed drought event in Korea, as compared to the results of frequency analysis of the existing drought index (precipitation, soil moisture).

Do subtle eco-hydrological human abilities have a place in water resources planning?

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Abstract:
There is evidence, though contentious that human thought impacts on other living organisms and also inanimate matter and in particular water. Carefully controlled experiments have shown how human thought can alter the PH of water by up to one unit. Double blind experiments have shown how the pattern of the ice crystals from water is significantly influenced by thoughts of specific kinds directed to the water from long distances. Several experiments also reveal that thought impacts significantly on the seed germination. A recent study by the authors found directed thought on lettuce seeds and the water used to germinate them to increase the length of the seedlings by an average of 15.6% ($p = 3\times10^{-6}$). Applying directed thought on water only led to a 7.5% increase in average seedling length ($p = 0.0167$) providing evidence of the effect of directed thought on water. Practically, thousands of farmers in rural India have adopted a combination of organic farming and the use of directed thought and as a healthier, more sustainable and better socio-economic alternative to chemical fertilizer-based farming. This paper reviews eco-hydrological human abilities and then describes the lettuce seed germination study carried out by the authors. The potential of these eco-hydrological human abilities to water resources planning and management is then discussed.

Water Risks Assessment in China Based on the Improved Water Risk Filter

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Abstract:
It has been a big issue for all levels of government and different economic sectors all over the world to find an effective way to deal with the water crisis and the relationship between water and development. Scientifically understanding water risk is the base for accomplishing the scientific relationship between water and development, and water risk assessment has currently been one of the focuses for researchers from various countries. To effectively deal with the global water crisis, World Wide Fund for Nature and German Investment and Development Company Limited proposed the concept of water risk and released an online water risk assessment tool Water Risk Filter in March 2012, which has been applied to at least 85 countries in the world. To comprehensively and accurately reflect the situation of water risk in China, this study adjusts the water risk assessment indicators in Water Risk Filter, taking the actual situation in China as well as the difficulty in obtaining the information of the indicators into account, and puts forward an index system of water risk evaluation for China which consists of physical risk, regulatory risk and reputational risk. The improved water risk filter is further used to assess the sources and causes of the water risks in 10 water resource areas (WRAs). The results indicate that, the water risk for the whole country is generally medium and low, while those for different regions in the country vary greatly and those for southern regions are generally lower than those for northern regions, government regulatory and policy implementation as well as media supervision in northern regions should be strengthened to reduce the water risk. The research results may provide decision supports and references for both governments and industrial enterprises in identifying water risks, formulating prevention and control policies and improving water resources management in the country.

Water Risk Evaluation of River Basin in China Based on WWF Water Risk Assessment Tools

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Abstract:
Water resource problems, as one of the most important environmental and social economy issues, has been a common concern for the whole world in recent years. Water resource risk is attracting more and more attention of the international community and the government of each nation. Given the current situations of water resources and water environment, and the characteristics of water resources management and information statistics in China, the paper establishes the evaluation index system of water risk for river basin based on the evaluation index system of water risk raised by World Wide Fund For Nature (WWF) and the Germen Investment and Development Co., Ltd (DEG), which is more suitable for Chinese national condition and confirms with international evaluation index. A variety of factors are considered to determine the critical values of classification for each index, and the indexes are graded by means of 5-grade and 5-score scale, some indexes are readjusted with the remaining indexes adopting the weights given by WWF. The Weighted Comprehensive Index Summation Process is adopted to calculate the integrated evaluation score of river basin with the improvement of calculation methods for some indexes. The smaller the calculation result is, the smaller the degree of water risk is; vice versa. Finally, the paper discusses the existing problems in the course of water risk evaluation and points out the research trends so as to provide reference for further study on this field.

Predicting Human - Hydrologic Interactions

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Abstract:
Anyone associated with hydrology and water resources engineering, planning and management knows how humans can alter existing hydrologic states or systems in their attempts to solve problems involving their water supplies and the risks associated with too much, too little or too polluted water. Both structural (hard) and non-structural (soft) approaches have been developed and used to increase the quantity and quality of our supplies, as well as their reliability, and to decrease their vulnerability and cost. Options for how humans can impact hydrology are clear, and libraries of books and Google-accessible files are witnesses to this. But what about the interaction in the other direction: the hydrologic-human interaction? Of the infinite possibilities available, can we predict what actions humans and their institutions will take, if any, in their attempts to improve the state of their water systems? Human responses to water problems are inevitably influenced by many drivers or factors, only some of which are directly related to water. Predicting this human/social behavior is the topic of this talk. Case examples illustrate just how unpredictable such predictions can be.

Shortage and surplus of water in the socio-hydrological context

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Abstract:
The adjustment of the spatial and temporal distribution of water to human needs demands interventions into the hydrological conditions. In the last decades it became obvious, that the increase of human requirements to prevent harmful consequences of water shortage and water surplus disagrees more and more with our limited knowledge about the natural variability and the cumulative effects of these interventions. Our technical capacities to modify the hydrological conditions seems to be more developed than our capabilities
to assess and forecast the results of human impacts, their cumulative effects and - most important - the limitations to adapt the hydrological conditions to human needs. Balancing the temporal variability of hydrological conditions in long and short term is often essential for steady socio-economic conditions. Nevertheless this equilibrium is very fragile in many cases. Hydrological changes or socio-economic changes may destroy it in short time. If we extend the bearing capacity of socio-hydrological systems we increase in many cases the harmful consequences of failures. Here two case studies are discussed to illustrate these problems. The limited success to adapt water resources to increasing human requirements without consideration of the natural bearing capacities will be discussed at the example of water use for irrigation in North-Eastern China. The demand for a new planning approach which is based on a combination of monitoring, model-based impact assessments and spatial distributed planning is demonstrated. The problems of water surplus which becomes evident during floods will be discussed in a second case study. It is shown how the gap between the social requirements for flood prevention and the limited technical capacities to avoid flood damages is widening. Here an increase of risk-awareness would be more sustainable than the promises of flood protection which forms the base for technical measures to affect floods and (or) to prevent flood damages.

On conceptual models describing the interactions between hydro-techno-socio systems

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Abstract
Engineers and natural scientists are increasingly becoming aware of, and interested in, the manner in which society interacts with the water system, has modified the hydrological cycle but even has influenced the research agendas of engineering and hydrology. Society permeates into the knowledge base of engineering and hydrological science. In a strikingly similar way, social scientists – including social geographers, sociologists, political scientists and philosophers of science – are increasingly interested in the biases in science and engineering and how this has shaped and informed policies, plans and interventions, but also the way we think about the role of nature in society and the role of society in nature. In trying to make sense of the dynamic interactions that exist between ecological systems, technical systems and social systems there is need for appropriate concepts that can adequately capture these interactions. However, the manner in which most, if not all, scientists define, observe and analyse phenomena is heavily influenced by the particular disciplines in which they were trained. To my knowledge there is no pan-academic discipline that transcends the individual disciplines and can propose meta-disciplinary concepts that connect phenomena of different natures in an even-handed, symmetrical, way, and that do justice to the different dimensions involved. Existing conceptual frameworks that aim to analyse the dynamics between socio-ecological and socio-technical systems may only be partially able to describe these interactions, since they tend to privilege the discipline that was taken as the point of departure. This paper aims to compare a number of existing frameworks developed by different disciplines in order to learn from their respective conceptual strengths, with a view to find ways of developing a truly meta-disciplinary conceptual model that can capture the multidimensional feedbacks and feed-forwards in hydro-techno-socio systems.

Leadership enhancement of CBOs and their role in water sector capacity development in rural areas in Palestine

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Abstract:
In the Palestinian context, Community Based Organizations (CBOs) are normally exist in the Palestinian communities. Vary in terms of types and missions, most of them are legally registered under the umbrella of Palestinian authority's law and system. CBOs are normally small in capacity, and offer services at local level. However, they offer different services that complement Palestinian Authority and Non-governmental organizations development efforts which mainly directed to rural communities as well as to improve living conditions for the poor. Most of CBOs are facing constrains preventing them from being able to offer services at a sustainable approach. Particularly, their participation in improvement of water accessibility and their role in resources management are limited; it is a reality that 11% of the Palestinian communities are not connected to Water supply networks, even for those whom are accessed, supplied water isn't enough to fulfill their basic needs, due to Israelis' overall control on water resources, in addition to the obstacles that usually imposed on the water sector and community development as well as lack of support and skills. Upgrading and development of the CBOs visions and missions; empowerment; improvement of staff's skills; enhancing of networking with local and external organizations are considered sustainable and coping strategies for CBOs upgrading, empowerment and development. These strategies will result in overall improvement upon their service delivery in terms of standards, quality and quantity, that will be considered as a complement and a sustainable approach, which absolutely will help those CBOs to be independent in offering better services to their communities and participate significantly in improvement of water sector and service delivery as well as reaching integrated rural sustainable development in Palestine.

Dealing with variability in water availability: the case of the Verde Grande river basin, Brazil

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Abstract:
This paper presents a water resources management strategy developed by the Brazilian National Water Agency to cope with the conflict between water users in the Verde Grande river basin, located at the Southern border of the Brazilian semi-arid region. The basin is dominated by water-demanding fruit irrigation agriculture which has grown significantly and without adequate water use control over the last 30 years. The current water demand for irrigation exceeds water availability (understood as a 95% percentile of the flow duration curve) in a ratio of three to one, meaning that downstream water users are experiencing more frequent water shortages than upstream ones. The management strategy implemented in 2008 has the objective of equalizing risk for all water users and consists of a set of rules designed to restrict water withdrawals according to current river water level (an indicative of water availability) and the size of water demand. Under that rule, larger farmers have proportionally larger reductions in water use, preserving small subsistence irrigators. Moreover, dry season river streamflow is forecasted at strategic points by end of every rainy season, providing evaluation of shortage risk. Thus, water users are informed about the forecasts and corresponding restrictions well in advance, allowing for anticipated planning of irrigated areas and practices. In order to enforce restriction rules, water meters were installed in all larger water users and inefficient farmers were obligated to improve their irrigation systems' performance. Finally, increases in irrigated area are allowed only in the case of annual crops and during months of higher water availability (november to june). The strategy differs from convectional approached based only on water use priority and has been successful in dealing with natural variability of water availability, allowing more water to be used in good years and managing risk in an isonomic manner during dry years.

Water footprints and hydrology: deformation or information?

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Abstract:
Water footprinting, either as a stand alone concept, or as part of life cycle assessment, is widely advocated as a means to inform society about issues of water scarcity. However, the commonly adopted procedures proposed for computing footprints, as set out by the Water Footprint Network, are seriously flawed. The actual footprint of a rainfed crop is often negative when compared to the natural vegetation in replaces. For irrigated crops, the total footprint is typically overestimated because even when yields are relatively low, crop water consumption is computed on the basis of potential rather than actual use. For crops grown on a combination of rainfall and irrigation, impacts are uncertain: annually, the impact of agriculture may increase water availability elsewhere in the system in one season while decreasing it in another season. Hydrology offers a scientific alternative to the over-simplistic approaches adopted by advocates of water footprints.

Climate change impact on flood hazard

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Abstract:
Climate changes have a high impact on river discharges and therefore on floods. There are a few different ways we can use to predict discharge changes in future. In this paper we used the complex HBV model for Vipava River and simple correlation between discharge and precipitation data for Soča River. The discharge prediction based on the E-OBS precipitation data for three future time periods (2011-2040, 2041-2070 and 2071-2100). Estimated discharges for those three future periods are presented for both rivers. But there is a specific situation on their confluence where two rivers with different heartlands unite which requires an additional probability analysis.

Water resources:
Monitoring, integrated assessment and management

Utility of the Priestley-Taylor expression in estimating actual evapotranspiration from satellite Landsat ETM + data

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Abstract:
The quantification of evapotranspiration from irrigated areas is important for agriculture water management, especially in arid and semiarid regions where water deficiency is becoming a major constraint in economic welfare and sustainable development. Conventional methods that use point measurements to estimate evapotranspiration are representative only of local areas and cannot be extended to large areas because of heterogeneity of landscape. Remote sensing based energy balance models are presently most suited for estimating evapotranspiration at both field and regional scales. In this study, we aim to develop a methodology based on the triangle concept, allowing access to evapotranspiration through the classical equation of Priestley and Taylor (1972) where the proportional coefficient α in this equation is ranged using a linear interpolation between surface temperature and Normalized Difference Vegetation Index (NDVI) values. Preliminary results, using remotely sensed data sets from Landsat ETM+ over the Habra Plains in west Algeria, show good agreement. The proposed approach appears to be more reliable and easily applicable for operational estimation of evapotranspiration over large areas.

Hydrological modeling and data assimilation in water resources assessment

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Abstract:
Water management and water policies are supported by adequate planning processes, also based upon long time series of river discharge data referred to several river sections. A combination of numerical and stochastic modeling is here proposed in order to optimize available observations, even few and sparse, with the possibility of taking into account different water resource allocation in a river basin (withdrawals, dams, groundwater), as implemented in a numerical modeling.
Sometimes long time series are not available for all river sections, or river bed could be heavily modified and data are not representative anymore of the river regime in the monitored section. A possible gap-fill technique is to perform numerical simulations to generate long synthetic time series reflecting the current river regime. The synthetic time series are assimilated only on control sections where long observed time series are available, while in absence of observed data the assimilation is performed through a regionalized approach.
The hydrological stochastic and numerical approach is provided in the context of the Water Protection Plan framework, implemented in the application of the European Directive 2000/60/CE (Water Framework Directive) and the national legislation D.Lgs. 152/2006 in Italy.

Using SDP to optimize conjunctive use of surface and groundwater in China

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Abstract:
A hydro-economic modelling approach to optimize conjunctive use of scarce surface water and groundwater resources under uncertainty is presented. Stochastic dynamic programming (SDP) is used to minimize the basin-wide total costs arising from allocations of surface water, head-dependent groundwater pumping costs, water allocations from the South-North Water Transfer Project and water curtailments of the users. Each water user group (agriculture, industry, domestic) is characterized by fixed demands and fixed water allocation and water supply curtailment costs. The non-linear one step-ahead sub-problems are solved using a genetic algorithm (GA) that minimizes the sum of the immediate and future costs for given surface water reservoir and groundwater aquifer end storages. The immediate costs are found by solving a simple linear allocation sub-problem, and the future costs are assessed by cubic interpolation in the total cost matrix from the following time step. The resulting total costs for all stages, reservoir states, and inflow scenarios are used as future costs to drive a forward moving simulation under uncertain water availability. The use of a GA to solve the sub-problems is computationally more costly than a traditional SDP approach with linearly interpolated future costs, but is still computationally feasible and represents a clean and customizable method. The method has been applied to the Ziya River basin in northern China. The basin is located on the North China Plain and is subject to severe water scarcity, which includes surface water droughts and groundwater over-pumping. The head-dependent groundwater pumping costs will enable assessment of the long-term effects of increased electricity prices on the groundwater pumping. The optimization framework is used to assess realistic alternative development scenarios for the basin. In particular the use of electricity pricing policies to reach a sustainable groundwater table is investigated.

Modeling irrigation behavior to inform management of integrated groundwater systems

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Abstract:
Groundwater underpins agricultural productivity in many regions, and therefore considerable research has been directed to address growing problems of human-induced aquifer depletion. However, the ability of existing integrated models to draw robust policy conclusions is limited by a failure to capture the physical, economic, and behavioral variables (e.g. well yield, soil moisture) that control both farmers' actual water use decisions and the response of groundwater systems to those choices. We develop a new modeling framework for determining field-level irrigation demand that is based on observed farmer behavior and captures the dynamic interactions within coupled agro-hydrological systems. We apply the model to case studies in the High Plains Aquifer, USA, to explore the co-evolution of irrigation practices with changing groundwater availability, and to assess the limits of current models for designing effective groundwater management policies. Our results illustrate that irrigation decision-making responds in complex and non-linear ways to changes in groundwater supply. Declining well yields lead to significant reductions in optimal irrigated area and irrigation demand, as constraints on instantaneous application rates limit the ability to maintain sufficient soil moisture levels to avoid crop yield losses. We demonstrate that this important behavioral response to groundwater scarcity is not captured by current approaches. This difference is explained by the fact that existing integrated models do not consider the impact of well yield on crop-water production relationships or the dynamic trajectory of well yield with groundwater pumping. Consequently, reliance on existing models is shown to lead to large errors in predictions of farm-level profitability, policy effectiveness, and resilience to future change.

Classical Karst hydrodynamics: a sheared aquifer within Italy and Slovenia

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Abstract:
Classical Karst transboundary aquifer is a limestone plateau of 750 km^2 that extends from Brkini hills in Slovenia to Isonzo River in Italy.
Since ten years, the Mathematic and Geosciences Department of Trieste University is conducting a monitoring project in order to better understand the groundwater hydrodynamic and the relation between fracture and conduit. 14 water points among caves, springs and piezometers are monitored: hourly temperature, level and EC data are recorded. Two sectors are highlighted: the south-eastern one mainly influenced by the sinking of the Reka River, and a north-western one connected to the influent character of the Isonzo River. Water table fluctuation are significant with risings of more than one hundred meters and during floods the most part of the circuits are under pressure and only a comparative analysis of levels, temperature and conductivity permits a precise evaluation of the water transit times in fractured and/or karstified volumes.

A prototype operational platform for water resources monitoring and early recognition of critical droughts in Switzerland

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Abstract:
In recent years, Switzerland experienced some unprecedented drought situations. At the political level solutions have been requested for early recognition of hydrological droughts. A prototype information platform has been developed to guide water resources management during situations where water resources drop below critical levels. www.drought.ch has been developed after a two-stage dialog with stakeholders from different sectors including national administration, hydropower, forestry, agriculture and river navigation. Since June 2013 the platform has presented daily updated real-time information on precipitation, streamflow, lake levels, groundwater levels, soil moisture deficit, snow resources, dryness in forests and stream temperatures. For three basins with different hydrological regime, ensemble forecasts of runoff, soil moisture, snowpack and groundwater storage are provided. Furthermore a nationwide operational hydrological simulation at 600x600 meters resolution gives indications on local water resources deficits. The contents are evaluated against a seasonal climatology allowing for identifying anomalies. Information for each variable is finally used for creating automatic “awareness maps” for nine large regions. The operators of the platform give interpreted comments on the content of the platform each week-day. The test phase of the platform will last until the end of 2014. Shortly after its launch more than 150 (free) login access codes were requested. In 2014 a standardized survey will be conducted in order to obtain feedback from the users concerning usefulness and hints for improvements.

Monte Carlo forecast of groundwater level rise in Milano, Italy

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Abstract:
A hydrogeological study assessed the evolution of groundwater levels in a site in Milano, Italy, where a road is under construction. In the area the depth to groundwater had been historically very low – less than two meters – until the industrial development and population increase, started in the 50', determined a high increase in groundwater withdrawal and a subsequent decrease of groundwater table. Level started to increase gradually during the 70', reaching a height able now to interfere with the road being built. This is consistent with the observed series of both public and private groundwater withdrawal rate from 1979 to 2005 in the town of Milano, which show a reduction with linear trend. Other collected data are irrigation, a part of which reaches the groundwater table, and rainfall. This has been previously analyzed to determine the variability and distribution during the period 1917-2010. The average rainfall has decreased by 200 mm since 1985, and its distribution is compatible with a Gaussian. Therefore, a groundwater flow was built with Modflow2000 and calibrated in steady-state condition with 2011 data. Since annual precipitation is responsible for low-period groundwater increase, a first simulation under a Monte Carlo approach was set by sampling 100 times the rainfall described as a Gaussian distribution with minimum and maximum equal to the minimum and maximum rainfall recorded during the observation period. One Modflow simulation was run for each sampling, observing the resulting groundwater head in some points along the road. As a result, probability curves of exceeding groundwater levels were delivered to the road designer. Also a deterministic simulation has been run to determine a precautionary groundwater level in the next 50 years. The rainfall was set equal to the average and well withdrawal was reduced by 35% following the observed evolution. This result is highly uncertain due to the impossibility to forecast the future industrial and civil groundwater demand.

Establishing Ecological Continuities. New Challenges to Optimize Urban Watersheds Management

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Abstract:
The river basin management promoted by the European Water Framework Directive raises the ecological continuity as a new challenge for the management of urbanised watersheds in Europe. In France setting ecological continuities has been recently embedded, not only into water management policies, but also into some urban planning projects (especially the Green and Blue Corridors). Ecological continuity in urban areas introduces new frameworks for the characterization of water quality and of ecological functions for heavily modified water bodies. The ecological continuity requires not only important technical and ecological expertise, but also social and political processes to define of a common goal and action plan. Even if the establishment of ecological continuity supposes the replacement of existing infrastructures (e.g. sluice gates, valves, concrete riverbanks, etc.) by softer technologies and practices, we observed science-driven approaches, disregarding the social contexts. We illustrate this through a socio-political analysis of two adjacent territories in Ile-de-France periurban area, developing projects of ecological continuity. We show that the implementation of such projects is a challenge for both, technical water management institutions and "classical" ecological policies. On a given territory, there is no pre-existing consensus on the "green" or ecological functions of urban water infrastructures, but competing expertises, knowledge and projects. Despite these difficulties, we claim that ecological continuity is an important issue for optimising the urban watershed management. We propose some social sciences contributions to deal with ecological unpredictability and reconsider stakeholder resistance to this kind of projects.

Truth concealed behind " Zero Increase of Total Water Use" and coordination approach of socio-economic and eco-environmental water uses in the Weihe River Basin of China

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Abstract:
Water resources situation in the water-stressed Wei River Basin of China becomes more serious at present than ever before because of water resources decrease and socio-economic development. "Zero increase of socio-economic water use" in recent years gives people a wrong conception and conceals the water crisis in the basin, because the socio-economic water consumption is actually increased. Water use for the hydro-ecological system has been greatly reduced by water resources decrease and socio-economic water consumption increase. New concepts of hierarchical water uses for every sector and water consumption control are suggested for coordinating water uses of socio-economy and ecosystems in the water-stressed basin. The traditional water resources allocation and regulation in China usually set up priority sequence for water use sectors. Generally speaking, domestic water use has a highest priority and a highest guarantee rate, next is industrial water use, then is irrigation and the last is ecological water use (although recent years in China, a minimum eco-environmental flow is set as first guaranteed but usually difficult to be satisfied). The concept of hierarchical water use for every sector is to distinguish the water use of every sector into minimum part, appropriate part, and expected extra part with different guarantee rates, and the minimum parts of all sectors should be first guaranteed. Through applying a water allocation model, we compared the water allocation results of traditional approach and those of the newly suggested approach. Although a further study is desired, the results are believed to be of an important referential value to sustainable development decision-makings in the basin.

A methodological framework for the expansion of multisource water supply systems

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Abstract:
The water systems should respond with an adequate performance to innumerous situations. However, the increase of water demand, the decrease of water supply or the imposition of new regulation might become evident the physical limitations of the existing infrastructure. Such situations may become inevitable structural level interventions to expand the capacity of the water systems. The problem to be solved here consists of determining the infrastructure that has to be built/rehabilitated at a specific time and that will be operated for 20-25 years or longer. The methodological framework set is based on a scenario planning approach, on an integration of two decision models and on an efficient solution method. The long term planning of infrastructures is subjected to several sources of uncertainty that can have strong influence in the performance of the water systems. Scenario planning approaches consider explicitly a set of uncertain situations (called scenarios) and aim to find solutions that are expected to perform well under all scenarios. The two decision models included in the methodological framework were named as the operating model and the strategic model. The operating model is a nonlinear simulation-optimization model intended to determine the optimal operating policy of the water systems in each scenario and each expansion solution. The strategic model is defined by a single mathematical function by which each expansion solution is evaluated taking the optimal operating policy for all scenarios into account. The solution method combines a simulated annealing algorithm with nonlinear programming. It is possible to focus on the tradeoffs between the gains in the performance of the water systems and the solution cost by setting different values to specific parameters in the strategic model. The application of the methodological framework to the Multimunicipal water supply system of the Western Algarve (Portugal) shows its capabilities in dealing with a complex real based problem.

Next stop: Implementation. Collaborative monitoring to inform adaptive policy-making and implementation

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Abstract:
There are limits to hydrological and societal predictions. Yet societies need to decide on water management infrastructures, investments, and regulations that cover long time-spans. Dynamic Adaptive Policy Pathways has been developed as an approach to deal with deep uncertainties and support robust decision-making. Decision-making needs to be followed up by implementation. Given the unpredictable and uncertain futures, implementation needs to be informed by regular monitoring, in order to learn from experience. Making this work, however, requires that different challenges are addressed. For instance, the establishment of expected values for indicators: values that trigger a revision of earlier decisions. Establishing such values, even bandwidths, is known to be difficult – especially in the face of uncertainty and given different priorities and timelines among policy actors. Also, monitoring needs to cover a range of aspects and the abilities to collect high quality monitoring data are likely to be dispersed. Monitoring then becomes a public good, hindered by sensitivities about data sharing, fears for blaming and shaming, and reluctance among some actors to spend precious resources on water-related monitoring. The paper presents a first outline for an approach to organize collaborative monitoring to support adaptive implementation of long-term water policies. The analytical basis rests on an extension of Dynamic Adaptive Policy Pathways with actor analysis principles. Monitoring is to be organized around adaptation tipping points, for which a limited set of questions needs to be addressed that put societal actors central:These actors have to do the monitoring, and they have to benefit. The approach will be illustrated with an example from water management in the Netherlands.

Hydro-economic optimization under inflow uncertainty using the SDP_GAMS generalized optimization tool

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Abstract:
The European Union's Water Framework Directive (WFD) calls for improving the efficiency in water resources systems through the application of economic principles, a circumstance that has raised the use of hydro-economic modeling methodologies and tools, often involving optimization routines. However, generalized river basin optimization packages do not usually deal with inflow uncertainties, but rather use deterministic optimization procedures that suffer the limitation of the "perfect foresight", which turns their results into something unattainable in real management. On the other hand, the use of methodologies that take into account inflow uncertainties is hindered by the lack of a generalized software. To overcome this, a general-purpose package named SDP_GAMS has been developed. The tool, programmed in GAMS, allows the resolution of the stochastic dynamic programming problem in single and multireservoir water resources systems, maximizing the expected benefits from water supply obtained through integration of the corresponding demand curves. The program uses a 1-lag Markov chain as inflow uncertainty descriptor, adopting a storage values discrete mesh. It facilitates optimal policies and benefits in the grid points, and performs a reoptimization stage to obtain the optimal decisions in response to specific inflow time series, interpolating the benefit-to-go function. The tool has been tested in the Mijares river basin (Spain), with two reservoirs and four major demands. Inflow variability has been described by the use of a 16-discrete-class 1-lag Markov chain, and a 91-class two-reservoir discrete mesh has used to establish the calculus grid. The demands are characterized through polynomial economic demand curves. The results showed that the application of the SDP hydro-economic modeling procedures allows to obtain optimal policies taken into account inflow uncertainty that can lead to an improvement in the efficiency of water resources systems.

CombiPrecip: Radar-raingauge combination in the alpine terrain of Switzerland

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Abstract:
CombiPrecip is the radar-raingauge combination scheme used currently by MeteoSwiss. It has been operational since 2012 and has been tested in a systematic fashion on numerous events. Additionally, it has been used to produce a thorough reprocessing of radar images since 2005. It employs a spatiotemporal geostatistical algorithm to achieve maximum stability of the merging process. Moreover it is equipped with several sub-algorithms to treat pragmatic problems such as: (a) best estimation outside the border where there is no raingauge coverage, (b) control for convective cases where the raingauge measurements do not sample the space sufficiently well and they, in addition, suffer mostly from representativeness errors, (c) production of very high temporal resolution images provided that for such resolutions using kriging is often problematic due to the occasional severe discrepancies between radar and raingauge measurements triggered by the temporal variability of rainfall. CombiPrecip uses co-kriging with external drift as its main variogram fitting module where both temporal and spatial data are incorporated in order to produce a very stable application, proper for unsupervised operational use. Cross-validation results over numerous cases suggest that it is highly efficient in reducing significantly the involved bias while improving considerably several other skill scores.

Assessing and managing irrigation water deficit in the Red-Thai Binh River Delta, Vietnam

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Abstract:
Water deficit (WD) is the factor that most affects agricultural productivity in irrigated land; that's why measuring water deficit plays a key role in water management. In real-world case study, the evaluation of WD can be done using expert-based indicators, which consider stakeholders' knowledge of the system, or model-based indicators, that rely on mathematical representation of the system behavior. Our work considers the Red-Thai Binh River Delta in North Vietnam, a large and complex river system, supplied by two main unregulated rivers and four large multipurpose reservoirs. A comparison between the two approaches is performed, considering the existing rules for water deficit management in the system, based on experts knowledge and an estimation of the distributed WD for 11 irrigation districts computed through a physically-based, distributed, dynamic model (Mike11). The model is able to simulate the hydraulic processes that occur in the system, including the operation of hydraulic structures, according with rules based on water demand and water availability. A validation of the model is performed against historically distributed datasets, together with a sensitivity analysis of canal levels to changes in water demand pattern and in reservoirs management policies. Finally, the global multi-objective optimal control problem, targeted to design the operating rules of the four reservoirs, is considered; together with the discussion on the integration, through model reduction techniques, of the two indicators in the optimization scheme and identification pros and cons of the two approaches.

Mandatory IWRM in an authoritarian society – Lessons from China

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Abstract:
The world is facing an increasingly severe water crisis, a crisis of governance rather than simple physical scarcity. Effective and sustainable water governance is vital. Developing countries like China are actively participating in changes of water paradigm from a traditional supply-driven, centralized government management towards participatory, decentralized water governance under the framework of Integrated Water Resources Management (IWRM). In hydraulic and authoritarian societies, IWRM implementation takes a rather narrow view with a "blue-print" approach which includes several fixed targets: IWRM aimed water policy; recognition of river basin as an appropriate unit of water governance; water pricing; and public participation, for example through establishing water users' associations (WUAs). However, formulating water policies is one thing, while implementation of these policies in practice is quite another. One should distinguish between the power of the state to formulate IWRM policies and its ability to implement them. Through comparative, in-depth study of IWRM implementations in two typical villages in the arid and semi-arid regions of northwest China, this paper shows that although the communist China is still among the most powerful states, its implemented IWRM policies are not necessarily as effective as planned. The so-called IWRM initiatives in the rural Chinese contexts have proved to be ineffective at best and even counterproductive. It concludes that IWRM process is constantly shaped and reshaped by localized understanding, experiences and negotiation among different stakeholders in the embedded physical, socio-economic, political and cultural environment, rather than the existence of officially-set policies or targets.
Keywords: WUAs, IWRM, water governance, China

Multi-criteria multi-stakeholder decision analysis using fuzzy-stochastic approach for hydrosystem management

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Abstract:
The conventional methods used to solve multi-criteria multi-stakeholder problems are less strongly formulated, as they normally incorporate only homogeneous information at a time and suggest aggregating objectives of different decision-makers avoiding water-society interactions. In this contribution, Multi-Criteria Group Decision Analysis (MCGDA) using a fuzzy-stochastic approach has been proposed to rank a set of alternatives in water management decisions incorporating heterogeneous information under uncertainty. The decision making framework takes hydrologically, environmentally, and socio-economically motivated conflicting objectives into consideration. The criteria related to the performance of the physical system are optimized, using multi-criteria the optimization and fuzzy linguistic quantifiers have been used to evaluate subjective criteria and to assess stakeholders′ degree of optimism. The proposed methodology is applied to find effective and robust intervention strategies for the management of a coastal hydrosystem affected by saltwater intrusion due to excessive groundwater extraction for irrigated agriculture and municipal use. Preliminary results show that the MCGDA based on a fuzzy-stochastic approach gives useful support for robust decision-making and is sensitive to the decision makers′ degree of optimism.

Along-the-net reconstruction of hydropower potential with consideration of anthropic alterations

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Abstract:
Even in regions with mature hydropower development, needs for stable renewable power sources suggest to revise plans of exploitation of water resources, while taking care of the environmental regulations. Mean Annual Flow (MAF) is a key parameter when trying to represent water availability for hydropower purposes. MAF is usually determined in ungauged basins by means of regional statistical analysis. For this study a "spatially smooth" regional estimation method (SSEM) has been developed for MAF estimation, that uses a multi-regressive approach based on geomorphoclimatic descriptors, using more than 100 gauged basins located in NW Italy. The method has been designed to keep the estimates of mean annual flow congruent in the confluences, by considering only raster-summable explanatory variables. Also, the influence of human alterations in the regional analysis of MAF has been studied: impact due to the presence of existing hydropower plants has been taken into account, defining basic indices of alteration and restoring the 'natural' value of the runoff through analytical corrections. To exemplify the representation of the assessment of residual hydropower potential, on two specific mountain watersheds the model has been applied extensively by mapping the estimated mean flow for the basin draining into each pixel of a DEM-derived river network. Spatial algorithms and data management were developed using the Free&OpenSource Software (FOSS) GRASS GIS and PostgreSQL/PostGIS. Spatial representation of the available potential was obtained using different flow vs elevation-drop relations for each pixel. Specific and abrupt changes due to existing plants have been managed. Final potential indices have been represented and mapped through the Google-Earth platform, providing a complete and interactive picture of the available potential, useful for planning and regulation purposes.

Groundwater governance in Asia: Present state and barrier for implementation of a good governance

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Abstract:
Present state of groundwater governance in Asia was reviewed. Legal status of groundwater in China, Indonesia and Vietnam are situated as public, in Thailand State-owned and in Japan private. In Thailand, no specific legal instrument exists in any law at the present, but in accordance with generally accepted principles of law and special legal provisions in various acts, the ownership of all water resources is vested in the State. In Japan, there are no provisions regarding the right of groundwater, in principally the land owners have a right of groundwater use. The main problem regarding the groundwater resources in each Asian country except in Vietnam is the overexploitation causing water level draw down, land subsidence and salt water intrusion. For those groundwater hazards, many countries have established the regulatory such as laws and regulations as countermeasures. Those laws and regulations, however, are not the principle/basic laws on groundwater resources but only for countermeasures to restrict the groundwater hazards occurred in each country. For sustainable use of groundwater resources, it is necessary to establish the conceptual law in each Asian country. One of common problems and barriers for implementation the groundwater governance in Asia countries is that there are more than one institute that have different and sometimes over lapping responsibilities in groundwater management. For the establishment of a good governance, an agency should be established and reinforced to direct coordination and facilitation of groundwater policy-making and implementation. Although the groundwater governance may be established in accordance with the physical, social, economical and cultural conditions in each country, the universal applicable groundwater governance should be established based on a conceptual law for sustainable use of groundwater resources.

Hydrogeochemical Characterization of Shallow Groundwater System in the Weathered Basement Aquifer of Ilesha Area, South-western Nigeria

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Abstract:
Hydrogeochemical characterization of weathered basement aquifer in the urban and peri-urban areas of Ilesha, SW-Nigeria was carried out in order to assess geogenic and anthropogenic influences on the chemical characters of the shallow groundwater system. The study approach involved in-situ measurements of physico-chemical parameters and hydrochemical analyses of groundwater samples. In-situ measurements revealed pH of 6.4-8.4 (av. 7.3) and EC of 22-825µs/cm in the urban areas of Ilesha reflecting low mineralized groundwater system compared to pH of 7.3-10.5 (av. 8.2) and relatively higher EC of 126-1027µs/cm in the peri-urban area. The concentrations of major cations (Ca, Na, K, Mg) in the urban areas revealed relatively lower average concentration of 18.3, 11.5, 23.7 and 4.8mg/l respectively compared to 42.6, 25.6, 66.6 and 12.3mg/l respectively for the peri-urban areas. The depletion of major elements in the water samples from the urban areas can be attributed to low mineral dissolution and resistance nature of quartzite and muscovite quartz-schist bedrock setting to weathering compared to the relatively more weathered granitic, amphibolite and biotite schist bedrock units in the peri-urban areas. However, the trace metal profiles (Cd, Co, Cr, Cu, Ni and Pb) exhibit slight enrichment with average values of 2 – 8µg/l for the water samples from the urban setting, suggesting anthropogenic impacts of urbanization, compared to average values of 0.5 – 4µg/l for the peri-urban areas. Nonetheless, hydrochemical characterization revealed two main water types; namely Ca-HCO_3 type mostly in the urban areas and Na-HCO_3 type in the peri-urban areas. While the Ca-HCO_3 water type is a reflection of CO_2-charged infiltrating recharge rain water with limited migratory history, the Na-HCO_3 water type is a product of water–rock interaction (dominated by cation-exchange reaction) within the weathered bedrock units.

The effect of water supply uncertainty and policy change on integrated water resource systems

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Abstract:
Saskatchewan, Canada, is a mid-stream province in the Saskatchewan River Basin (SaskRB), receiving water from the upstream province of Alberta and releasing water to the downstream province of Manitoba according to a national apportionment agreement. The competing water users in Saskatchewan, including hydropower, agriculture, mining, domestic, and instream flow requirements, are supplied mainly through operating Lake Diefenbaker – a large reservoir created in 1968. SWAMP is an integrated water resources systems model built within the system dynamics environment that simulates the water resources system in Saskatchewan's portion of the SRB. SWAMP can estimate the long-term hydro-socioeconomic aspects of the various components of the system. In this study, SWAMP is employed to quantify the net revenue of various water use sectors (e.g., hydropower) over a 30-year planning period in a new risk-based framework. First, net revenue is presented in a probabilistic chart as a result of the natural randomness of the reservoir inflows, represented by stochastically generating multiple realizations of historical inflows. Climate change-induced variability of reservoir inflows and policy changes represented by varying the reservoir operating rule curves add additional levels of uncertainty. The considered policy changes include alternative reservoir operating rule curves based on flood protection, drought resilience, and hydropower maximization priorities. Second, probabilistic charts representing the effects of natural randomness of historical flows, climate change, and policy change on net revenues are produced to show the relative contribution of each risk factor to the overall risk encountered by the various water sectors in Saskatchewan. Factors considered include agricultural expansion and the ability to maintain environmental flows and lake levels.

Simulation of blue and green water resources in the Wei River basin, China

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Abstract:
The Wei River is the largest tributary of the Yellow River, China. It is suffering from water scarcity, water pollution, and shortage of ecological and environmental water availability. In order to quantify the amount of water resources in the study area, a hydrological model was developed by using SWAT (Soil and Water Assessment Tool), calibrated and validated with SUFI-2 (Sequential Uncertainty Fitting program) based on river discharge in the Wei River Basin (WRB). Sensitivity and uncertainty analyses were also performed to improve the model performance. Water resources components of blue water flow, green water flow and green water storage were estimated at the HRU (Hydrological Response Unit) scale. Water resources in HRUs were also aggregated to sub basins, river catchments, and then city/region scales for further analysis. The results showed that most parts of the WRB experienced a decrease in blue water resources between the 1960s and 2000s with minimum value in the 1990s. The decrease is particularly significant in the most southern part of the WRB (Guanzhong Plain), one of the most important grain production basements in China. Variations of green water flow and green water storage were relatively small on the spatial and temporal dimensions. This study provides strategic information for optimal utilization of water resources and planning of cultivating seasons in the Wei River basin.

Integrating Hydrology and Society Through the Concept of Ecological Infrastructure: An Inovative Approach to Water Resources Management in uMngeni Catchment, South Africa

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Abstract:
If their research is to be relevant, it is incumbent upon hydrologists to engage with the broader society of which they are part. Ecosystems Goods and Services has been promoted as a concept which provides an effective means of doing so. In South Africa, a related concept i.e. “Ecological Infrastructure”, defined as functioning ecosystems that deliver valuable services to people, is being promoted as a means of connecting catchment functioning with societal needs and benefits.
The uMngeni catchment (4 349 km^2) in South Africa is one of the world’s fastest growing urbanisation centres. Providing water and sanitation for the rapidly expanding residential population and sustaining agricultural and industrial production in the catchment is crucial, typifying the challenges facing many developing regions. These catchments are stressed by high demands for water for competing uses and deterorating water quality. Many of the residences are semi-rural or peri-urban and so require different approaches to those used in most major cities. The uMngeni River and its catchment is now the focus of an innovative water resources management programme which is aims to retain and restore its ecological infrastructure.
Sustaining a catchment’s ability to generate benefits depends on recognition of the key processes, the linkages between different components, understanding their structure and function, and the spatial and temporal scales at which these are dominant or dormant as well as the complexity of society’s interaction and feedback to these. In this paper, we describe the uMngeni study approach and how this complexity is adddressed, with a focus on hydrologically related ecological infrastructure.

Evaluation of surface water dynamics for water-food security in seasonal wetlands, north-central Namibia

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Abstract:
Agricultural use of wetlands is important for food security, especially in semi-arid regions. However, land-use changes in wetland areas could alter water cycle and the ecosystem. To conserve the water environments of wetlands, care is needed when introducing new cropping systems. This study is the first attempt to evaluate the water budget in the case of the introduction of rice-millet mixed-cropping systems to the Cuvelai system seasonal wetlands (CSSWs) in north-central Namibia. We first investigated seasonal changes in surface water coverage by using satellite remote sensing data. We also assessed the effect of the introduction of rice-millet mixed-cropping systems on evapotranspiration in the CSSWs region. For the former investigation, we used MODIS and AMSR-E satellite remote sensing data. These data showed that at the beginning of the wet season, surface water appears from the southern (lower) part and then expands to the northern (higher) part of the CSSWs. For the latter investigation, we used data obtained by the classical Bowen ratio-energy balance (BREB) method at an experimental field site established in September 2012 on the Ogongo campus, University of Namibia. This analysis showed the importance of water and vegetation conditions when introducing mixed-cropping to the region.

Hydrological studies in experimental and representative basins in Pernambuco state - Brazil

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Abstract:
Hydrological studies in experimental and representative basins are of fundamental importance to the management of water resources. This paper details the activities of hydrological research in experimental and representative basins in the Pernambuco state - Brazil. The study areas are located at Tapacurá and Mundaú representative basins and the Gameleira experimental basin, besides experimental plots in Pajeú basin. In the Tapacurá basin, three studies were performed: (1) it was tested different monthly coefficients "k" of the Thornthwaite method to calculate the effective temperature and, consequently, the reference evapotranspiration, giving rise the method identified as Modified Thornthwaite; (2) it was analyzed the spatial variability of the retention curve and hydraulic conductivity parameters, using the Beerkan method; (3) it were evaluated whether changes in vegetation cover through the NDVI and NDWI index using two TM - Landsat 5 images; (4) in the Mundaú representative basin, the performance of different evapotranspiration methods was evaluated and compared to the FAO standard method Penman-Monteith; (5) In Pajeú basin, the experimental plot is covered by pasture and sensors were installed to monitoring the fallowing variables: rainfall, air temperature, components of energy balance (latent and sensible heat, heat flux in soil), wind velocity and CO_2 flux into atmosphere, soil moisture and Runoff.

Marrying Hydrological Modelling and Integrated Assessment for the needs of Water Resource Management

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Abstract:
There exists a wealth of experience and knowledge in understanding water resources issues from a human and interdisciplinary point of view, just one repository of this knowledge being the integrated assessment (IA) community. IA is an interactive modelling process that brings together researchers, policy makers and stakeholders to share their views and knowledge in order to improve system understanding, generate trust and support decision making. One of the cross-disciplinary gaps where IA could help to meet water management challenges is the interface between the hydrological and social sciences. Recent encouraging developments in the field of socio-hydrology aim to build a stronger relationship between hydrology and the human dimensions of WRM. This paper focuses on IA and related meta-disciplines that address water management issues, with an aim of focusing at a high level on how collaboration between hydrologists and other scientists and stakeholders can be suitably enhanced. WRM sets a challenge for a new agenda in hydrology that meets the needs of IA and decision support. The terms of a 'marriage' between IA and hydrology should include a tighter and more engaging focus on appropriate concepts, model structures, scales of analyses, calibration techniques, objective function selection, performance analyses, uncertainty analyses and communication - and the associated tools that need deployment or development. To illustrate the openings for progress, an IA case study in groundwater and surface water allocation in the Lower Namoi catchment of NSW, Australia is presented. This explores the trade-offs between the social, hydrological, economic and ecological impacts of various climate and policy scenarios.

The impact of poor governance on water and sediment quality: A case study in the Pitimbu River, Brazil

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Abstract:
Sustainable democratic water resources management implies a local collaborative and power-sharing approach. In many cases, it means a shift in paradigms and requires a political-institutional reform. Poor land use management and governance models in many Brazilian urbanizing basins has caused adversely impacts on water and river system due to pollutants transfer and contamination. Pitimbu River basin (107 km^2) is located at the Brazilian northeastern region and supplies potable water to approximately 35% of the Natal population. This study investigated how the Pitimbu River basin management and governance model influences land-use configuration and fluvial system contamination by metals. To address this issue, it was explored the links involving water and sediment contamination, land use management approach and institutional arrangement. Bottom sediment samples collected during one-year period at eight sites along the river were analyzed by flame atomic absorption spectrometry. Enrichment ratios revealed high contamination levels for Pb, Fe, Al, Ni and Zn (1,000x, 110x, 40x, 100x and 15x respectively), sourced by industries, vehicles contaminants, agriculture and construction wastes. In the surface water, downstream enrichment of Al is caused by septic tank water discharges in the soil. Indeed, the river basin settlement in a context of poor institutional capacity is the main cause of contamination. A disorganized and bureaucratic institutional model fails in responding to local environmental and social needs. Finally, Brazilian water management framework seems not to efficiently deal with the need of institutional capacity building at the local level.

Monitoring surface water velocity using a camera: a case study on the Tiber River

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Abstract:
Monitoring surface water velocity is critical to addressing several research questions in hydrology, whereby traditional techniques, such as flowmeters and tracers, are often difficult to implement in inaccessible stream cross sections or during floods. Beyond such practical constraints, existing techniques tend to be time consuming and expensive. Some of these drawbacks can be addressed through an innovative and nonintrusive approach, which consists of recording stream surface flow using low cost cameras and applying image analysis algorithms to reconstruct velocity maps. This encouraging methodology is known in the literature as LSPIV (Large Scale Particle Image Velocimetry), and it is based on correlation analysis between pairs of consecutive images. Recently, some of the authors proposed a substantial improvement to LSPIV sensing platforms, which minimizes inaccuracies associated with image orthorectification and calibration. Such an approach includes a low-cost GoPro Hero 3 camera installed on a telescopic aluminum bar with its axis orthogonal to the water surface. Two lasers are mounted at the ends of a 1 m pole connected at one end of the bar, to create reference points in the field of view. The platform is designed for installation on river bridges; however, it can be easily integrated on hydrological cable-ways or aerial vehicles. In this work, we describe a case study LSPIV application on the Tiber river, using the proposed platform. Specifically, we monitored the flood observed in January-February 2014 from the Ripetta hydrometeorological station located at Ponte Cavour in Rome. Surface velocity maps are developed and compared to average velocity values estimated from the available rating curve and to values obtained from visual analysis of the images.

Impacts of the dryness on water quality: case of some aquiferes of east algerien.

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Abstract:
The studied area is located in the extreme part of Algeria. It is limited to North, by the Mediterranean Sea and it is in the front of the desert in the South. This position confers a variation of the climatic mode, Mediterranean climate in North and arid in the South, resulting in a very important fall of precipitations, passing from 1200 mm/year in North, with 300 mm/year in the South. The hydrographic network is very dense; very important wadis (Seybouse, Mellague, Medjerda, Kebir-Are, Kebir-West) cross this area, which implies important contributions (solid and liquids). Water of aquifers is often fed by these rivers. During its displacement water acquires a certain mineralization. The carried out studies showed that this mineralization increased during these last years thus translating the influence of the climatic factors on water quality. To explain the origin of this salinity, we were interested in the climatic variations and particularly in dryness which touched the area during these last years, it arises a considerable fall of the infiltrations being translated in North by an imbalance of the interface fresh water, salted water, generating a salinity of water. In the South the dryness accelerated the water salinity, to highlight this impact several approaches were used, such as:
- Statistical tool, using the PCA, gives an outline on the elements at the origin of observed salinity;
- Stuyfzand method, based primarily on chlorides, can determine various classes of salinity;
- The thermodynamic tool shows the influence of certain minerals on water salinity. The compilation of all the results enables us to conclude that the observed salinity in various zones remains influenced by the dryness.

Local Decision-making for Adaptation to the Urban Heat Island: Governance Responses to Climate Change in the U.S. Southwest

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Abstract:
Residents of cities in the Southwest U.S. have long endured hot, arid conditions. However, they are beginning to experience even hotter, drier summers and more variable precipitation. What can the decision-making processes of these residents in their workplaces offer urban dwellers in other arid regions as they face increasing temperatures and drier conditions compounded by the urban heat island effect? In this study of Tucson, Arizona, business, governmental and non-profit water users were interviewed to see what types of adjustments they are making, both incremental and dramatic, to water use for their landscapes to promote a more comfortable environment for themselves, their customers and their community members. These water users represent several different geographic areas of the city of Tucson and different socio-economic strata. The use of alternative water sources such as greywater, harvested rainwater and stormwater were examined as well as the conservation of water through lower water use vegetation. Alterations made to designs of buildings and parking lots were also included. Less attention has been placed on workplace innovations in water use than on household-based innovations related to the urban heat island and climate change. In order for broader-scale change to take root, however, workplace water use innovation must be understood and replicated to help cool warming cities while using water sustainably. The study revealed knowledge sharing pathways between and among individuals, grassroots groups, businesses and agencies which helped shed light on how planners and other community decision-makers can assist innovators in replicating successful interventions that address the urban heat island effect and climate change in a context of growing variability in water availability and accessibility. Geo-visual components of the study helped identify areas of the city that could benefit from the innovations and the efficacy of some of the innovations to lower localized urban temperatures.

Developing a dynamic framework to examine the interplay between environmental stress, stakeholder participation processes and hydrological systems

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Abstract:
Stakeholder participation is increasingly discussed as essential for sustainable water resource management. Yet detailed understanding of the factors driving its use, the processes by which it is employed, and the outcomes or achievements it can realise remains highly limited, and often contested. This understanding is essential to enable water policy to be shaped for efficient and effective water management. This research proposes and applies a dynamic framework that can explore in which circumstances environmental stress events, such as floods, droughts or pollution, drive changes in water governance towards a more participatory approach, and how this shapes the processes by which participation or stakeholder engagement takes place, and the subsequent water management outcomes that emerge. The framework is able to assess the extent to which environmental events in combination with favourable contextual factors (e.g. institutional support for participatory activities) lead to good participatory processes (e.g. well facilitated and representative) that then lead to good outcomes (e.g. improved ecological conditions). Through applying the framework to case studies from the literature it becomes clear that environmental stress events can stimulate participatory governance changes, when existing institutional conditions promote participatory approaches. The work also suggests that intermediary outcomes, which may be tangible (such as reaching an agreement) or non-tangible (such as developing shared knowledge and understanding among participants, or creating trust), may provide a crucial link between processes and resource management outcomes. If this relationship can be more strongly confirmed, the presence or absence of intermediary outcomes may even be used as a valuable proxy to predict future resource management outcomes.

Resiliency Assessment Model

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Abstract:
Although a huge volume of research on resiliency assessment, limited studies have been reported to address the operational resiliency issues related to water distribution system in terms of various aspects to evaluate and diagnosis the overall system response and to detect failures location. To address this limitation a model has been proposed for better evaluation and diagnostic investigation of water distribution system resiliency. In this model, using fuzzy set theory based modelling coupled with Analytic Hierarchy Process, a methodology has been developed to estimate the global resiliency in a WDS regarding three aspects; pressure, flow and water quality. The methodology evaluate the overall ability of the system to return to a satisfactory state (*S*) once has entered to a failure State (*F*). Three kinds of failure are considered in this model, demand failure, pressure failure, and water quality failure. System or component is considered in failure state, if it is not capable to supply the minimum requested threshold values of the considered three parameters. The methodology has been demonstrated using the distribution network of Matera city (Basilicata, Italy) in order to test the validity of the model under normal operating conditions. The results have been also plotted in space and time using GIS tool in order to show the system response during the whole operation time. The model has shown its capability to detect the faulty nodes that experience deficit in terms of the required service, which might require the intervention of the water manager to take the preventive actions.

Probabilistic assessment of the rainwater harvesting potential of schools in South Africa

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Abstract:
In comparison to other sources of water supply, rainwater harvesting has the typically advantages of being cheaper and easier to operate and maintain. This study aimed at assessing the hydrologic rainwater harvesting potential of rural schools in South Africa by obtaining storage capacity – level of supply - reliability relationships of representative schools. Thirty two schools located in three rural areas that have varied rainfall characteristics were selected for the analysis. For each school, a daily time-step behaviour analysis of the rainwater harvesting system with a specified storage was carried out for a period of 101 years (over which rainfall data was available) and the number of days that the school's daily water demand was met in each year obtained. Using the Weibull plotting position formula, the expected number of days that the demand can be met per year was then obtained for 85, 90 and 95% reliability. For the two summer rainfall regions where a large proportion of rain falls during school holidays, the number of days of supply per year improved up to a storage capacity of 25m3. For the winter rainfall region where the rainfall periods and school learning times have more co-incidence, a tank volume of 5m3 obtained similar supply levels as larger capacities. At 90% reliability, the supply levels for different schools in the summer rainfall area with a mean annual rainfall (MAR) of 800-1000 mm/year ranged from 60-120 days per year while the summer rainfall region with a lower MAR (500-600mm) gave supply levels ranging from 40-70 days per year. The winter rainfall area had a MAR of 500-600 mm and obtained supply levels ranging from 60-80 days at 90% reliability.

Social and ecological aspects of the water resources management of the Transboundary Rivers of the Central Asia

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Abstract:
Zeravshan River is Transboundary River which is used mainly for irrigation of agricultural lands of Uzbekistan. Zeravshan River Basin in the territory of Tajikistan is characterized by limitation of farmlands (about 20 Th.ha) but with sufficiently rich hydropower resources. Continuous monitoring of water resources condition is necessary for planning of development of basin by the account of power and irrigational interests. Quality of water of the Zeravshan River nowadays is one of actual problems in relationship of the Republics of Uzbekistan and Tajikistan on water questions and it becomes frequent the reason of emergence of conflict situations. In most cases the problem of water quality of the Zeravshan River consider in organic communication with activity of the Anzob Mountain-concentrating Industrial Complex (AMCC) in Tajikistan. In the paper results of research of chemical and bacteriological composition of the Zeravshan river waters on all territory of the river are presented. It is experimentally established the minimum impact of AMCC on quality of water of the river. For a solution of the problem of pollution and quality of waters of the Transboundary rivers of Central Asia is indicated the need of creation of Interstate structure on monitoring and control of waters quality.

Risk Management Frameworks: Supporting the next generation of Murray-Darling Basin water sharing basin

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Abstract:
Water jurisdictions in Australia are required to prepare and implement water resource plans. In developing these plans the common goal is realising the best possible use of the water resources – maximising outcomes while minimising negative impacts. This requires managing the risks associated with assessing and balancing cultural, industrial, agricultural, social and environmental demands for water within a competitive and resource-limited environment. Recognising this, conformance to international risk management principles (ISO 31000:2009) have been embedded within the Murray-Darling Basin Plan. Yet, to date, there has been little strategic investment by water jurisdictions in bridging the gap between principle and practice. The ISO 31000 principles and the risk management framework that embodies them align well with an adaptive management paradigm within which to conduct water resource planning. They also provide an integrative framework for the development of workflows that link risk analysis with risk evaluation and mitigation (adaptation) scenarios, providing a transparent, repeatable and robust platform. This study, through a demonstration use case and a series of workflows, demonstrates to policy makers how these principles can be used to support the development of the next generation of water sharing plans in 2019. The workflows consider the uncertainty associated with climate and flow inputs and model parameters on irrigation and hydropower production, meeting environmental flow objectives and recreational use of the water resource. The results provide insights into the risks associated with meeting a range of different objectives.

Hydrogeological characterization of peculiar Apenninic springs

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Abstract:
In the northern Apennines of Italy, springs are quite widespread over the slopes. Anyway, due to the outcropping of low-permeability lithologic units, they are generally characterized by low-yield capacities and high discharge variability during the hydrologic year. In addition, low-flow periods (discharge lower than 1 ls-1) reflect rainfall and snowmelt distribution and occur in summer seasons. These features strongly condition the water management for water-supply purposes, making it particularly complex. The “Mulino delle Vene” springs (420 m a.s.l., Reggio Emilia Province) are one of the largest for mean annual discharge (120 ls-1) and dynamic storage (1,7 Mm3) and are considered as the main water resource in the area. They flow out from several joints and fractures at the bottom of a flysch rock outcrop in the vicinity of the Tresinaro River. To date, these springs haven’t been exploited yet, as the knowledge about the hydrogeological characteristics of the aquifer and their hydrological behaviour is not fully achieved. This study aims to define hydrogeological boundaries of the aquifer and recharge processes. It is based on river and springs discharges monitoring and groundwater balance assessment carried out during the period 2012-13. Two springs were equipped with weirs and levels were collected monthly. At the same time, river discharges were estimated up and downstream of the springs confluence by means of salt dilution method. In addition, groundwater discharge from one of the weirs was continuously measured using a pressure-transducer. Results confirm the usefulness of the approach, as it allowed the total aliquot of discharge of the springs to be assessed on a continuous basis. Moreover, by comparing the observed discharge volume with the one calculated with the groundwater balance, the aquifer has been identified as an arenite slab (mean altitude of 580 m a.s.l.), extended about 6 km2 and located 1 km west of the monitored springs.

Hydrogeochemistry of some Selected Springs’ waters in Ekiti Basement Complex Area, Southwestern Nigeria

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Abstract:
The occurrence of surface water and shallow groundwater in Ekiti Basement area is erratic and subject to seasonal variation while the eleven selected springs under study have history of continuous yield throughout the year. Hence, this study aimed at assessing the hydrochemistry of the selected springs with a view to understand their hydrochemical evolution and suitability for domestic and irrigation purposes. Temperature, pH and EC of water samples from the springs were measured in the field using Schott electric conductometer. Subsequently, 30 springs’ water samples were collected in polyethylene bottles and analyzed at the Laboratory for cations and anions determinations using Buck Scientific Model 210VGP Atomic Absorption Spectrophotometer and colorimetric method respectively. Results of the analyses indicate that pH of the springs’ water range from 5.7 – 11.5 exceeding approved World Health Organization (WHO) standard for drinking water in few locations. The EC range from 19 - 239µS/cm while the TH of 90% of the springs’ water is less than 70mg/L signifying soft, low mineralized water with no pronounced effects of rock-water interaction arising from transient residence time. Ionic concentrations in the springs’ waters exhibiting trend of Cl^{-}>HCO_3^{-} >NO_3^{-}, Mg^{2+}> Ca^{2+}> Na^{+}>K^{+} and Fe^{2+}>Zn^{4+}>Cu^{2+}>Mn^{4+} are within approved WHO standard values for drinking water. The hydrochemical facies are Na-(K)-Cl (dominant) and Ca-(Mg)-Cl water types. Irrigation indices (sodium absorption ratio, residual sodium bi-carbonate, permeability index) signified good quality water suitable for agricultural use while magnesium absorption ratio and Kelly’s ratio were indicative of moderately suitable irrigation water.

Three methods comparison for recover the missing hydrometric record.

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Abstract:
Three methods are presented to recover the missing hydrometric record in a basin in the State of Chiapas (southern Mexico) watershed that drains into the Pacific Ocean. The importance of achieving a successful recovery of missing record, is that such figures were used for three purposes: (1) A water balance of surface water, 2) The estimate of the volume of water entering the coastal wetland located in the lower part of the basin, in order to establish a conservation policy of the same and, (3) An analysis of the variation of runoff in the area during the review period (1970-2001).It is pertinent to note that the three aforementioned issues are beyond the scope of this paper because of its size, here we will only show the methods used to recover the missing record that allowed to achieve stated above.The first two methods are common in the literature on the subject and were developed by Paulhus and Kohler (Kohler and Paulus, 1952), and the third is a proposal, which consists in establishing a pattern constructed average with the proportion of the station log that it wish to fill between registration of a support station the above for temporary space in which both have registration.This procedure was used because the support station has a very complete record for the time period reviewed, and is acceptably close (approximately 10.5 km) of the station that we want to retrieve its record; additionally both methodologies used as others that exist in the literature, point as a limit of recovery around 10% of the total record, and in this case such rate is higher. Despite this condition the results for the three alternatives were similar and numerically satisfactory.

Runoff production on hill slopes under conservation practices A micro level study

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Abstract:
The mountain soils of the North East India are becoming increasingly denuded and deforested and have reached the most degraded form due to overexploitation and shifting cultivation. Alternative farming systems to replace shifting cultivation have indicated that mixed land use system may prove much better from conservation and production point of view. Watershed based farming system, appropriate soil conservation measures, mixed land use of agri- horti- silvi pastoral system, subsidiary source of income through livestock rearing, creation of water harvesting and silt retention at lower reaches - these are the important distinguishing features of the suggested agricultural strategy on this hill slopes. Nine micro watersheds were instrumented in the experimental farm located at Barapani (Meghalaya) in North East India to study the effect of land use pattern on hill slope runoff- the principal erosive agent. Considering the potentialities of land uses in this regions, the farming systems studied were: livestock based farming system, timber plantations, agroforestry, agrihortisilvipastoral system, horticulture, natural vegetation, shifting cultivation and pine afforestation. Mixed land use systems with appropriate soil conservation measures were most effective in checking erosion and retaining 90 –100% of annual rainfall in situ. The contributions to stream flow in the watersheds having substantial area under natural forest is primarily by subsurface flow. The watersheds having continuous stream flow characteristics generated base flow to the extent of 70- 90% of its total water yields. As expected the watershed treated with shifting cultivation yielded the highest peak runoff while the one left undisturbed with natural vegetation yielded minimum peak runoff. Maximum peak flow rate did not differ in mixed block forest, silvi pastoral system and agri horti silvi pastoral system, showing the effectiveness of suitable soil conservation and appropriate land use systems in hill slopes.

The Problem of Storage of Surface Water in Arid Regions Case Garagar Dam (Algeria)

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Abstract:
The Algerian dams are confronted with three very serious hydraulic problems which are intense evaporation, the excessive silting and the water escapes through banks and foundations especially that our country and more precisely the arid regions are affected by a dry period since approximately twenty years. it presents also very serious threats of the stability of the hydraulic works and influences in a remarkable way the increase of the total losses of the dams. The problem of the water escapes became extensive on the level of the Algerian dams in the course of time owing to the fact that the majority of the dams are exposed to this phenomenon from where the study of the water leakages on the level of the strongly threatened dams proves of great importance, particularly for the dams which are in strategic zones especially for those in arid and semi arid regions where the economic development is closely related to the stored quantities of water. Located in the wilaya of Relizane, 5 km south-west of the town of Oued Rhiou is known for these losses in water. With a capacity approaching 450 hm3, the dam of Gargar is intended to increase the degree of regularization of the Wadi Rhiou and supply water to the wilaya of Oran and 15 localities of Relizane and Mostaganem. However, the dam has never reached its maximum level is threatened by water loss and whose impotrance is clear evolution in time. The volume of loss was estimated at 22 hm 3, which corresponds to a considerable volume of water lost. In this study, We attempt to analyze the variation of losses based on the rating of the dam due to a leakage, siltation and intense evaporation.

The assessment of heavy rains in the region of Annaba (NE Algeria) to improve extreme flood forecasting. Use of Depth-Duration-Frequency curves.

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Abstract:
The knowledge of space and time distribution of short duration rainfall depths is of primary interest in hydrotechnical studies and in extreme floods modeling. This work is carried out to establish a 'Depth-Duration-Frequency (DDF)' relationship for the region of Annaba (Northeast of Algeria) through the examples of Pont Bouchet (El Hadjar) and Ain Berda raifall gages. The results of the frequency study of stochastically generated annual series (Pearson's distribution model) and the regression analysis (least square method) permitted to develop an envelope curve of heavy rainfalls distribution in the region. This result is used to evaluate, from daily rainfall recordings, the amount of rain that could be recorded over a specified duration in basins that lack recording rain gauges.

Influence of climatic factors and the overexploitation of aquifers on the equilibrium of the freshwater and saltwater interface: case of Annaba region (north-east of Algeria)

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Abstract:
Like Mediterranean countries, water resources in Algeria remain dependent on rainfall that supplies the aquifers. Over the last years, the phenomenon of climate change has caused very significant reductions in rainfall resulted a shortage of water inflows in aquifers. Parallel to that, we note an increasing freshwater demand, which requires a greater solicitation of groundwater, often, result an overexploitation of aquifers. However in coastal aquifers this disequilibrium can be compensated by the saltwater intrusion with adverse impacts on water quality. This paper focuses on the evolution of the disequilibrium of the Freshwater and Saltwater Interface in coastal aquifers influenced by the excessive pumping. Annaba city is supplied from two batteries of boreholes, the Salines area and the dunes of Bouteldja, situated less than 5 km from the coastline. Water flows extracted are near of 1500 l / s, but not compensated through water infiltration; whose show a significant decrease last years, this drop has resulted firstly, the increase of water salinity, whose origin is either natural or anthropogenic. To put in evidence the origin of this water salinity, we used hydrochemical tool for water characterization in Annaba aquifer system. In this aim, we studied the chemical elements evolution in a South-North profile. Chlorides and Sodium concentrations show an increase in South-North direction. The values of Bromines / Chlorides ratio confirm a marine salinity origin.

The investigation of sediment processes in rivers by means of the Acoustic Doppler Profiler

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Abstract:
The measurement of sediment processes at the scale of a river cross-section is desirable for the evaluation of many issues related to river hydro-morphodynamics, such as climate change impacts, maintenance of navigation channels and hydropower intakes. Suspended- and bed-load have traditionally been measured by means of cumbersome techniques that are difficult, especially in large rivers. The acoustics for the investigation of small-scale sedimetological processes gained acceptance in the marine community because of its capability of simultaneously profiling, sediment concentration and size distribution, non-intrusively, and with high temporal and spatial resolution. The application of these methods in true riverine case studies presents additional difficulties mainly related to water depths and stream currents that limit sound propagation into water and challenge the instruments deployment especially during floods. The Acoustic Doppler Current Profiler (ADCP), primarily devoted to assess the flow discharge, overcame these difficulties to some degree. Indeed, the ADCP, deployed from a moving boat, was used to estimate (i) the roughness velocity due to river-bed shear, (ii) the multi-frequency backscatter from suspended particles that is related to suspended-load features, and (iii) the Doppler velocity induced from moving particles at the river-bed thus inferring the bed-load rate. This article introduces the motivations for using the ADCP for sediment processes investigation other than for flow discharge measurement, summarizes the developed methods and indicates future desirable improvements.

Contribution of hydrochemistry to the characterization and assessment of the water resources. The case of Tebessa Alluvial Aquifer (ALGERIA)

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Abstract:
Assessment of the water resources of an aquiferous system requires the knowledge of geometric and hydrodynamic features. In the Mio-Plio-quaternary aquifer of the plain of Tebessa (Algeria), the groundwater quality is deteriorating. Different methods using geochemistry (ions Na+, Cl−, SO4--, NO3-) and conductivity are compared with the hydrogeological information to identify the main processes involved in the increase in pollution. The evaluation for water contamination necessity the method proposed by Pusalti (2009), for irrigation waters, and on that proposed by Neubert et al (2008), for those intended for drinkable water supply .it is a new technique of indexation of water sensibility to pollution. It combines data from the chemistry of water and the results obtained by applying the DRASTIC model to the area of study. The obtained maps of sensibility reveal zones that coincide almost perfectly with those of strong anthropological activities. A policy of management of water is inevitable to save this unconfined aquifer and provide the data necessary to define the area at increased risk from these phenomena.

Analysis of drought characteristics for improved understanding of a water resource system

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Abstract:
Droughts are a reoccurring feature of the UK climate; recent drought events (2004-2006 & 2010-2012) have highlighted the UK's continued vulnerability to this hazard. There is a need for further understanding of extreme events, particularly from a water resource perspective. A number of drought indices have been developed to improve our understanding of drought characteristics such as frequency, severity and duration. However little of this research is applied to water resource management in the water supply sector. Improved understanding of drought characteristics using drought indices can inform water resource management plans and enhance future drought resilience. This study applies the standardised precipitation index (SPI) to a series of rainfall records (1962-2012) across the water supply region of a single utility provider. Key droughts within this period are analysed to develop an understanding of the meteorological characteristics that lead to, exist during and terminate drought events. The results of this analysis highlight how drought severity and duration can be variable across a small scale water supply region, indicating that the spatial coherence of drought events cannot be assumed.

Coupling hydrology, geochemistry and hydrodynamic towards rational management of discontinuous aquifers. Application to the Ursuya massif (Basque Country, France)

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Abstract:
The metamorphic massif of Ursuya (French Basque Country) is a strategic aquifer for the water supply of southwestern France. A multidisciplinary approach, conducted between 2009 and 2013 has led to understand the behaviour of this system made of discontinuous media. The input signal was characterized by both quantitative and qualitative methods. Monitoring of climate parameters was used to estimate the amount of the aquifer recharge. Isotopic and geochemical characteristics of rainwater were studied together with groundwater geochemistry to delineate the water-rock interactions along the underground flowpaths. The chemical characteristics of groundwater, the residence times (less than 10 years to more than 50 years) and the associated mixing processes allow the achievement of a conceptual model of the groundwater flow. It points out the role of the weathering profile from the point of view of mineralization as well as flowpaths. Finally, a quantitative approach shows highly heterogeneous hydrodynamic properties, in relation with the weathering profile development. These results are synthesized and validated by a numerical model. This numerical model and all these results constitute the basis for a rational management of the Ursuya aquifer, in a region subject to a constant increase in water needs.

The origins of water-sources in the region of Annaba: confirmation by the isotopic tools

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Abstract:
The studied area contains several water tables which are either superficial or deep. They constitute the main sources of groundwaters. The complexity of the exchange between groundwater and superficial water as well as the casting of urban and industrial wastes remain unclear which require the application of isotopic techniques. Hence, a campaign involved 48 samples was conducted. We attempted to find the links between those groundwaters. We noticed that the water levels of oxygen 18 (18O) range from -6.5 ‰ in Orelait to 0.12 ‰ in Oued Meboudja. The majority of oxygen-18 values is homogenous and is less than -5 ‰. However, some values belong to the evaporated water area indicating an enrichment of these waters.
According to Tritium levels, we notice three main groups:
The very recent waters: the levels were above 15 UT,
Recent waters: the levels were between 5 and 6 UT
Ancient waters: the levels were below 6 UT.
The isotopic study showed that evaporation is important in the region.

Modeling hydraulic regime and water quality of Sebou river (Morocco): Understanding interactions for a better management

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Abstract:
In this study, a first attempt is performed to model the hydraulic regime and water quality of Sebou river in the Gharb agricultural zone (Morocco). A 90 km long reach situated upstream a reservoir dam is studied during the low flow periods during which water resources are very scarce. Agriculture is the major consumer of rivers water via many pumping stations installed along the watercourse. Also, hydraulic regime is influenced by the river's meandering morphology and the ongoing management of the dam. Water quality is very problematic due to organic pollution generated by many sugar plants wastes. Rejected wastes are untreated and occur intensively during the low flow period of the year. In other hand, an important agricultural development program was undertaking in order to produce raw material for agro industrial plants which are the largest employment sector in the region. Hence, simple closure of these units cannot be feasible, since the socioeconomically role they insure. The Water Quality Analysis Simulation Program code was used in this study. Hydraulic simulations results predict water depth, water flow and the available water reserve in the dam reservoir with a good accuracy. Several solutions have been undertaken to overcome the lack of data as the interpretation of aerial photos and field investigations. In water quality, dissolved oxygen and biological oxygen demand were simulated with the model. The impact on the oxygen depletion of each plant wastewater was estimated. Model developed can predict the impact on river water quality of future waste treatment actions and can help for a better locations choosing for future plants installation. This study focus on the good understanding of all interactions influencing the river water flow and quality. The proposed model is a synthesis tool that can be easily used as a management tool for a complex ecosystem.

Operational Hydrologic/Reservoir Application with EPS Driven Inflow Forecasts

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Abstract:
Deterministic weather predictions and corresponding streamflow estimations directly restrict the manager on yes/no response which is inadequate for making a complete decision especially for dam and gate operations. The aim of this study is to establish effective operating policies for a multi-purpose reservoir by means of probabilistic weather products and integrated hydrological forecasting instruments. The application basin of Yuvacık has high variable climatic conditions and limited reservoir capacity compared with its annual water potential. Besides, snow is considered as a vital element for its operating policy, since there is considerable snowmelt contribution to streamflow during the melt season. Daily targets make hourly release decisions a challenging task regarding the constrained downstream safe channel capacity especially in spring months when the discharges increase. An integrated basin/reservoir forecasting system combining probabilistic weather predictions and a calibrated/validated hydrological model is developed to provide probabilistic inflow predictions for Yuvacık Dam. One of the key advances that EPS brings is generating probabilistic and medium range (2-10 days) products and provides 51 different scenarios for weather forecast. Predicted inflows computed by HEC-HMS model are used as the main forcing inputs into HEC-ResSim for daily operation of reservoir. The reservoir model enables to have effective operational decisions under dynamic climate and hydrologic conditions where a case study is carried out for the 2012 water year. The main merit part of this work is exploiting EPS data for the first time in Turkey as an operational hydrologic/reservoir application. The EPS streamflows provide enlarged vision of taking decisions on spillway releases and water supply where final decisions can be chosen with respect to dispersion and uncertainty of results.

Phenomenon of denitrification associated with the mobility of chromium and tin case of Meboudja plain.

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Abstract:
In the region of Sidi Amar Annaba South. Storage of industrial waste from the Arcelor-Mittal Steel, complex directly on the floor produced an infiltration of heavy metals to the under saturated and groundwater area. To know the exact origin of some pollutants and their evolution in time, monthly monitoring of water chemistry (potential hydrogen, potential of oxydo-reduction, temperature, conductivity, Oxygen, Calcium, Magnesium, Sodium, Potasium, Chlorine, sulfate, bicarbonate, Nitrate, Strontium, total Chrome, total Tin) was performed on wells for water cycle.
Statistical analysis shows a common origin of chromium and tin that would be due to electroplating waste. The temporal evolution of these elements highlights the influence of several factors (potential hydrogen, potential of oxydo-reduction, rainfall and pumping) in the dissolution of these species and the evolution of the dominant aqueous species. There presentation of water points on the Eh-pH equilibrium diagram indicates that chromium may appear in the water table in two complex forms, trivalent and hexavalent by against the tin is in the hexavalent form.

Groundwater Contaminant Transport 1-D FDM Approach

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Abstract:
Management of ground water resources including both quantity and quality requires the ability to establish a regional groundwater balance, to calculate flow of ground water, to predict water regimes in aquifers in response to proposed management schemes, to predict changes in water quality, to predict the transport of response of an aquifer system, both in terms of quantity which is observed as water levels and quality, is provided by flow and solute transport models that describe the response of the considered groundwater system to excitations.
When the contaminant is subject to non-linear degradation or decay, or it is characterized by a chemical constituent that follows a non-linear sorption isotherm, the resulting differential equation is non-linear. Analytical solution of non-linear differential equation is difficult. In the present thesis analytical model is The practical scenario of an instantaneous spill is studied for situations of non-linear decay, non-linear Freundlich isotherm, and non-linear Langmuir isotherm.
The FDM predictions were found to be in excellent agreement with analytical solutions for a wide range of field conditions with regard to dispersion and source definition. The new developed numerical model can be used for the forecasting of contaminant dispersion in laboratory and field under non-linear reactions, or for the quantitative description of the effect of non-linearity in the sorption parameters, on the time-space distribution of the contaminant. The implicit method used here which is unconditionally stable.

Use of treated Waste water for the development of drylands-possible hazards

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Abstract:
Allocation of water to drylands regions for the purpose of increasing agricultural activity is not free risk. Intensive cultivation may degrade soil structure, weaken aggregate stability , and decrease soil organic matter(OM) content, all of which may , in turn ,increase the possibility for development of runoff and erosion. The use treated waste water (TWW) for irrigation could increase the likelihood for and the magnitude of the aforementioned occurrences, because of the higher loads of OM and the levels sodicity and salinity in this water compared with fresh water. The adverse effects of irrigation with TWW are expected to take place not during the irrigation season, but rather during winter when the soil is exposed to rain water (ie water without electrolytes), which increases the sensitivity of soil clays to the processes of swelling and dispersion.
In the current presentation we summarize recent data , obtained on clay and sandy clay soils, which indicated that both degree of tillage and irrigation with TWW affected a number of soil physical properties and content and characteristicsof soil OM.The relatuionship between the changes in physical parameter s and those in OM was not consistent. Concerning the impact of tillage, a trend was noted whereby high level of aggregate stability and saturated hydraulic conductivity were associated with the presence in the soil of young highly aliphatic OM(non-cultivated TWW-irrigated soil),.In the case of TWWapplication , no conclusive trends could have been detected as the relationship between soil physical parameters and those of the OM depended on the type of soil and tillage . Based on those observations ,it is therefore recommended that caution should be exercised when introducing the use of TWW for irrigation in newly cultivated dryland soils and that change in indices related to soil structural stability and OM content and characteristics should be closely monitored to ensure sustainable crop production.

Making management decisions on environment protection based on the assessment of a danger level of subsurface contamination

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Abstract:
In most countries an approach based on the risk assessment in money terms of negative consequences of contamination is used to make management decisions on environment protection. At this, the risk assessment is often problematic. We proposed to make management decisions on environment protection based on a danger level, which is equal to a predicted time (t) of object contamination. The following danger levels were distinguished by a correlation of predicted contamination time and remediation time: crisis situation, critical, high, moderate and low levels. For each of these danger levels corresponding management decisions were developed including engineering and remediation actions, estimating, controlling and special monitoring and assessment of assimilative soil capability. We developed the scheme of danger level validation based on a probable error (Δt_p) of contamination time estimated by two sets of calculated parameters providing determination of minimal and maximal contamination time. If ($t \pm \Delta t_p$) is within a distinguished danger level zone, calculated parameters are considered to be reliable. Even through one of $t \pm \Delta t_p$ ends lies in an adjacent danger zone, it requires additional research to specify calculated parameters and predictions on an adopted mathematical model.

Geostatistical modeling of nitrate pollution of groundwater in the Mitidja

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Abstract:
The study aims to evaluate pollution by nitrates of water of the rainfall groundwater of the Mitidja.
The geostatistic approach is justified by the great space-time variability of the characterized hydrochimic data of the remainder by different sampling and chemical analyses from various qualities. The research will study the space evolution of pollution by putting forward the zones of strong content through a probabilistic study, by using the software SURFER 10 coupled to a GIS. The identification of the space structure of the contents and the choice of the method of interpolation will be preceded by an exploratory and statistical analysis by the available data. This analysis will make it possible to quantify the uncertainty of the contents while polluting which are produced.
The geostatistic approach allowing cartographic working of the hydrochimic information will take as a starting point the model "GeoSipol" (http:/www.geosipol.org.).

Study of surface water quality in the Wadi El Harrach for its use in the artificial groundwater recharge of the Mitidja (North Algeria)

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Abstract:
The Mitidja coastal groundwater which extends over an area of 1 450 km2 is a strategic resource in the Algiers region. The high dependence of the regional economy on the use of this groundwater forces us to have recourse to its artificial recharge from the Wadi El Harrach in its upstream part. This system of artificial recharge has shown its effectiveness in the development of water resource mentioned in the succeeding works in several regions of the world. The objective of this study is to: Increase the reserves of water inputs by infiltration, raise the water level and its good quality in wells and boreholes, reduce losses to the sea, and address seawater intrusion by maintaining balance in the freshwater-saltwater interface in the downstream part of the groundwater basin. After analyzing the situation, it was noticed that a qualitative monitoring of the Wadi water for the groundwater recharge has to be done. For this purpose, we proceeded during three successive years (2010, 2011 and 2012) to the monthly sampling of water in the upstream part of the Wadi El Harrach for chemical analysis. The variation of the sediment transport concentration will be also measured. This monitoring aims to characterize the water quality and avoid clogging in the proposed recharge area. The results of these analyses showed the good chemical quality according to the analyses we performed in the laboratory during the three years, but they are too loaded with suspended matters. We noticed that these fine particles come from the grinding of limestone of sandpit located upstream of the area of the proposed recharge system. This problem can be solved by a water supply upstream of sandpit. For the recharge, we propose the method of using two wells for dual use, which means that it can be used for water supply and extraction. This solution is inexpensive in our case and could easily be used as wells are already drilled in the upstream part. This solution increases over time the piezometric level and also reduce groundwater contamination by saltwater in the downstream part.

Evaluation of Climate Change Impact on Blue Nile Basin Cascade Reservoir operation (Case Study of proposed reservoirs on the Main Blue Nile River Basin, Ethiopia)

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Abstract:
This study mainly deals with evaluation of climate change impact on Blue Nile basin cascade reservoir operation. To evaluate the impact of climate change, climate change scenarios of evapotranspiration and precipitation were developed for three periods using output of ECHAM5 with RCM for A1B emission scenario. A hydrological model, HEC-HMS, was used in order to simulate current and future inflow volume to the reservoirs. The projected future climate variable shows an increasing trend for both maximum and minimum temperature and evapotranspiration but precipitation shows fluctuating trend in the next century. Relative to the current condition, the average annual open water evaporation for Beko-Abo and Mandaya reservoir shows increasing trend whereas Border reservoir shows decreasing trend. Comparison to the base period and the future period average annual inflow vloume shows an increase for Beko-Abo and Mandaya and at Border reservoir adecrease in volume observed. The average annual power generation using HEC-ReSim also shows increase at Beko-Abo and Mandaya hydropower stations whereas slightly decreasing for Border hydropower station. On average the time based and volumetric reliability of the reservoirs estimated to be more than 90%. The resilience of the reservoirs is below 50% and their vulnerability is less than 50%. Therefore, these performance indices reveal good performance of the reservoirs except the speed of recovery of the reservoir from failure because ther reservoir will not be able to recover from failure to safe state.

Water quality in Mining Basin – Gafsa Tunisia

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Abstract:
Tunisia is suffering not only from the problem of water shortage but also from water quality. In fact, about 50% of water has a high salinity (>1.5g/l). Moreover, there are several parameters which affect water quality such as sodium and fluoride, whose excess may induce human health risk. In Tunisia, the mining basin area has a huge trouble of industrial waste which may affect water quality of the groundwater. Therefore, the purpose of this work is to assess the drinking water quality in Basin Mining and the impact of fluorine.
Water samplings were carried from eight well drilling in the area of mining region (Gafsa governorate). Then, specific water analysis was implemented in the laboratory to determine physical and chemical parameters.The water analysis showed that there are high concentrations of some parameters such as fluorine, sodium, sulfate. However, some of them have a serious human health risks. Fluorine (F) is necessary for the human body, but its overabundance lead to serious diseases. Moreover, Sodium fluoride and sodium silicofluoride are more soluble. They may spread in animals and plants and their risk are high. However, the more complex particles such as cryolite and fluorite, almost insoluble, are more stable and less toxic. Furthermore, the assessment of fluorine in the drinking water shows that this parameter exceed European standards (1.5mg/l) and Tunisian (2mg/l). Therefore, in this study, a method was applied to remove fluorine and to reduce its effect on human health. In fact, the electrodialysis method was assigned and showed a good performance.
High concentration of Fluorine in drinking water may increase the risk of serious diseases. Therefore, the assessment of this parameter and its removal will be helpful for the decision makers to preserve drinking water and to protect human health.

Evaluation on Sustainable Groundwater Resources in Feng-Lin Area by Conjunctive Use with Surface Water in the Whole Basin

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Abstract:
Steep terrain and insufficient regulatory capacity in Taiwan have made conjunctive use of surface water and groundwater an important issue on water resource management. In order to avoid over withdrawal of groundwater in a developing region located in the upstream region of Hua-Lien River basin in eastern Taiwan, we assess the impact of demanded water supply on groundwater drawdown on both spatial and temporal scales. In this study, a groundwater model for whole Hua-Lien River basin was built for better control of numerical boundaries. MODFLOW model associated with PEST optimization tool, artificial adjustment and field data during were used to calibrate and verify the distribution of hydraulic conductivity in the basin. The verified model was then employed to perform sensitivity analysis on key parameters (river leakance and inflows at all upstream branches in the basin) and assess the impact of different withdrawal rates on regional groundwater behavior. Based on different degrees of development, four different withdrawal rates were applied to Feng -Lin area and were represented by 16 distributed wells. Sensitivity analysis shows a quick response between rivers and groundwater in most parts of the basin. By analyzing water budgets for whole basin and sub-regions, we found that the interaction between rivers and groundwater is influential for whole basin. However, the inflows at upstream branches are significant for sub-regions. With the dry year data in 2002, the results for applying different withdrawal rates in Feng -Lin area show that the sustainable withdrawal rate of groundwater in Fon-Lin area need to be less than 4 cms.

Streamflow depletion by well using the program Glover

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Abstract:
Groundwater pumping can reduce the water flow to streams and rivers, therefore impacting ecosystems and water quality. Several analytical and numerical models have been developed in the past decades in order to understand and describe the streamflow depletion caused by groundwater pumping. The streamflow depletion program Glover developed by IGME (Institito Geológico y Minero de España) is herein used to examine stream depletion caused by pumping from a well that is located near the river. It calculates the water flow from the stream to the well under the assumption that the aquifer is fully connected with the river itself. In detail, the Glover-Jenkins model is used, that is based on the analytical solution of an homogeneous, isotropic and semi-indefinite aquifer with a constant values of transmissivity and storativity.
The grade to which groundwater pumping depletes surface water supplies depends on several features such as: the degree to which the river and aquifer are interconnected, the distance between the river and the pumping source, the rate of pumping, the physical characteristics of the aquifer, and do on. In particular the Glover software allows to analyze the influence of the distance between the river and the well, the rate of pumping, the transmissivity and storativity.
The results show that the rate of stream depletion associated with pumping is proportional to the rate of groundwater pumping. Highly transmissive aquifers with limited water storage capacity will transmit effects more rapidly than aquifers with lower permeability or higher storage capacity. Finally, depletion decreases for increasing distance of the well from the river.

Towards a specific definition of alpine water uses for accurate quantification

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Abstract:
Several integrated studies on water management have been conducted recently in the Alps. They combine water resources and uses estimations in order to identify water scarcity issues that could occur in mountainous regions. Regarding the quantification of water resources availability, these works often rely on well-known hydro-climatic science and exhaustive datasets. However, regarding water uses, direct measurements are rare and researchers either depend on rough estimations given by water managers or create indirect datasets using proxies. Therefore, there is a strong need to correctly quantify water uses and to define a monitoring methodology in alpine regions. But before that, the definition and conceptual scheme of water use must be clarified.
First, there is some confusion about the terms used in water management and scientific literature, like for instance water 'needs', 'uses', 'demands', 'withdrawals' or 'consumption', but also between the terms 'drinking', 'delivered' and 'household' waters. In this work we propose a methodical terminology to precisely define water uses in mountainous territories.
Secondly, when water uses need to be quantified, many questions arise on how they are conceptualised, from a systemic approach. Which kind of water system should be considered: hydrological or human-impacted catchment? From which point of view should we apprehend water uses: preservation of water resources or management of water use conflicts? What about the upstream-downstream issue? Which spatial scale should be considered when uses have to be compared to other uses and water resources?
Block-diagrams have been designed to answer these questions and to illustrate the different definitions of alpine water uses. For each conceptual definition, scenarios of water balance between water uses and resources are computed. The most suitable systemic and spatial approaches capable of highlighting local alpine water shortages are then identified. This gives the first guidelines for a monitoring strategy.

A review of impact studies of hydraulic fracturing on water resources

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Abstract:
Hydraulic fracturing or fracking is a drilling technique to create fractures in the deep layers rock injecting a highly pressurized fluid, which is a mix of water, sand and chemicals additives. This method is used to create unconventional oil and gas wells, geothermal wells and even water wells. Hydraulic fracturing has been used since the late 1940s, but nowadays raises concerns regarding its potential environmental impacts. Mainly issues related to this method are: the microseismic effect on the nearby areas, the potential impact in the contamination of ground and surface waters and the large amounts of water needed for the process. This work focuses on the water related issues and it gives a critical look about possible influences of this process on the water resources management. Furthermore the poster describes the diffusions of fracking around the world along, the possible future developments of this method and the U.S.A. and European legal framework. This poster aims to evaluate if drilling method will affect the local and the global water resources.

Geophysical investigation of the fresh-saline water interface in the Coastal area of Abergwyngregyn

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Abstract:
The importance of the study of saline/fresh water incursion cannot be over-emphasized. Borehole sampling has been extensively used, but it is intrusive, quite expensive and time consuming. Electrical resistivity and electromagnetic techniques have proved successful in groundwater studies since geologic formation properties like porosity and permeability can be correlated with electrical conductivity signatures. Non-intrusive surface geophysical mapping comprising electrical resistivity and electromagnetic methods has been employed to investigate freshwater intrusion and delineate the fresh-saline water interface at the inter-tidal area of Abergwygregyn, North Wales, United Kingdom. Frequency Domain Electromagnetic Profiling and Constant Separation Traversing were used to produce 2-D images and contour plots enabling the identification of freshwater plumes onshore and in the central parts of the study area. Ground truth methods comprised chemical analyses and detailed, point specific information on the stratigraphy. The freshwater intruding from the coastal area appears to be pushing the saline-water further offshore due to the high piezometric head caused by the mountains and hills of Snowdonia adjacent to the study area. The fresh/saline water interface correlates quite well with previous studies carried out in the area. On the basis of the results of the resistivity and conductivity geophysical investigations, the freshwater plumes and fresh/saline water interface in the study area were effectively identified and delineated.

Hydrogeological modeling of a fractured aquifer

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Abstract:
The Mulino delle Vene springs (Carpineti, Reggio Emilia Province) are a challenging case study in hydrogeological research, which can be exploited to improve knowledge and experience in the numerical modelling of fractured non-karst aquifers. They are one of the most important springs of the northern Apennines for mean annual discharge (110 ls-1) and dynamic storage (1.57 Mm3). They flow out from an intensively fractured arenite slab, with a recharge area of 5.2 km2. Starting from 2013, they were equipped with a pressure-transducer which allowed to collect continuous discharge data. Moreover, a well-known hydrogeological setting together with 2 pumping tests and groundwater level monitoring in four wells are available. These hydrogeological data have been used to build a finite-element model with Feflow code (Wasy). Simulations have been carried out considering an Equivalent Porous Media approach (EPM). This is an approximation of the network of discontinuities crossing the whole aquifer, and do not consider fractures widths and their degree of interconnection. The numerical model has been calibrated against the discharge depletion curve, without rainfall recharge, for estimating the mean hydraulic conductivity and storativity of the aquifer. Furthermore, rainfall and snowmelt have been applied and so simulated discharge values were compared to the daily springs outflow for the whole monitoring period. Despite first results have highlighted the general capability of the EPM approach for simulating springs discharging from fractured aquifers, further efforts will be spent to take into account the different hydrogeological characteristics of the upper part of aquifer which feed Mulino delle Vene springs, even considering more sophisticated approaches such as Multi-Domain EPM, Discrete Fracture Network (DFN) and Hybrid (EPM for matrix and DFN for fractures).

Dissolved Oxygen modelling using Artificial Neural Networks

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Abstract:
This paper describes the use of some physical and chemical parameters proceeding from water samples of Meia Ponte river, whose drainage basin is located in metropolitan region of Goiania, capital of Goias state, Brazil, for determination of dissolved oxygen parameter. The study of dissolved oxygen is important because its quantity on the river body is directly connected with the capacity of that body to sustain life. The Artificial Neural Networks technique is used, through the error back-propagation training algorithm, for modeling dissolved oxygen by using ten physical and chemical parameters as the network input. Most ecological systems have shown not having plenty of databases to describe the variables of the system, because of the difficulty of installing sensors and collecting data; for this reason, a technique is used to expand the training database in order to get a more well trained network. Then the data are normalized [0,1] due to the sigmoidal transfer function used. After this brief processing, it is then divided in two data sets that are used for supervised training and validation tests. The ANN architecture is discussed, as well as the results. The objective is not only to find the best architecture for the given problem but also validate the accuracy of prediction for the dissolved oxygen values. A good accuracy of dissolved oxygen means that the tool can be used for future researches predicting dissolved oxygen based on the extrapolation of one of the ten input parameters. These parameters may vary due to changes in the ecological river environment. It is presented an application that implements the Artificial Neural Network techniques, programmed using Java language, multi platform, open source code, that can be used by any interested researcher free of cost.

Efficacy of Communication in Water Resource Management and Sustainability

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Abstract:
One of the major factors causing setback in water resource management and sustainability is communication breakdown. Lack of well-grounded communication process will only exacerbate existing challenges in the water resource and environmental management scheme. Water resource utilization, management and sustainability involve a chain of processes, and communication is an indispensable tool for harmonious operation of these processes. In all the institutions involved in water management, the strategies and functions of the different bodies vary, and for efficient, equitable and sustainable development and management, these units must work in harmony in terms of their structures, policies, rules and regulation, a feat that can only be achieved by excellent and strategic communication. Governments always establish laws, the implementation of which will require great resources, perfection of design of operation, technical expertise, safety management, cohesive and vigilant teaming, experienced leadership, political will and social responsibility. Lack of effective communication will result in failures of policies and operational procedures, leading to degradation in water resource management. This research considers Lagos State with increasing space occupation and population density without enough public water supplies, misappropriation of water resources, un-gauged and undocumented abstraction, increasing contamination of water bodies, and climatic fluctuations. Therefore, how can technical information be efficiently and effectively communicated to participants in the water resource management activities? How will organizational policies and Government laws be integrated, and be communicated to both providers and users in a way that will engender understanding of the processes involved in utilization, management and sustainability? What training might be employed to acquaint Government officials, civic society, institutions and stakeholders with communication tools that will aid responsible utilization of water resource and management? These are pertinent questions this study aims to analyze.

MaWaR (Management of Water Resources): a Simulation Game Focused on Drought Management

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Abstract:
MaWaR (Management of Water Resources)is a strategy game based on simulating hydrological cycles at a user defined catchment or in predefined catchment. The player represents a decision maker that regulates the water consumption by assembling pricing policy. The consumers are inhabitants, industry of several orders of importance, and agriculture. The selling of water generates a profit, while consumption regulations and assigning legislation changes create financial losses. The goal of the game is to avoid a lack of water that is defined by dropping the water level of user defined (or predefined)water reservoir bellow a critical value. The water reservoir is described by its batygraphic curves. The transport of water in the catchment is described by a deterministic model that covers evaporation, complex porous media within vadose zone and groundwater, open channel river flow, and surface runoff.

Natural Capital Accounting for Water: Measuring and mapping water quality accounts, evidence from small island developing Caribbean states.

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Abstract:
Natural capital is an important environmental-economic asset. It can include resources such as minerals and energy, forest timber, agricultural land, fisheries and water. It also include ecosystem producing services such as, air and water filtration, flood protection, and habitat for fisheries and wildlife. These values are not readily captured in markets, so we don't really know how much they contribute to the economy and livelihoods. Natural capital accounting can provide detailed statistics for better management of the economy and by incorporating natural capital into national accounts, support better decisions for inclusive development (WAVES, 2014). Measuring and mapping the effects of water quality on nature and economy, ecosystem functions and their ability to provide ecosystem services, natural and anthropogenic roles in the provision of clean water are key research challenges to be addresed in this study. Pilot studies in water quality accounting will be conducted in small island developing Caribbean states, to better understand the interactions between water, ecosystems and the economy at the local level, and how that can be scaled up nationally and regionally.

Sensitivity of simulated groundwater recharge to multiple projections of climate change and scenarios of groundwater abstraction

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Abstract:
There are multiple sources of uncertainty associated with modelling the sensitivity of water resources to future climate change. In addition to climate and hydrological model prediction uncertainty, impacts to water resources include anthropogenic uncertainties around the characterisation of future water resource demand, which combines population pressure and water use efficiency. On the island Sjælland in Denmark, which includes urban (i.e. Copenhagen, Roskilde) as well as agricultural regions, a doubling of groundwater abstraction rates has been proposed in selected catchments to meet increasing water resource demands. Within this context, the present study analyses the sensitivity of the groundwater resource on Sjælland to increased abstraction rates and the feasibility of doing so under projected climate change. For 11 climate models from the EU project ENSEMBLES, the variables precipitation, temperature, and calculated reference evapotranspiration are first bias corrected with a distribution based scaling (DBS) method which is implemented at different spatial scales (i.e. 10 km grid to regional scale). The bias corrected climate variables are then used to force hydrological simulations of groundwater recharge under future climate conditions (2071-2100) with the National Water Resources Model (DK-model), which is set up in MIKE SHE, a distributed groundwater-surface water model. Scenarios of future groundwater abstraction are represented by imposing incremental percent increases to the current (2010) groundwater abstraction rates on Sjælland (i.e. +5%, +10%, etc.). The individual impacts of climate change and groundwater abstraction on groundwater recharge are quantified and compared to assess the relative sensitivity of the water resource. Finally, a variance decomposition method is applied to quantify the uncertainty contributions from the different climate models, subsequent bias correction methods, and groundwater abstraction scenarios to simulated groundwater recharge.

Management of water quality in a catchment-lake ecosystem with the use of modelling of mitigation measures and climate change

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Abstract:
Using a model chain comprising of a hydrological model (IHACRES), a catchment-scale models for phosphorus and nitrogen biogeochemistry (INCA-N,P) and a lake ecosystem model (CE-QUAL-W2), we quantified nutrient sources and water quality in a large central European catchment (the upper River Vltava in the Czech Republic, about 12,000 km^2) during the last half-century (1960–2010). The model chain was employed to analyze the impacts of future climate change and various potential trends in socio-economic development in the catchment on nutrient status and eutrophication of surface waters and also to suggest cost-optimum measures for achieving compliance of currently too high phosphorus concentrations in the runoff from the catchment and in the receiving reservoirs with the EU Water Framework Directive (WFD) standards for good ecological status. The climate change that was predicted for the period 2031-2060 with three regional climate models of different sensitivity to CO_2 emissions (ECHAM5-KNMI, HadRM3-HacCM3Q0, SMHIRCA-BMC) showed well discernible effects on hydrology and nutrient concentrations in streams and lakes, however, these impacts were low when compared to much larger influences of human activities and land use in the catchment. The best cost-effective set of mitigation measures to decrease phosphorus concentrations below the WFD standards included a high-efficiency P removal at most wastewater treatment plants combined with phosphorus-balanced fish production in fishponds and reduction of P losses from agricultural areas. However, these mitigation measures were shown on consultations with major stakeholders of the catchment problematic to realize due to their high costs and inconsistencies in the national legislation in the water management and surface water quality regulations.

Electrical conductivity monitoring in a Mediterranean river system: the case of the Llobregat River basin.

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Abstract:
Knowledge on sediment dynamics and sediment transport rates and loads is a basic issue to take into account when managing water systems. Sediment transport is inherent to fluvial systems and determines the water quality of the water body. These characteristics have an influence on the fluvial ecosystem, and also, determine the costs needed for water treatment for industrial, agricultural and domestic use of water.
Mediterranean fluvial systems are exposed to extreme variability of rainfall and discharge patterns. Periods of ephemeral, intense high flows alternate with long periods of low and very low flows. This is the case of the Llobregat River, a Mediterranean fluvial system that drains an area of 4900 km^2 and supplies half of the water needs of Barcelona city and its metropolitan area with a population about 3 million people. During high flows suspended sediment concentrations can reach high values (up to 15 g/l), but also dissolved solids concentrations can be high. Records of electrical conductivity, an indirect measurement of dissolved solids, show mean daily values in fluvial waters under 1000 μS/cm but exhibit values over 5.000 μS/cm during rainfall events. Instantaneous conductivity values up to 10.000 μS/cm have been recorded in the water quality stations that the Catalan Water Authorities had in this water system. Monitoring the electrical conductivity of waters is a must to record the range of daily changes, to follow the evolution with time and discharge, to record the spills from industries, to calculate the total dissolved load that these rivers transport, to use this data to calculate the indices needed to accomplish the European Water Framework Directory, to focus the sources of sediment, to assess the costs for water treatment and to improve water quality.

Adapting to Climate Change: Water distribution in BBA City: Algeria

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Abstract:
For over 20 years, eastern Algeria region had significant rainfall deficits that resulted in severe droughts, which seriously affected the water drinking in terms of quantity. Owing to considerations of affordability, water drinking is systematically underpriced because water is essential for life. Such a low price results in water being used inefficiently. This research presents the impact that a high leakage level in the water distribution network has on the water service price in BBA City and expected future water resources management scenarios in BBA watersheds by taking into account to the river flow simulated by GR2M using the outputs of climate models with emissions scenarios A1 and A1B. The analysis of the results shows a large economies can be made at the level of water losses touching up to 47% of the produced water volume and BBA city is expected to experience water stress before 2030.

An introduction to the database supported Distributed Hydrological modeling Tool: EasyDHM version 2.0

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Abstract:
Spatially distributed modeling is an important tool for simulating the hydrological cycle. This paper presents an overview of the distributed hydrological model EasyDHM developed in 2009 by our research group and introduces a new database supported version: EasyDHM version 2.0. The new version has been developed as a comprehensive, user-friendly standalone modeling framework, composed of three modules: pre-processing, core simulation and post-processing. Besides, an independent GIS tool with a hydrological analysis sub-module is developed to enhance the pre-process module and visualization function. Data storage media switching from text files to databases is the primary improvement of this version. Except for the user interface and the GIS tool, all modules being built into Dynamic Link Library is another improvements. And for the extensibility and calculation efficiency, the core simulation code in Fortran90 is rewritten in an object-oriented approach. A brief overview of an application of this version demonstrates the flexibility of the modeling framework, the convenience of the data management based scenarios and the satisfactory of the simulation results.

Groundwater resources in Moroccan oasis: challenges and opportunities

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Abstract:
The oasis areas in Morocco are located at the South-Eastern part of Atlas Mountains, on the margins of desert where the annual rainfall doesn't exceed 200 mm. In this arid region, Water is mainly provided by the khettara which are an ancestral groundwater mobilization system. The water drains by gravity, with the destination lower than the source, which is typically an upland aquifer. It allows water to be transported over long distances in hot dry climates without loss of much of the water by evaporation. The downstream of the khettara is connected to a network of canals for irrigation.
The water resources are divided between the families with regard to the number of labour days during the construction of these systems. All the water right holders are in a list with their attribution of water. The water rights can be sold or rent for a year or crop cycle. The rotation for irrigation depends on the number of family using Khettra's groundwater.
The irrigated lands are not too large, so to increase the income of farmers the agriculture is composed by three levels. The first is on the soil such as cereals and vegetables, the second in the palm trees and between those two levels, olives or grenadine trees. Although the water resources end the distribution doesn't fit the irrigation's needs, the crops are insufficient and the incomes are low. A part of population is living to urban areas.
The challenge is not only technical such switching the irrigation way to drip for example, but also requires an effort in building capacity of farmer to improve their skills enough to raise their standard of living. This is able to reduce the rate of immigration and continue to work the land and maintain oasis.

Hydrological processes modeling using advanced hydroinformatic tools

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Abstract:
The water has an essential role in the functioning of ecosystems by integrating the complex physical, chemical, and biological processes that sustain life. Water is a key factor in determining the productivity of ecosystems, biodiversity and species composition. Water is also essential for humanity: water supply systems for population, agriculture, fisheries, industries, and hydroelectric power depend on water supplies.
The modeling of hydrological processes is an important activity for water resources management, especially now, when the climate change is one of the major challenges of our century, with strong influence on hydrological processes dynamics. Climate change and needs for more knowledge in water resources require the use of advanced hydroinformatic tools in hydrological processes modeling. The rationale and purpose of advanced hydroinformatic tools is to develop a new relationship between the stakeholders and the users and suppliers of the systems: to offer the basis (systems) which supply useable results, the validity of which cannot be put in reasonable doubt by any of the stakeholders involved. For a successful modeling of hydrological processes also need specialists well trained and able to use advanced hydro-informatics tools. Results of modeling can be a useful tool for decision makers to taking efficient measures in social, economical and ecological domain regarding water resources, for an integrated water resources management.

Application of isotope Techniques in Verifying Groundwater Recharge Processes in Bulacan Province, Philippines

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Abstract:
Bulacan Province is one of the fastest growing provinces in the Philippines in terms of development and population. Groundwater has been the main source of water supply and water shortages, owing to the deterioration of water quality, mainly from high salinity, have been commonly experienced. Indiscriminate drilling by public and private entities threatens the groundwater system by inducing salt water intrusion into the freshwater aquifers. Isotope and chemical techniques were employed to verify the recharge processes to the groundwater and to delineate the source of salt water intrusion. Tritium, stable isotopes of hydrogen and oxygen, and major ions in the groundwater and surface water were determined. Major ion chemistry and tritium levels have indicated saline contamination of the groundwater in Bulacan. The profile of tritium concentrations, oxygen stable isotopes, and chloride concentration provided useful information for differentiating the source of salinity of the groundwater in specific of the aquifer sytems. The saline water contamination identified in the area can be classified according to the origin of the saline water : a) leaching of salts by percolating water, b) intrusion of saltwater bodies or connate marine water, and c) concentration of dissolved salts due to evaporation. The information generated from the study will be useful for groundwater development and management, improving the success rate of production drilling ultimate while protecting the groundwater system from salt water intrusion and overexploitation.

Impact of Climate Change on Evaluation of Future Water Demand in the Euphrates and Aleppo basin, Syria

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Abstract:
Syria is one of the Middle East countries that suffer from scarce in water resources availability, which affects the growth and development of economic activities. In this research the Water Evaluation and Planning (WEAP) model is applied to evaluate future water demand in the Euphrates and Aleppo (EAB) basin, Syria by taking into account the changes climate that may affect water demand in the domestic, industrial, and agricultural sectors until 2050. The climate change projections of temperature and precipitation were assessed using a new version of MAGICC/SCENGEN tool with two greenhouse gas emissions scenarios (A2 and B2) of the Intergovernmental Panel on Climate Change (IPCC). Based on the results of IPCC (A2, B2) scenarios projections, The EAB basin is likely to face a decrease in precipitation amount by 21% according to A2 and by 12% according to B2 while temperature would increase by about 2.5°C according to A2 and by 2 °C according to B2.
Within the three scenarios adopted in this research (1- available technology development; 2- increasing treated wastewater in agriculture and industry sectors; 3- and two combined scenarios), The results of the simulation of these scenarios showed that these scenarios effective to ease the pressure on water resources in EAB basin but not sustainable to bridge the gap between demand-supply by the year 2050, which leads to the deterioration of the available water resources.

Improved DRASTIC model and its applying for the assessment of phreatic groundwater vulnerability

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Abstract:
Groundwater vulnerability evaluation is to identify potential risks of groundwater being polluted that generated by aquifer intrinsic properties or by human activities. Based on different concepts of groundwater vulnerability at home and abroad, the inherent vulnerability and special vulnerability were put forwarded. For example, aquifer systems present intrinsic properties, but contamination and human activity presented special vulnerability. Vulnerability of groundwater is not a characteristic that can be directly measured in the field. This paper based on the traditional DRASTIC model and GIS techniques to evaluate aquifer vulnerability. In view of the fuzzy essential characteristic of groundwater vulnerability and many defects of DRASTIC model, DRSMIC model for assessing phreatic groundwater vulnerability is proposed. And the tone operator will be used to determine weights of indexes. By the range of DRMSIC index, a classification was generated, it can be divided into five vulnerability levels: very low, low, medium, high, and very high. Usually there is a immediate relationship between high vulnerability and poor water quality. As a case study, this paper carries out the phreatic groundwater vulnerability assessment in Chaoyang district Beijing city, and matches the vulnerability with nitrate content of the groundwater. The result indicates that the Improved DRASTIC model (DRSMIC model) is feasibile to assess phreatic groundwater in the study area. This is due to the improvement of parameters and the introduction of the tone operator to determine the weight. The assessment of groundwater vulnerability is an effective tool for groundwater planning and management, and it is a scientific basis for groundwater protection.

Characterisation of the main karst acquifers of the Tezbent plateau, Tebessa region, northeast of Algeria, using a hydrogeochemical approach

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Abstract:
The Hammemt Plain, situated in the northwest of the Tezbent mountain range, northeast of Algeria, drains carbonate aquifers through some important karst springs. The physical and chemical characteristics of spring and well water samples were studied for two years in order to assess the origin of groundwater and determine the factors driving the geochemical composition. The ionic speciation and mineral dissolution/precipitation was calculated. Water wells, characterizing groundwater circulation at shallow depths, are moderate to high mineralized waters of Na-HCO3 type. In contrast to the shallow environment, the CO2-rich, deeper waters are of the Ca–HCO3–SO4 type, and undergo significant changes in the baseline chemistry along flow lines with increasing residence time. The main factors controlling the groundwater composition and its seasonal variations are the geology, because of the presence of carbonate formations, the elevation and the rate of karst development. In both groups, the carbonate chemistry is diagnostic of the effect of karst development. The supersaturation with respect to calcite indicates CO2 degasing, occurring either inside the aquifer in open conduits, or at the outlet in reservoirs. The undersaturation with respect to calcite shows the existence of fast flow and short residence-time conditions inside the aquifer. In the present study, saturation indexes (SI) with respect to carbonate (calcite, dolomite, and aragonite) and evaporate (gypsum, anhydrite) minerals, as well as activities of soluble species, were calculated using the computer chemical program PHREEQC-2 version 2.10, because all the investigated groundwaters were very low in total dissolved solids, the expression of Deby and Huckel (1923) was used for the computation of coefficient activities.

Using Pyomo for Optimizing Groundwater Reservoir Operation in Tailan River Basin, China

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Abstract:
Tailan river basin is in the inland arid region at northwest of China. In this basin large evaporation, high river sediment, extreme imbalanced stream flow, and great difficulties in building surface water resources engineering severely restrict the local socioeconomic development. Groundwater resources are rich but less utilized in this basin. Constructing groundwater reservoir to improve the basin storage capacity is one of the most important approaches for alleviating the stress of water shortage of local area. Based on the analysis of recharge sources, recharge points and recharge modes of groundwater reservoir in Tailan river basin, this study focused on the optimal operation of the groundwater reservoir. The water supply LP model was built for maximizing the local irrigation benefit, which subjected to the storage capacity and the water supply capacity of groundwater reservoir. A new open source software package for modeling and solving mathematical programs in Python, Pyomo, was utilized to solve this water resources optimization model, which can help the users to more efficiently construct and compute the model. The computation results illustrated that, firstly under the condition of current water supply capacity the water demand of service area can be satisfied to resolve the local seasonal water shortage problems through the optimal operation of groundwater reservoir in Tailan river basin. Secondly the water service area of the groundwater reservoir can be amplified to stimulate the local socioeconomic development.

Characterization of sub-daily rainfall properties in three raingauges located in northeast Brazil

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Abstract:
This paper aims to evaluate the spatial and temporal characteristics of rainfall events of the past decade in three experimental basins located at the Brazilian Northeast. The study areas are located in Ceará (semiarid region) and two in Paraíba State, one in a tropical rainy zone and the other one in the semiarid region. This type of study is important to regions such as the Northeast Brazil and where the precipitation is measured only once a day and the density of pluviograph is very low. Thus, the definition of rain events in this study was based on two characteristics: minimum inter-event time (MIT) greater than 30 minutes and minimum event depth greater than 1.016 mm. Then, the events were classified according to the shape of hyetograph: rectangular, triangular, triangular with peak to left and to right, bimodal and not characterized. The aim of this study was to investigate the distribution patterns of rainfall events in three experimental basins, in order to see if there is any similarity in the distributions of events over wet years and dry years. Therefore, we evaluated the number of recorded events, the annual total rainfall, the percentages of each type of hyetograph, the distribution of these events throughout the year, as well as several other characteristics of rainfall events (intensity, frequency, etc.). The results indicated that the two experimental basins located in the semiarid region have similar distribution of events, while the one located in a tropical rainy area had very different characteristics. We also noticed that over the years, there is a pattern in the distribution in the transition from a dry to a rainy year. Furthermore, not characterized events, with a low participation on the total number of events, have importance due to the significant accumulated rainfall.

Research on the Comprehensive Effect of Ecological Regulation in the Mainstream of Weihe Basin

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Abstract:
Along With the increment of population and socio-economic growth in Weihe basin, the lack of basic ecological flow of main stream is becoming more serious. The sources and regulation means to guarantee the ecological flow is the key point of Weihe basin. On the basis of ecological regulation theory and the social-economic development and current situation of water supply and use in Weihe basin，in this paper principles of ecological regulation are presented, then the sources guarantee and dispatching channels for ecological water supply are analyzed from several aspects, including water saving，recycled water use，reservoirs operation for eco-flow，joint regulation of surface water and ground water，control of intake of hydropower，local water source project，inter-basin water transfer project. According to control target of the ecological environment water of the key section of the mainstream， mathematical model of water regulation for the mainstream of Wei River based is developed based on the multi-objective optimization algorithms and the reservoir operational rules. Scenarios are set based on the 7 regulational aspects and simulated by the model, the effects of water-saving, reservoirs operation for eco-flow，control of intake of hydropower on the ecological water in main stream are discussed in terms of the scenarios results. In addition, satisfaction degree of the ecological flow for each control section is analyzed, and the demand-supply balance of outside river, impact of water supply of important reservoirs after ecological operation are also discussed. The results and discussion show the comprehensive influence of ecological regulation and provides reference for similar studies in other basin.

New monitoring technique for rapid investigation of nitrates pollution in aquatic system

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Abstract:
In situ measurement with portable multi-parameter sonde was used in the framework of the Cleanwater project – LIFE09 ENV/RO/000612, for a rapid investigation of nitrates pollution in Barlad river basin, in rivers and domestic wells, in addition of laboratory measurements. Water samples were analysed in accredited Laboratory for water monitoring, such is the Vaslui Water Management System from Barlad basin. Sampling campaigns were performed monthly in the period april –november 2011. In order to find the main factors that influence the measurements, the behavior of equipment was analyzed in rivers, for different water sampling points along the river and the cross sections, taking into account the water level, the turbulence, the vegetation and the obstacles along the river. Results proved multiparameter sonde as useful device for rapid monitoring spatial distributions or temporal trends of nitrates or chlorophylle a, and detecting sudden changes in surface and ground water quality.

Assessing the importance of sub-basin heterogeneities for modelling the rainfall-runoff dynamics of the Okavango River for its transboundary management

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Abstract:
The neighbouring river systems Cubango (103.800km²) and Cuito (57.300km²) drain the south-eastern part of the Angolan Highlands and form the Okavango River after their confluence, thus providing 95% of the Okavango River discharge. Although they are characterised by similar environmental conditions, runoff records indicate remarkable differences regarding the hydrological dynamics. The Cubango River is known for rapid discharges with high peaks and low baseflow whereas the Cuito runoff appears more balanced. These differences are mainly caused by heterogeneous geological conditions or terrain features. The Cubango headwaters are dominated by crystalline bedrock and steeper, v-shaped valleys while the Cuito system is characterised by wide, swampy valleys and thick sand layers, thus attenuating runoff. This study presents model exercises which have been performed to assess and quantify these effects by applying the distributive model J2000g for each sub-basin. The models provide sufficient results representing the spatio-temporal runoff pattern, although some peaks are over- or underestimated, particularly in the Cuito catchment. This is explained by only scarce information on extent and structure of storages like aquifers or swamps in the Cuito system. However, model results aid to understand the differences of both tributaries in runoff generation and underpin the importance of flood plains regarding the control of runoff peaks and low flows in the Cuito system. Model exercises reveal that basin heterogeneity needs to be taken into account and must be parameterised appropriately for reliable modelling and assessing the entire Okavango River basin for managing the water resources of the transboundary Okavango River in a harmonic way.

Establishing Strategies for Sustainable Groundwater Management Plan for Typical Granitic Aquifers-A Pilot Study near Hyderabad, India

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Abstract:
For sustainable groundwater management plan (SGMP), a pilot study has been taken up in Palmakul-Kottur watershed (214 km2) near Hyderabad, India with integrated approach including remote sensing, hydro-meteorological, hydrological, hydrogeological, geophysical and hydrochemical studies. Geologically the watershed is underlain by Archaean granites (hard rocks) characterized by semi arid conditions with annual normal rainfall of 836 mm. Remarkable changes in land use pattern, have led to substantial impact on the groundwater recharge to the aquifers. The productive phreatic aquifer up to 30 m depth is desaturated forcing to tap the groundwater from deeper aquifers of 150 m depths leading to deeper groundwater levels (>20 meter below ground level) at places. Overall the stage of groundwater development (GD) varies from 76% to 104% in the area. Fluoride, nitrate and electrical conductivity with highest concentration of 4.6 mg/L, 300 mg/L and 4200 micro siemens/cm respectively is observed. For suggesting zone-wise SGMP, the area has been divided into three zones, using geographical information system (GIS). Zone-1 (95 km2) is characterized by high weathering (> 10 m) & moderate to high yield (> 1 liters/second (lps). Zone-2 (35 km2) by low weathering (<10 m & low yield (< 1 lps) and Zone-3 (84 km2) by poor groundwater quality (beyond drinking and irrigation permissible limits). The suggested SGMP includes site specific suitable artificial recharge structures (ARP), cultivation of irrigated dry (ID) crops, adaptation of micro irrigation techniques along with provision for alternate source of drinking water. Desilting of existing tanks and participatory groundwater management are recommended. The approach and the outcome of the pilot study will go a long way for upscaling in similar hydrogeological environs of the country.

Electricity vs Ecosystems - understanding and predicting hydropower impact on Swedish river flow

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Abstract:
The most radical anthropogenic impact on water systems in Sweden originates from the years 1900-1970, when the country was electrified and almost all rivers were regulated. The construction of dams and changes in water flow caused problems for ecosystems and thus modification of hydromorphology is today a recognized environmental indicator. To understand the consequences on flow dynamics, we have quantified the hydropower impact on river flow for Sweden by using the S-HYPE model and observations. Moreover, we have quantified the model skills in predicting hydropower impact on flow. The results show that the average redistribution of water during a year, due to regulation, is 19%, for the total discharge from Sweden. Distinct impact was found in seasonal flow patterns and flow duration curves. The median NSE for simulating hydropower impact on river flow was 0.71 for eight dams studied and the model results are thus recommended for decision support in further assessment studies on electricity production vs ecosystem protection.

Considering long term sedimentation for reservoir operation: Foum el Kherza (Biskra, Algeria)

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Abstract:
The present work deals with optimal reservoir operation in Aures region. This region is well known for its vulnerability to erosion, which will be identified by a rapid sedimentation of reservoirs located at its outlet. An optimized curve of reservoir sedimentation as a result of sediment-water power relationship will be used for future estimation of trapped sediment volume in the reservoir. Implicitly, this estimate of the useful volume is introduced into the reservoir operation optimization model using Explicit Stochastic Dynamic Programming (ESDP), in order to derive optimal management rules for each horizon. Optimal releases from this optimization are subsequently introduced in a neural model to extract a more flexible relation expressing the releases according to storage in the reservoir and water inflows. The results of this optimization showed optimal region-based management of the useful volume of the reservoir and thus flexibility of reservoir management is necessary to ensure the sustainability of the resource.

Oxidation and decontamination of secondary effluents by infiltration percolation process

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Abstract:
The infiltration percolation is an urban wastewater treatment process, it based on the purification capacity of the sol. The experimental study of this process consists in following its purification performances by using sand infiltrating bed and a daily hydraulic load of 0.27m3/m2 of secondary effluent from the treatment plant of Gabes (South-East of Tunisia).
The main objective of this work was to determine the oxidation and disinfection performances of the infiltration percolation technique in arid conditions of Tunisia.
The experimental study has shown the influence of the filter depth and temperature on the purification performances of infiltration percolation process.
Results indicated that the oxidation of organic matter and nitrogen takes place mainly in the surface layers of the sand filter and that the treatment efficiency of infiltration percolation process increases with the depth of the sand filter. A 50cm, the elimination of the carbon pollution was about 56%. At the same depth, the reduction of nitrogen pollution was 76.9%. At the output of the filter, mean reductions of COD and NH4-N were respectively 85.6% and 92%. The removal efficiencies of Total Coliforms, Fecal Coliforms and Fecal Streptococci obtained at 1.5m were respectively 2.41, 2.37 and 2.32 Ulog. At 50cm, the elimination of these bacteria generally does not exceed a logarithmic unit.

Urban stormwater source control policies: why and how?

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Abstract:
Stormwater source control is becoming a common strategy for urban stormwater management in many countries. It relies on regulations or other policy instruments compelling or inciting to implement, for each new urban development, small-scale facilities to locally store and manage stormwater. Local authorities that pioneered source control since the 1980s already observe that small-scale facilities systematically implemented over a catchment are able to influence its hydrological behaviour. This capability is the main strength of source control, as it allows compensating the negative effects of urbanization. Yet, it also represents its main risk: if initial decision-making is not sufficiently accurate, source control can produce long term negative effects. Because of its current spreading, source control will acquire an increasing role as a driver of hydrological changes in urban catchments, and the directions of these changes depend on current policy-making practices. This paper presents an analysis and a critical discussion of the main objectives that policy-makers attribute to stormwater source control. The investigation is based on a sample of French local authorities, completed by a literature review for international comparison. It identifies five main objectives, some typical of urban stormwater management and some more innovative: flood reduction, receiving waters protection, sustainable development, costs reduction, public awareness improvement. The discussion focuses on how current policy-making practices are able to translate these objectives in concrete policy instruments, and on which knowledge and tools could improve this process. It is shown that, for some objectives, basic knowledge is available, but the creation of policy instruments effective at the catchment scale and adapted to local conditions is still problematic. For others, substantial lacks of knowledge exist, casting doubts on long term effectiveness of current policy instruments. Research directions are identified to improve source control policies, and thus the future hydrologic behaviour of many urban catchments.

Hydro-economics and optimization of water resources systems: changing boundary conditions, targets and criteria of water management

Genetic Algorithms Optimization of Hedging Rules for Operation of the multi-purpose Ubonratana reservoir in Thailand

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Abstract:
Ubonratana multipurpose reservoir in north-eastern Thailand plays a significant role in water resources management by helping to reduce the impacts of floods and droughts in the region. The reservoir is operated by using rule curves to guide decision making for water releases. During low-flow periods, shortages will occur due to inability to fully meet the demand of various water users. However, water rationing (or hedging) during normal operational periods of the reservoir can go a long way in reducing the magnitudes of such shortages and hence its impacts but determining the best timing to ration and the rationed quantity is still problematic. Consequently, this study has developed an optimal hedging policy for Ubonratana based on its existing rule curves. The hedging policy was applied whenever the reservoir storage falls below a critical level. The two decision variables, i.e. the critical storage that triggers rationing and the rationing ratio, were optimised by genetic algorithms (GA). Both single stage (i.e. with one trigger and one rationing ratio) and double stages of the hedging policy were considered in the optimisation. To test the effect of the optimised hedging policies on reservoir performance, simulations were carried out in WEAP, forced alternatively with the existing rule curves (i.e. without hedging) and the optimised hedging policies. Performance was summarized in terms of reliability (time- and volume-based), vulnerability, resilience and sustainability. The results showed that the maximum single period water deficit, or vulnerability, was significantly reduced by using the optimised hedging rules. However, the number of water shortages increased with the optimised rules, causing the time-based reliability to worsen significantly. This should not be worrisome since, although the number of shortages increased, the associated shortage quantities were small, leaving the volumetric reliability largely unchanged. Both the resilience and sustainability indices were also largely unchanged.

Environmental equity as a criterion for water management

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Abstract:
Environmental equity is a concept derived from the (un)equal exposure to environmental degradation by different social groups, usually minorities and low-income people exposed to major environmental risks, also known as environmental justice. It is assumed that no group of people, independently of race, ethnicity or socio-economic class, should support, either in concentrated or unevenly distributed form, the negative consequences of unequal access to adequate quantities of acceptable water quality for sustainable livelihood, human well-being and socio-economic development. While most empirical investigations of environmental equity have focused on the geography of industrial pollution or the locations of landfills and waste sites and historical process in urban areas, few investigations have considered the access to water. In this paper the concept of environmental equity is explored as a criterion for water management. The perspective of *waterscape* is adopted in the analysis, as defined in the literature as "the ways in which flows of water, power and capital converge to produce uneven socio-ecological arrangements over space and time". This concept enabled the analysis of a typical coupled human-natural system: the Epitácio Pessoa reservoir, located in the drought-prone semiarid region of Brazil, suffering from poor management, which produces unequal access to water by population and farmers, particularly during drought periods. However, data and indicators from sanitation census indicate that population have practically equal access to water, not being able to reflect the actual picture. We argue in this paper that environmental equity can be an additional criterion on which to base an improved water management. Empirical data describe the characteristics of the different strata of population and farmers, upon which the unequal access to water is identified and discussed.

Investigation of Sustainable Development Potential for Ulubey Aquifer System, Turkey

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Abstract:
This study investigates sustainable development potential for Ulubey aquifer system which serves as an important water supply for Usak province, located in inner parts of the Aegean Region, Turkey. In recent years, growing population, accelerating industrial activities and on the contrary decreasing rainfall and contamination of the surface water resources made groundwater indispensable to meet domestic, agricultural and industrial water demands of Usak province. These facts necessitate setting up a sustainable groundwater development plan by determining the sustainable yield of the system, which is the aim of this study. To achieve this goal, a conceptual model is set up to comprehend the system and then a mathematical groundwater flow model is constructed to support this conceptual model and also to create and to test the alternative development scenarios. Results of the groundwater flow model show that system preserves the equilibrium conditions under present stresses. Future effects of possible increase in stresses are also simulated and response of the aquifer system is investigated. Based on the dynamic responses of the aquifer system to changing stresses, sustainable yield and sustainable pumping rate of the Ulubey aquifer are determined and compared with the safe yield of the system.

Strategic decision making under climate change: a case study on Lake Maggiore water system

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Abstract:
The water resources planning processes involve different kind of decisions that have to be evaluated under a stationary climate scenario assumption. Coherently, all the possible decision combinations are mutually compared as single alternatives. However, the ongoing climate change requires to re-consider this approach, in order to compare not individual alternatives, but families of alternatives that are characterized by the same structural decisions, i.e. by actions that have long term effects and entail irrevocable changes in the system, and may be associated to different normative and management decisions. The rational is that while the structural actions, once they have been implemented, cannot be easily modified, the normative and management decisions can be adapted to the evolving conditions. The paper consider this methodological problem in a real case study, in which a strategic decision has to be taken: a new dam was proposed to regulate Lake Maggiore outflow, but, alternatively, either the present dam can be maintained with its actual regulation normative or with new regulation normative. The problem was dealt with multi-criteria decision analysis involving many stakeholders. An exhaustive set of indicator has been defined in the participatory process, led under the integrated water resource management paradigm, and many efficient (in Pareto sense) regulation policies were identified. The paper explores different formulations of a synthetic index to evaluate and compare the effectiveness of the families of alternatives under both stationary and changing hydrological scenarios in order to assess their adaptability to the ongoing climate change. In order to improve the robustness of identified indexes, an uncertainty range has been also provided.

Green roof as a solution to solve stormwater management issues? Assessment on a long time period at the parcet scale

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Abstract:
Experimental green roof observations have shown a positive impact on stormwater management at the building scale: decrease and slow-down of the peak discharge, decrease of runoff volume. This efficiency of green roof varies from a rainfall event to another depending on precipitation characteristics and substrate antecedent conditions. Due to this variability, green roof are rarely officially used as a regulation tool to manage stormwater for now. Indeed, regulation rules allowing -or not- the connection to the stormwater network are usually based on absolute threshold values that have to be always respected: maximum areal flow-rate or minimum retention volume for example.
In this context, the aim of this study is to illustrate how green roof could represent an alternative to solve stormwater management issues if the regulation rules were further based on probabilities. For this purpose, a modeling scheme has been established at the plot scale to simulate the hydrological response of several roof configurations: impervious, strictly regulated (in terms of areal flow-rate or retention volume), and covered by different types of green roof. Simulations have been carried out on a long precipitation time period (25 years) comprising a large and heterogeneous set of hydrometeorological situations.
Results obtained for the different roof configurations have been compared. Depending on the return period of the rainfall event, the probability to respect some regulation rules (defined from real situations) has been assessed. They illustrate that green roof always reduce stormwater runoff comparing to an impervious roof and can guarantee the respect of the regulation rules in most of the cases. Moreover their implementation can appear more realistic than that of a strict regulation infrastructure needing significant storage capacity.

Economic impact assessment of river flood risk under current and future climate

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Abstract:
An integrated methodology for assessing direct and indirect cost of fluvial flooding is used to estimate current and future fluvial flood risk in Italy. The methodology combines a Geographic Information System spatial approach, with a general economic equilibrium approach using a downscaled modified version of a Computable General Equilibrium model at NUTS2 scale. Given the level of uncertainty in the behavior of disaster-affected economies, the simulation considers a wide range of business recovery periods. Expected annual losses are calculated for each NUTS2 region and exceedence probability curves are used to determine probable maximum losses. Given a certain acceptable level of risk, we describe the conditions of flood protection and business recovery periods under which losses are contained within this limit. Because of the difference between direct costs, which are an overestimation of stock losses, and indirect costs, which represent the macro-economic effects, the two have different policy meanings. While the former is relevant for post-disaster recovery, the latter is more relevant for public policy issues, particularly for cost-benefit analysis and resilience assessment.

Trading off the costs and benefits of planned hydropower and irrigation investment in Kenya's Tana Basin

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Abstract:
Kenya's Tana River supplies the majority of the country's hydropower from a cascade of 5 dams. Competition for this water resource is particularly high in the semi-arid lowlands below the cascade where it supports rural livelihoods and high value biodiversity. Large food and biofuel irrigation schemes are planned which would further intensify competition. Further dams and modifications are planned in the system to increase generating capacity and irrigation potential. Balancing the costs and benefits of multiple water uses is a challenge in the context of a growing population with increasing demands for water, energy and food security. We demonstrate an approach which quantifies the trade-offs between various monetary and non-monetary costs and benefits to help decision makers select investments on the basis of their broader implications. By coupling a water resources model to a multi-criteria search algorithm, sets of infrastructure and their operating rules which achieve Pareto-optimal benefits are identified. The search algorithm works heuristically to discover the 'best possible' schemes by simulating various combinations of assets and optimising their operating rules. Options include whether to build irrigation schemes or dams and if so how to size and operate them. Benefits are evaluated by a range of objective functions representing conflicting uses of the available water including supplying municipal water, providing environmental flows, generating electricity and growing food and other crops. Visual analytic plots are used to enhance decision makers' ability to interact with and understand the trade-offs they face. Results illustrate impacts on different stakeholders of various infrastructure development portfolios and their operation.

Optimization In Searching Daily Rule Curve At Mosul Regulating Reservoir, North Iraq Using Genetic Algorithms

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Abstract
To obtain optimal operating rules for storage reservoirs, large numbers of simulation and optimization models have been developed over the past several decades, which vary significantly in their mechanisms and applications.
Rule curves are guidelines for long term reservoir operation. An efficient technique is required to find the optimal rule curves that can mitigate water shortage in long term operation. The investigation of developed Genetic Algorithm (GA) technique, which is an optimization approach base on the mechanics of natural selection, derived from the theory of natural evolution, was carried out to through the application to predict the daily rule curve of Mosul regulating reservoir in Iraq.
Record daily inflows, outflow, water level in the reservoir for 19 year (1986-1990) and (1994-2007) were used in the developed model for assessing the optimal reservoir operation. The objective function is set to minimize the annual sum of squared deviation from the desired downstream release and desired storage volume in the reservoir. The decision variables are releases, storage volume, water level and outlet (demand) from the reservoir. The results of the GA model gave a good agreement during the comparison with the actual rule curve and the designed rating curve of the reservoir. The simulated result shows that GA-derived policies are promising and competitive and can be effectively used for daily reservoir operation in addition to the rational monthly operation and predicting also rating curve of reservoirs.

Impact of hydraulic works on the balance of the ecosystem of the Oued Seybouse (NE of Algeria)

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Abstract:
Oued Seybouse drains a large watershed of 6400 km^2, it resulted from the confluence of the two oued; Charef and Bouhamdane. The first arises in Sellaoua by against the second comes from the mountains of south Guelma. These two rivers carted large amounts of water, thus explaining the high flow recorded at different gauging stations. Moreover, oued Seybouse receives all wastewater cities crossed by the river. These contributions are insignificant compared to record especially during the rainy season flows. However in the early'80s, a dam was built at the oued Bouhamdane, what has for consequence the catchment water that must feed the oued Seybouse, So echoing by a reduction in flow at the level of this stream. This reduction in contribution of water amounts to 2,27 m^3/s, or 17% of the total flow of the Seybouse. Besides, the reduction in the precipitation and the contribution of waste water boosted the degradation of the quality of waters. Let us note that after the putting in water of the dam, the irrigation of the agricultural perimeter of Guelma is made from the released of water of the dam, these released are made from the end of may to end of October, but in front of the reduction in the precipitation, the cultures will be irrigated from waste water transported by oued, what expose the population to the dangers, particularly further to the consumption of products that do not require cooking. The analyzes showed the presence of contaminants such as iron, manganese, zinc, copper and nutrients at the level of upstream area (region Guelma) by against the downstream zone is marked by the presence of pollutants such as chromium, lithium, iron, manganese and other nutrients. That they are organic or metallic these pollutants indicate that the region is for agro-industrial use.

Optimal hydropower plant operation A case study in Red River basin in Vietnam

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Abstract:
The efficiency of a turbine depends on the operational conditions and the head loss on the actual flow in the penstock. That is why the manager of a storage power plant takes great care in optimizing the distribution of the volume that is daily released from the reservoir, among the turbines of the power plant and the production time units (e.g. hours) within the day. Notwithstanding this fact, in the optimal design of management policies of large multi-purpose reservoir systems the within-day operational optimization of storage power plants is often neglected, in order to reduce the computational burden of the study. In other words, the power production of the plant is approximated by the product of the hydraulic head, the daily turbined volume and the average efficiency of the turbine-generator couples. However, the approximation error so introduced is often of the same order of magnitude of the improvements that the optimal design of the reservoir policies may produce, and thus the improvement may be not unrevealable or questionable. We propose a procedure to identify a static model of a storage power plant, i.e. a function that expresses the energy production in one day, given the reservoir level at the begin of the day and the volume released in the same day, when this latter is optimally distributed among the turbines and the production time units of the day. This function can then be used for solving the optimal policy design. The proposed procedure is tested in identifying the models of the hydropower plants which are fed by the four large reservoirs that are located in the Red-Thai Binh river system in North Vietnam.

The virtual water trade: the case of Tunisia

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Abstract
This study is part of the research project " Virtual Water and Food Security in Tunisia: Findings in support of Development ." It aims to assess the virtual water consumed by different cultures in irrigated and rainfed in the Cap Bon from a sample of 64 farms. The main objective of this work is to make the necessary policy formulation lights that incorporate the concept of virtual water in food security strategy in Tunisia, and to better understand the role of farmers in water management . The methodology adopted is based on the estimation of virtual water while relying on a farm typology stratum area . Cultures studied are divided into market gardening as Tomato, Potato, Watermelon , Strawberry , Pepper and arboriculture as : Citrus , vine table wine grape and pomegranate . The results show that the majority of farmers realize a waste of irrigation water especially for fruit bowl and irrigated by a good knowledge of cultural package may result in lower quantities of virtual water ensuring good production.

Artificial reservoirs performances under climate variability. A case study Analysis

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Abstract:
Water resources system management is a very complicated task and when dealing with non stationarity, especially with climate variability, it becomes even more challenging. As an example, the climate variability, on which, during the last few decades, many researchers have focused their efforts, can indeed seriously compromise the operation of artificial reservoirs, and this study aims at the investigation of this issue. A comparison of artificial reservoir performances, assessed through the calculation of reliability, resilience and vulnerability indices (Hashimoto et al., 1982), between present and future scenarios of climate variability is herein reported.
The Piano della Rocca case study is illustrated, an earth dam reservoir, located along the Alento river in Southern Italy, an artificial river basin planned for civil, agricultural and hydropower production water demand. Available data consist in rainfall, air temperature, water levels, water demand, for the time period 1993-2013. Time series of stream inflow to the artificial lake is estimated as the residual term of a continuity equation applied to the reservoir.
As the first step, the present situation is assessed and considered as the baseline for future discussion. An ARMA model is calibrated, at the monthly time scale, for the estimated stream inflow time series corresponding to the present situation, and it is further used to generate future scenario stream inflow time series, under different climate forcing scenarios. Different climate scenarios are, on their side, generated according to the tendencies in precipitation and air temperature observed during the last decades for the studied area, as reported in related investigations. The proposed approach can be suggested as a valuable tool to mitigate the effects of moderate to severe and persistent droughts periods, through the allocation of new water resources or the planning of appropriate operational rules.

Research on mechanism of bilateral interaction between natural water cycle and socio-economic development by coupling CGE and WEP

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Abstract:
Nowadays, natural-artificial dualistic characteristic of water cycle has been generally considered as the key issue of water resources assessment and management in a changing environment, especially for those countries in water-stressed conditions. However, mechanism of bilateral interaction between natural water cycle evolution and socio-economic development has been obscured due to complexity of hydrological process and socio-economic system. The coupling of economic model CGE (Computable General Equilibrium) and distributed hydrological model WEP (Water and Energy Process) provides a model-based tool for researches on response and feedback of water cycle to social development, as well as economic prospects under the constraint of water resources, by quantitatively analyzing the effect of industrial restructuring readjustment, water saving and pollution treatment. To simulate water demand of socio-economic development, water account should be added into social accounting matrix of traditional CGE model as one of its factors so that water demand could be calculated as an endogenous variable. On one hand, Water policies, including water use limitation and water price adjustment, are evaluated by CGE as preset scenarios under different levels of socio-economic development, and its results of water demand are put into WEP model to simulate corresponding response in the process of water cycle. On the other hand, variation of available water resources under different conditions could be well simulated by WEP model, and its results may provide proper constraints for water demand in CGE to indicate the influence of water resources on socio-economic development. The research is believed to provide better understanding on two ways interaction between water and society.

Study on the Water Resources Efficiency in China from the Economic Perspective

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Abstract:
Researches about Water Resources Efficiency (WRE) are one of the main research fields in the study of water resources and water resources economics. Even then, some researchers consider that WRE research is the core of water resources economics, because WRE reflects the ratios of unit water resources amount to unit economic outputs. However, researchers from different fields have various opinions about WRE, hydrologists think WRE on the base of physically mechanism by water cycle in the nature, while in economy the researchers consider water resources as an important means of production. In fact, water resources have different traits in different economic departments and areas. Considering the current research situation about WRE which mainly focuses on the physical efficiency of water resources, this paper attempts to re-explain WRE based on the economic perspective and water resources' unique traits. In this paper, an advanced economic method Data Envelopment Analysis is proposed in the measurement about WRE, which is based on the social cycle of water resources in different economic departments and areas. The advances of this research are as following: firstly, WRE from the economic perspective emphasizes the social traits of water resources which are the bases of the value of water resources; secondly, research on WRE from the economic perspective gives the special link between water resources and economy; thirdly, because the usages of water resources in different economic departments and areas are various, the measurements of China's WRE are run by different economic departments and areas, and then the advance analysis are proposed.

Governance, Learning and Complexity in Water Systems

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Abstract:
It is widely recognized that competing demands for water resources will present dramatic challenges for water governance in the near future. Yet the complexity of coupled water-social systems imposes barriers to finding solutions to these challenges. Hydrologic change can be rapid but may alternatively be manifested in subtle trends or masked in fluctuating indicators. And the social structures interacting with water systems themselves constitute considerable sources of complexity given the diverse ways society is coupled to water. In the face of these complex dynamics, it can be difficult to identify the early onset signals of looming water resource challenges much less find appropriate solutions to mitigate them. Even when governance change is possible, short-term solutions may not be suitable to long-term challenges requiring sometimes large-scale transformations in water governance. Too often transformation and change come only after disasters have already occurred. Given the vast diversity in water governance regimes globally there is a need for new approaches to better understand what governance approaches work under what social and environmental conditions. This talk will highlight key gaps in our understanding of the social dimensions of hydrological change specifically addressing issues of 'institutional fit' and tools to diagnose the nature of water resource challenges. We can't expect governance to solve all problems in complex water resource systems, but neither can we rely solely on engineered solutions without considering the interplay between social, technical and environmental systems.

Urban water in transition: Optimal pricing, supply augmentation and consumer welfare

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Abstract:
The presentation reviews the key challenges of managing urban water in 'transition' and presents a test case of optimal water pricing and when to undertake water supply augmentation. Using data from Sydney, Australia results are presented of the consequences of a fixed, regulated water price given weather variability versus dynamically optimal pricing. Model results are used to show the welfare benefits to water consumers of using dynamically efficient water prices and an optimal supply augmentation rule.

Trade-off Decision Making in IWRM: Water for Economic, Social and Environmental Outcomes

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Abstract:
Water is a crucial element to human survival, environmental, social and economic sustainability. As freshwater is mainly delivered through river networks that can cross country boundaries, it is often a major dispute between countries or states. The distribution of costs and benefits within river basins is usually complex and can include sustainable healthy ecosystems, potable water supply, irrigation water for crops, hydropower generation, as well as, spiritual and recreational value. Resource issues are likely to increase with changing river flows from climate change, increasing population and increasing environmental, food and energy security issues. Trade-off processes in these basins are highly contestable and are usually a political process that is based on assumptions and beliefs rather than on quantifiable scientific evidence. Trade-off decisions are often made between environmental sustainability, social values and economic security, which have different value based assessments by different stakeholders and parts of the community. This paper outlines a new framework, 'Nexus Webs', for decision making on water resource allocations for economic, social and environmental outcomes. The framework provides a transparent method for determining the distribution of benefits from water resource management decisions using an ecosystem services approach. The framework is demonstrated in its use in water allocation decisions in the Murray-Darling Basin in Australia and in food-energy-water nexus issues for poverty alleviation in developing economies.

Using ecosystem services to manage water resources for greatest societal benefit

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Abstract:
Freshwater ecosystems and associated water resources provide a myriad of benefits to society and these benefits can be organized and measured using the ecosystem services framework. Smart operation and management of river systems should aim to maximize the supply of ecosystem services for greatest societal and economic benefit. Integrated water resources management is a discipline that bridges the social and biophysical sciences and we argue that the ecosystem services framework provides a valuable tool to this end (e.g Liu et al., 2013). This paper provides an overview of 3 case studies where ecosystem services are used to assist decision-making about sharing water between the environment and society. Each case study has its very own unique set of water management challenges. The first case study is in the Murray-Darling Basin (Australia) where water has been over allocated for consumptive use and is now being returned to the environment to restore important ecosystems. The second case study is in the Flinders catchment in far north Australia, a location of relatively low water resources development that is now the focus of much attention for green fields irrigation development. The third case study is the Somerset Levels and Moors in southern United Kingdom, a working landscape with a very long history of human modification and yet is of very high ecological significance nationally and internationally and has a relatively long history of wetland management for conservation. In all three case studies we demonstrate how the ecosystem services framework can be used to identify and organize the many benefits supplied by freshwater ecosystem services, but also show how the framework can transparently assess trade-offs between benefits and beneficiaries from various water management regimes.

Hydrological feasibility of flood barriers to protect the Gothenburg city, Sweden, during the 21st century - an initial assessment

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Abstract:
Climate change due to increasing of greenhouse gas emissions to the atmosphere will cause mean sea level to rise about +1 m by 2100. To prevent coastal floods resulted from this sea level rising, different flood control structures have been built and showed acceptable protection levels at least so far. Gothenburg on south-west coast of Sweden, with the Göta älv River running through it, is one of vulnerable cities to the accelerated sea level rise. Besides, a high tide in southern Sweden will be increased to +2 m above the st current sea level by 2100. Hence, most parts of Gothenburg will experience flooding events during the 21century, even the City Planning Office of Gothenburg suggests +2.5 m above the current sea level as the safe level for setting the shelter of especially important facilities by 2100. Developing water level model by MATLAB, we investigated the hydrological feasibility of using flood barriers in the Göta älv River to protect the Gothenburg city against flooding events during this century. One flood control barrier at the river upstream (upstream barrier) in the Gothenburg region and a sea barrage (Göta älv barrage) at the entrance point of the river to the North Sea were suggested by this study. Considering three operational scenarios for these barriers, the highest sea level was estimated to +2.95 m above the current mean sea level by 2100. To prove flood protection against such high sea levels, both barriers have to be closed. In order to prevent high water levels in the Göta älv reservoir due to the runoff generation from rainfall, the barriers would be open when the sea level is low. This preliminary assessment concluded the suggested sea and flood barriers would successfully protect the Gothenburg city from flooding events during the 21st century.

The Delta model: a tool to support policy analysis in the Dutch Delta program

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Abstract:
The objective of the Delta program in the Netherlands is to prepare a long term water management plan to cope with the effects of climate change and socio-economic developments on flood protection and fresh water allocation. The Delta model has been developed as a tool to support the policy analysis within the framework of the Delta program. The Delta model includes a range of (existing) models to address issues related flood protection and fresh water allocation. These models have been integrated within the Delta model to enhance internal consistency, standardization of the coupling routines and unification of presentation tools. The Delta model is hosted at a centralized server, rather than distributed over individual desktops, in order to facilitate support and maintenance for the system. Moreover, as all models are using the same servers, the hardware could be optimized both in terms of performance and resilience.
The users of the Delta model include both researchers of specific topics/domains as well as integrated policy analysts. Their cooperation within the framework of the development of the Delta model has resulted in improvements in the (sub)models and mutual understanding. The calculation results of the Delta model are supported by the researchers and are being used in the policy analysis in the Delta Program.

Indicators for consumers' willingness to pay to improve water supply services in Kazakhstan

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Abstract:
Kazakhstan has been transitioning from state planned to market economy that has affected many facets of life including provision of water and sanitation. For development of market water supply services the willingness of consumers to pay is important. Consequently, the present study develops and evaluates indicators for consumers' willingness to pay (WTP) for piped water supply. The investigated Pavlodar region is arid to semiarid with annual precipitation of 200-250 mm whereas Class A pan evaporation is 700-800 mm/year. Water resources of the region are mainly constituted by the Irtysh river (86%) and to a minor extent by groundwater (14%). Indicators for WTP were developed using questionnaires for major peri-urban areas applying the Contingent Valuation Methodology (CVM) using open-ended question and bids format with different starting points. The results showed that households with access to groundwater (well/borehole water users) perceived this as of good quality. Consumers without access to groundwater used open source, standpipe or delivered water for which they had to travel/spend time or to pay. Open source water quality and standpipe water quality were perceived as bad or satisfactory. More than 90% of the consumers were willing to pay for a better water quality and regular supply. The mean value of WTP was estimated to be 1117 (5,60 euro) tenge/household/month. One of the main influencing factors is the source of water (groundwater or surface water) and the access to private or public water supply. The bids from CVM displayed a substantial influence of the first price as a reference in a group that had no charges and used private wells and boreholes and for other categories of water users the starting price had no impact. Consumers' WTP can help to identify the proper technological choice and the level of services to be provided making rural water projects both sustainable and replicable to a larger scale.

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