SWAT

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Book of Abstracts

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The Soil and Water Assessment Tool (SWAT) is a public domain model jointly developed by USDA Agricultural Research Service (USDA-ARS) and Texas A&M AgriLife Research, part of The Texas A&M University System.

SWAT is a small watershed to river basin-scale model to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change. SWAT is widely used in assessing soil erosion prevention and control, non-point source pollution control and regional management in watersheds.

Contents

Foreword

The organizers of the 2014 International SWAT Conference want to express their thanks to the organizations and individuals involved and their preparation and dedication to coordinate a successful conference. We would also like to thank the Scientific Committee for their support in preparing the conference agenda and allowing for scientists and researchers around the globe to participate and exchange their scientific knowledge at this conference.

A special thank you to Pernambuco Federal University and Pernambuco Federal Rural University along with Suzana Maria Gico Lima Montenegro, Josiclêda Galvíncio, Josimar Gurgel Fernandes, and Danielle de Almeida Bressiani for their countless hours and efforts to host the SWAT Community. On behalf of the SWAT Community, we extend our sincere gratitude to you and your university for the kind invitation and welcoming hospitality.

The following Book of Abstracts contains abstracts for presentations covering a variety of topics including but not limited to large scale applications; climate change applications; model development; database and GIS application and development; environmental applications; hydrology; best management practices (BMPs); sensitivity, calibration and uncertainty; pesticide, bacteria, metals and pharmaceuticals; sediment, nutrients, and carbon, urban processes and management; and more.

The Conference Organizers hope you enjoy the conference and continue to view these SWAT gatherings as a positive opportunity for our international research community to share the latest innovations developed for the Soil and Water Assessment Tool.

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Setting up SWAT for the Upper Amazon

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Abstract

The Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP, www.isi-mip.org) is intended to provide a challenging framework for comprehensively examining the impacts of global climate change within and across different sectors (water, biomes, agriculture, health and coastal infrastructure). For the water sector, a Regional Model Intercomparison (RegMIP) is currently established to intercompare climate impacts for a number of regional-scale river basins using a wide range of hydrological models. The SWAT model is part of this multi-model ensemble and will be used for nine river basins located in Africa (Blue Nile, Upper Niger), Asia (Ganges, Lena), Australia (Upper Murray-Darling), Europe (Rhine, Tagus), North America (Upper Mississippi), and South America (Upper Amazon).

The talk will point out our work in RegMIP and discuss the current stage of model setup and streamflow calibration for the Upper Amazon Basin. Covering a size of more than one million km^2 and ranging in altitude from 25 to 6,270 m above sea level, the basin represents a challenging task for process-based models such as SWAT. We will critically discuss input data and scaling problems (e.g. the parameterization of soils and land management), as well as present obstacles and practical solutions (e.g. the use of elevation bands) for successfully calibrating the model for streamflow at several gauging stations in the river basin.

Parameterization of physical and climatic characteristics in the Amazon basin for hydrological simulation with SWAT model

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Abstract

The Amazon region has raised great interest worldwide in the scientific community due to environmental services provided by its dense forest with respect to climate regulation, land use, carbon balance, water supply and biodiversity. On the other hand, currently there is a major challenge to be faced in terms of addressing scale problems in hydrometeorology, being noteworthy to mention parameterization of distributed rainfall-runoff models to adequately represent basic physical phenomena that occur in this vast region. Despite many efforts of environmental management and research organizations, the Amazon basin can still be considered poorly monitored when considering its local, regional and global importance. In this sense, hydrological simulation models, such as SWAT, are presented as a good alternative to estimate streamflows in different locations and especially for river stretches that are inaccessible or difficult to reach. Thus, we developed in this work a consolidated dataset of physical and climatic parameters for taking into account the whole Amazon basin using the SWAT model covering the time period from 1985 until 2012 at a daily basis. The statistics required for the climatic generator SWAT model were calculated based on daily data from 40 weather stations of the National Meteorological Institute - INMET (Brazil) available in the region. The time series of precipitation were prepared from 204 rainfall gage stations provided by the National Water Agency - ANA also on a daily basis. Satellite observations (MODIS) were used to prepare land use data, with 500 m spatial resolution, considering sixteen classes of land cover. In addition, soil physical characteristics data were prepared using pedotransference functions based on soil texture and on organic matter datasets for different

soil horizons. The streamflows were simultated and compared with measurements at the flow station of Obidos, which is the closest to the mouth of the basin. The overall conclusion is that we used tools and datasets, although both limited in space and in time, that allow us to better understand the Amazon basin to support planning and decision making regarding the management of water resources in this region.

Acknowledgement

This work was conducted with support from CNPq, National Council for Scientific and Technological Development – Brazil and FAPEMIG, Foundation for Research Support of Minas Gerais State, Brazil.

Keywords

Parameterization, Hydrological simulation, Streamflow, SWAT model

Coping with challenges in the application of SWIM in a heavily managed lowland region in Central Europe

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Abstract

In the river catchments of Schwarze Elster, Spree and Lusatian Neisse, the model set up and parameterization of hydrological models is constrained. Firstly, the input data (especially soil maps) to set up hydrological models in the three states sharing in the river catchments, Germany, Czech Republic, and Poland, are of different resolution and quality. The main challenge for calibrating hydrological models, however, is the strong impact of mining and water management on river discharges. In order to extract lignite in open pit mining, the groundwater table has to be lowered prior to and during the mining operation. Consequently, a groundwater depression cone has been formed widely around the mines, whereas river discharges have been increased. Water management in terms of reservoir operations and water transfers additionally impacts discharges in the region.

Therefore, in a first step, the Soil and Water Integrated Model, SWIM, was calibrated for small subcatchments without influences of mining and water management on discharge. To address the issue of data availability, the effects of different soil maps on the calibration of the Soil and Water Integrated Model and simulation results of water balance components have been analyzed.

In a second step, the models for the entire catchments (total area: about 17 000 m^2) were parameterized using regionalization. The simulated natural discharges were then compared to long-term pre-mining discharges as well as results of other hydrological models. That way, the model was verified and evaluated as a suitable tool for climate and land use change impact studies.

Keywords

SWIM, hydrology, mining, parameter regionalization

The SWAT Literature Database: Overview of Database Structure and Key SWAT Literature Trends

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Abstract

The SWAT Literature Database for Peer-Reviewed Journal Articles can be accessed directly at https://www.card.iastate.edu/swat_articles/index.aspx or via a weblink at the SWAT model homepage (http://swat.tamu.edu/). The origins of the database can be traced to the "Comprehensive review of SWAT model paper" (also accessible via a weblink on the SWAT model homepage) that was published in*Transactions of the ASABE* in 2007. At the time of publication of the comprehensive review paper, approximately 250 SWAT-related articles were documented in the peer-reviewed literature. At present, over 1,600 SWAT-related papers have been identified in the peer-reviewed literature which have been entered in the database. The majority of papers included in the database have been written in English although citation data has also been included for some papers written in other languages including Chinese, Farsi, German, Portuguese and Spanish. In addition, most of the papers included in the database describe some type of specific application of the standard SWAT model. However, other types of papers are also included which describe key predecessor or related models (i.e., ALMANAC, APEX, EPIC, GLEAMS, ROTO, SWRRB), applications of modified SWAT models including the SWIM model, or other types of pertinent analyses such as review studies covering SWAT and multiple other models. Models used in studies that are not part of these subcategories (e.g., HSPF or AnnAGNPS) are not specifically mentioned in the database.

Basic citation information, the DOI or URL weblink to the article (if available), basic information for the watershed(s) analyzed in the respective study, article abstract, and keywords (if applicable) are included for each article entry in the database. Calibration, validation, and/or other general information is also available for a limited set of articles included in the database. Also, subjective broad, primary, and secondary classifications are included for most articles. At present, most of the article abstracts are not visible to database

users due to publisher copyright restrictions; however, abstracts are visible for journals whose publishers have granted permission (and can virtually all abstracts can be viewed via the DOI or URL weblinks to the original webpages for each respective article). Search capabilities provided in the database include searching on: (1) journal title, (2) model, (3) broad, primary, or secondary category, (4) language, or (5) year. Searches can also be performed on any word or phrase of interest and article abstracts are included in these searches (even if the abstract is not visible). Database users have the option of uploading citation data for a peer-reviewed SWAT-related journal article. Citations for each new article are automatically generated and added to reference lists ordered either alphabetically or by the specifc model(s) featured in the paper (as noted above).

A general overview of the structure of the database will be presented including the different types of papers that are included, search options, and other details of potential interest to users. Key trends in the SWAT literature will also be described based on the literature that has been included in the database through the first half of 2014.

Keywords

SWAT model, modified SWAT models, literature database, peer-reviewed literature, citations, SWAT literature trends

The SWAT model and a web-based information system to assess the water balance of Sardinia (Italy)

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Abstract

Water monitoring and assessment systems are evolving from a simple, local-scale approach toward complex spatially explicit regional applications, thanks mostly to the achievements of Information and Communication Technologies (ICT) and the advances of computer simulation. With support of the Sardinian Regional Water Authorities, we aim at developing, a catchment observation and assessment system for the management of water resources in Sardinia. The objective is to build a innovative and interactive system, based on the Soil and Water Assessment Tool (SWAT) model, to assess the water resources for the island and to monitor state indicators of the environment and their changes. SWAT has been employed to study the water cycle of the island taking into consideration natural and/or man-made changes to the system. The Sardinian SWAT set up is composed of 108 catchments, subdivided in 1209 subbasins, each characterized by a rich variety of soil, land cover and geo-morphological regions. The model has been calibrated and validated versus streamflow data of various monitoring gages scattered within the island. One important effort is to improve and promote a innovative environmental management system particularly targeting observational (e.g. agricultural droughts and water quality measurements) gaps for the water domain.

Results of the application of the model are exposed within BASHYT, a modern web-based information system, that exploits a Spatial Data Infrastructure (SDI), complex server side technologies (such as relational database management system) and client side applications. Through the web-based approach, we aim at fostering integration of expertise from various fields to create a lively system where end-users and scientists can cooperatively work and create reliable applications. In this work, we describe the implementation of the SWAT model for the Sardinian case study and how the web information system has been further developed to meet end-user's needs.

Keywords

SWAT, water budget, hydrology, Sardinia, Swat Cup, BASHYT

Hydrologic assessment in a Brazilian forest watershed using SWAT model.

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Abstract

The original Subtropical Ombrophilous Forest has been replaced by reforestation and agricultural activities in Santa Catarina State, Southern Brazil. The aim of the study was to estimate the hydrological process for the Rio Preto watershed (1000 km ^{2}), located in the Northern Plateau of Santa Catarina State, with the Soil and Water Assessment Tool (SWAT) model. A Latin Hypercube and One-factor-At-a-Time sensitivity analysis was performed. The most sensitive parameters for runoff were curve number, soil evaporation compensation factor, and threshold depth of water in the shallow aquifer required for return flow to occur. To evaluate the performance of the model, simulated monthly flow data were compared with those observed in the basin outlet using two index: Nash - Sutcliffe efficiency (NASH) and determination coefficient (R^2). The values of NASH and R^2 for the monthly simulations were 0.63 and 0.61, respectively. The simulations indicated that the base flow, which is an important component of total water yield, is 54% of measured and simulated runoff. The results suggest that the SWAT model can be used for further analysis of the effect of climate and land use changes on hydrological processes.

Keywords

Hydrological modeling, water balance, sensitivity analysis

Agricultural drought analysis in the Arrecifes basin (Pampas region, Argentina) using the SWAT model

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Abstract

Droughts are a climatic risk, which occurs in practically all parts of the world and whose characteristics and frequency of occurrence depends on every region. Agricultural activity is highly vulnerable to weather conditions, and especially to extreme events. In the Pampas region, the expansion of agriculture to more fragile environments has been associated to an increase in the frequency of agricultural droughts. The aptitude of the SWAT model to simulate soil moisture (SSM) was assessed considered a monthly time step. It aimed to detect and characterize agricultural droughts in the Arrecifes' basin. To this end, 30 years were simulated considering situations involving excess or deficit of soil water. Within this period, 14 years were considered for calibration and 6 for validation. We analyzed the correlation between the anomaly of SSM with the Normalized Difference Vegetation Index (NDVI), which was derived from the Advanced Very High Resolution Radiometer (AVHRR) instrument on-board of the National Oceanic and Atmospheric Administration (NOAA). Further, SSM and the Standardized Precipitation Index (SPI) were correlated. In both cases the period between 1981 and 2011 was taken into account for the analysis of correlation. The calibration (NSE 0.67) and validation (NSE 0.72) results indicated a good performance of the model. The analysis of correlations between anomaly of SSM (aSSM) and anomaly of NDVI (aNDVI) was less significant, which is consistent with the results obtained by other authors. Moreover, correlations between aSSM and SPI (three month) showed significant positive correlations. This research has showed that SWAT could be a suitable tool to estimate soil moisture at the basin level.

Keywords

Water stress, hydrological modeling, NDVI, AVHRR, SPI

Hydrology of Tigris river and its tributaries contributing to Hawizeh marsh

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Abstract

The Al-Hawizeh marsh is located east of the Tigris River in lower Iraq between the cities of Amara and Basra, and extends over the international border into the Islamic Republic of Iran. The marsh has been designated as Ramsar wetland of international significance to migratory birds. The marsh is dependent on water contribution from the Tigris and Karkheh rivers within the Tigris and Euphrates basin. Currently, the marsh is facing a great danger and is becoming hydrologically and ecologically stressed because of decreased water inflows.

A hydrology model of the Tigris Euphrates basin with emphasis on flow contributing to marsh was developed. The SWAT model was used to simulate the hydrology in the basin, as it allows simulation of runoff in the ungauged stream network because feeder streams into the marsh are unmetered. The SWAT model is calibrated using long-term monthly average water flow data collected from existing stream flow monitoring stations. The presentation overviews the hydrological analysis (flood/drought frequency, intensity and probability of exceedance) of flow in the Tigris and its tributaries (including Karkheh river flowing from Iran) feeding the marsh using calibrated SWAT model. Also the impacts of current and future dams on flow contributions are explored.

Environmental modeling and representation of the dynamics of environmental systems

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Abstract

Over the past few decades there have been issues that converge to the same questions, which are those of how to explain the inter-relationships that exist between the components of a dynamic system, how to measure the organization, above the junction of enumeration elements. These systems sometimes don't present themselves in a linear way (predictable) in time and space, having different complexities, scales and continuity of processes that occur internally, is this an open system (hydrographic basin) or closed (hydrological cycle). Even though different in form and scale hierarchy both cited systems interrelate, one providing another means to work. To analyze the complexity of dynamical systems has been increasing the adoption of mathematical models to improve understanding of environmental processes. It is in this context that fits this work, discuss the importance of environmental modeling for the explanation of such complexity. The advancement of computer technology, processing and data integration and generation of real or hypothetical scenarios made possible the emergence of new possibilities for the analysis dynamics of environmental processes. The adoption of mathematical models as well as its operation has been supported by the development of geographic information systems (GIS), where the user has the possibility to opt in to use an interface that will ensure that best represents the dynamics of the process or phenomenon studied.

Slope Analyses in Watersheds using SWAT

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Abstract

The analyze of the drainage net of an area is extremely important and we need to have in mind two principles: planning: where we organize the agricultural and urban actions and the classes that correspond to the land use (classes I, II , III , IV , V , VI and VII) and, the ability of land use: which will be detected if the soil will be used for some culture as well as to diagnose the most appropriate crop to be used. There are the limitations of use on each unit (I to VII), and it is very important to adopt management practices considering the slope classes (class A: ; class B: ; class C: ; class D: ; class E: ; class F: ; class G:). Thus to ensure conservation practices of land use and to determine the slope classes of an area, it has been used the Soil and Water Assessment Tool - SWAT. The model has been shown as an important tool in the analysis of river basins in order to assess the possible impacts of various management practices. Knowing the effects of changes in land use and the runoff in a watershed is essential in making decisions about the conservation and soil and water. This paper aims to evaluate the slope areas at the Patos de Minas Municipality in its subbasins using the SWAT model. So, we can apply better management practices at agricultural areas.

Keywords

Slope, SWAT, quality / topography

Calibration of the SWAT model for a watershed in Aracruz, ES, with the predominant land use eucalyptus

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Abstract

The realization of hydrologic studies in watersheds comes from the need to understand the processes that control the movement of water and the impacts of the use and occupation of soils on water resources. The estimate of these processes and quantification of such impacts has been performed based in utilization hydrologic models, especially those computational. The computational model SWAT (Soil and Water Assessment Tool) was selected as the basic tool for this study in function of its objective, which aims at assess the effects of management on water, sediment, nutrients and pesticides, and be being tested in different parts of the world, with satisfactory results. In this context, the present study had the objective of assess the applicability of SWAT to estimation flow in an experimental watershed (MBE) with an area of 2.84 km ^{2}, in the city of Aracruz, ES. The main land use in MBE consisted in the cultivation of eucalyptus. Obtained values of NS and PBIAS equal to 0.39 and -17.53% and -14.34% and 0.74 in steps of calibration and validation, respectivelyby qualifying the model as appropriate and satisfactory for the simulation of flows from MBE study. Statistical indices calculated for the calibration and validation of SWAT were sufficient magnitude to qualify him as appropriate and satisfactory for the simulation of flows in MBE.

Keywords

Hydrologic model, calibration, hydric availability.

Impact of Land Use changes on Runoff in a Representative Basin in the Semiarid of Pernambuco State Using the SWAT Model

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Abstract

The Brazilian semiarid region is characterized by a high variability of rainfall and long periods of water scarcity. Thus the main springs and rivulets are usually intermittent, and both the native vegetation and human activities have a strong influence on hydrological processes over time. The Alto Ipanema catchment is located in the Pernambuco State semiarid, where long term hydrological monitoring has been carried out by Soil and Water Laboratory of Federal Rural University of Pernambuco State. Previous studies have been developed focusing on rainfall-runoff relationships over the catchment, and on rainfall-recharge processes for the main alluvial aquifer. The objective of this work is to investigate the impact of land use and land cover changes on the catchment scale using the SWAT model, mainly the deforestation impacts on water availability. In the studied catchment, communal farming is well developed at alluvial valleys, and native vegetation degradation is usually observed at the hillslopes. It has been a verified that simulated runoff in the catchment is very sensitive to parameters such as CN (Curve Number), Alpha_Bf (alpha factor base flow), ESCO (soil evaporation compensation factor) and EPCO (Plant uptake compensation factor), which are dependent upon changes on land use, especially for the rainy season.

Keywords

Alluvial valleys, native vegetation, semiarid catchment

Neural network for Seasonal Rainfall and Streamflow forecasting for West Africa: case of the Sirba basin

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Abstract

Rainfall in the Sahel region, West Africa is known to have a high interannual variability that makes water resources management extremely difficult. Unexpected floods and droughts often compromise economic activities and sometime lead to severe humanitarian crises. Seasonal streamflow forecasting is one possible way to increase resilience to climate variability by providing a few months in advance information about the amount of runoff to expect in the next rainy season. A feedforward neural network is developed and used for seasonal precipitation forecasting in this study. It uses Sea Surface Temperature (SST), Relative humidity (RHUM), Sea level pressure (SLP) and Air temperature (AirTemp) in an attempt to predict streamflow up to 18 months ahead at the Garbe-Korou station on the SIRBA Watershed located in between Niger and Burkina-Faso Republics, West Africa. A nonlinear model was used to link each predictor to the July-September total precipitation in the watershed. The predictor vector size was reduced prior to the application of the nonlinear model by a screening predictor's grid points followed by a leave one cross-validation and feedforward neural network, having gradient descent with adaptive learning rate backpropagation. The precipitation is then disaggregated to the daily scale using the fragment method, and the resulting precipitation time series are used in a SWAT (Soil and Water Assessment Tool) hydrological model of the watershed to generate hydrographs. For each method and each of the predictor data sets, 171 different averaging periods were tested using a leave-one-out validation technique in which the performance is evaluated using either the Nash-Suttcliffe coefficient (Ef), the coefficient of determination (R2) and a three-category hit score (H). Results showed that for that particular watershed, the RHUM averaged over the 8 months ahead (October-October) was the best predictor for the rainy season starting in July 12 months later (R2=0.458, Ef=0.387 and H = 66.67%). The AirTemp and SLP averaged respectively over 14 months ahead (January-April) and May-June (0 month lead times) of the previous year presented a R2 of 0.271, an Ef of 0.257 and H of 52.38%). The rainfall forecast using the best method was temporally disaggregated and used to force a SWAT hydrological model of the watershed. Streamflow at the outlet of the watershed could be forecasted 12 months in advance with a R2 of 0.552, an Ef of 0.487 and a H of 73.28%.

Keywords

SWAT hydrological model, Seasonal forecasting, SIRBA basin, Neural network, Temporal disaggregation, Relative humidity

Hydrological Response to Climate Change based on SWAT Model validated by Extreme Climatic Conditions in Fuhe River Basin of Poyang Lake, China

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Abstract

Soil and Water Assessment Tool (SWAT) was used to study the impact of future climate change on hydrological process, while it is urgent for simulation efficiency to validate hydrologic model using extreme climate conditions caused by the uncertainty of the future climate. A case study was carried out for a 15811 km^2 watershed of Fuhe river basin to validate the stability of SWAT model with extreme climate conditions representing wet (1975-1977) and dry (1963-1965) year, and high (1963-1965) and low temperature (1969-1971)year and then studied the hydrological impact of potential climate change. Results indicated that the established model had certain stability under the extreme weather conditions, which R^2 and E_{NS} were greater than 0.80.The simulated results showed that increased temperature alone caused a decrease in water yield and stream flow and an increase in evapotranspiration while increased precipitation alone caused an increase in water yield, stream flows and evapotranspiration. Increase of precipitation by ±10% and ±20% generally changed stream flow and water yield proportionally but had small influence on evapotranspiration. Increased temperature by 3°C and precipitation by 20% caused the largest increase in evapotranspiration while increased precipitation by 20% alone caused the largest increase in water yield and stream flow.

Keywords

SWAT model; stability validation; climate change; hydrological response; Fuhe river basin

Hydrological Response of a Mountainous Catchment to Different Climate Scenarios

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Abstract

Water availability is vital for development of (semi) arid regions. Increasing competence amongst different stakeholders, future climate scenarios, land-use change and resource degradation are a few of the problems many catchments are dealing with. To address all these challenges, medium term planning and integrated management are required. The 120000 hectare Río Dulce Irrigation District in Santiago del Estero, Argentina depends fully on upper catchment contribution, situated in three neighboring provinces. This study´s main objective was to evaluate climate scenario impact on water availability in Río Hondo reservoir, which is the main contributor of irrigation water for Río Hondo Irrigation District.

The Soil and Water Assessment Tool (SWAT) coupled with different climate scenarios were used to observe hydrological response for the Salí-Dulce catchment in northern Argentina. The calibration of monthly streamflow resulted in a satisfactory fit of simulated and observed data, which is indicated by Nash-Sutcliffe efficiency (NSE) values of 0.69 and 0.74 for the calibration (1998-2003) and validation (2004-2010) periods, respectively. Daily future weather data were generated by employing LARS-WG and analyzed and processed by using R and included scenarios for 100 years of dry, normal and humid years based upon 40 years of existing data. This study showed that discharge under all scenarios is likely to increase. This first attempt to estimate future discharge in this catchment could be a useful starting point to explore future hydrological impacts in the area and collectively establish management policies.

Keywords

Hydrologic modelling, Climate Change, Climate scenarios, Argentina

Introduction to the new modular SWAT code: The input file structure explained using the example of the Little River Experimental Watershed, USA

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Abstract

Over the past years SWAT users from all over the world have contributed to the ongoing development of the model. Due to the integration of new variables and subroutines, the code as well as the input and output files have become more difficult to manipulate and maintain. Also, opening and reading separate files for each HRU can take a considerable amount of time and thus cause long model runtimes, especially in large watersheds with hundreds or even thousands of HRUs. Therefore, the SWAT code is currently being completely revised and restructured.

The new modular SWAT code makes the maintenance of the code and the integration of new variables easier, since data is stored in objects instead of a large number of individual arrays. In the future, the data structures and files can be shared with other models like EPIC and APEX. HRUs, aquifers, and reaches are treated as separate spatial objects, which gives the user more flexibility in defining the spatial interactions within a watershed. Instead of separate files for each HRU, there is now one HRU file that lists all the HRUs occurring in a watershed. This HRU file points to different files that store all the HRU-related data, e.g. management schedules, soil data, weather data and topographic properties. As before, plant, soil, fertilizer, tillage, pesticide, urban, and septic parameters are stored in large databases. A similar approach is now used for other data as well, e.g. management schedules and operations. All the management schedules occurring in a watershed are listed in one file, which points to separate files listing the respective management operations, e.g. one file for all fertilizer application operations occurring in the watershed and one for all the tillage operations. These files in turn point to the respective fertilizer or tillage type in the general fertilizer and tillage databases. Just like the general databases, data files like the management schedule and operation files can now be extended by the SWAT user communities and do not have to be specific to a watershed anymore. This way, data obtained and pre-processed by users can be more easily shared with the rest of the SWAT community.

The new input files and their structure and interactions are introduced and explained using the example of the Little River Experimental Watershed in Tifton, Georgia.

Keywords

Modular SWAT code, input files

Development and evaluation of SWATDRAIN model to simulate surface and subsurface runoff

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Abstract

The DRAINMOD model was recently incorporated into Soil and Water Assessment Tool (SWAT) model, as an alternative tile flow and water table depth simulation methods, as well as a tool to design cost-effective tile drain water management systems. The developed model, referred to as SWATDRAIN, was evaluated using measured tile drainage and water table depth data in a fully tile drained watershed in Ontario, Canada. Simulations were carried out over the period from 1991 to 1993; 1991 and 1992 data serving in model calibration and 1993 data serving in validation. Along with hydrographs, the Nash-Sutcliffe efficiency (NSE), percent bias (PBIAS) and R^2 statistics were used in evaluating the accuracy of SWATDRAIN tile flow and water table depth predictions in light of measured values. During both the calibration and validation period, SWATDRAIN simulated the hydrologic response at the watershed outlet adequately and the water table depth and tile flow very well. Model accuracy statistics for monthly mean and daily water table depth over the validation period were respectively 0.93 and 0.77 for R^2, 0.11 and 2.90 for PBIAS, and 0.89 and 0.72 for the NSE. Model accuracy statistics for events, monthly and daily tile drainage over the validation period were respectively 0.89, 0.88 and 0.74 for R^2, 11.7, 17.26 and 23.85 for PBIAS, and 0.88, 0.90 and 0.70 for the NSE.

Keywords

Hydrlogic modeling, SWAT, DRAINMOD, Watershed scale

Water Exchange between River Water and Groundwater in the floodplain of the Garonne River with SWAT model

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Abstract

Hydrologic linkage between surface and subsurface water systems have great impacts on water quality, ecosystems and biogeochemistry cycling of both systems. Numerical models were developed to simulate this function, but require detailed spatial inputs, take significant computer run time, and are difficult to apply at large scales. SWAT model is a semi-distributed model that simulates large watersheds with readily available data and has been successfully applied all over the world. However, SWAT didn't include algorithms for river water and groundwater exchange. In this study, a new structure called Landscape Unit was developed, which is the unit between HRU and subbasin. Based on this structure, Darcy's equation was used to simulate the groundwater flow, flooded water volume, and groundwater level during flood periods. This new module was tested in the floodplain of the Garonne River and results show that simulated channel water depths and groundwater levels of the riparian zone matched very well with the observed data. Conductivity and chlorine were used as conservative tracers to test simulated water exchanges, and simulated water exchange quantity of SWAT model was compared with the output of a 2D numerical model—2SWEM.

Results demonstrate that SWAT can reflect the actual water exchange between river water and groundwater in the floodplain of the Garonne River.

Keywords

SWAT model, Landscape structure, water exchange, floodplain, Garonne River

Trace metals transfer in rivers: a semi-empirical formulation to describe a complex sorption – desorption process to be implemented in SWAT model.

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Abstract

The rivers play an important role in the transport of trace metals (TM) since they are the major transport path between the land and the oceans. In the river, TMs are known to travel either in dissolved or particulate phase. As the dissolved phase will be carried by the water flow only, the particulate phase is bound to the suspended sediments and thus is subject to all erosion and deposition processes, increasing significantly the complexity of its fate. Furthermore, the exchanges between the two phases can alter significantly the exported quantities of TMs. This sorption – desorption process still poses a challenge to modellers.

Various modelling approaches have been tested to simulate the exchanges between the dissolved and particulate phases of TMs, ranging from empirical formulation to mechanistic chemical models. However, the actual empirical models are not capable of coping with the very complex and dynamic chemistry of surface waters while mechanistic models require extensive knowledge of the water chemistry (pH, major ions concentration, fine description of the suspended sediment, etc.) and computer resources.

In these works, we propose a semi-empirical model to represent the sorption – desorption processes of the TMs in rivers based on previous modelling experiments with the chemical model WHAM (Windermere Humic Acid Model) coupled to the mechanistic river model MOHID. A sensitivity analysis was performed on the MOHID – WHAM coupled model to extract

dominant parameters and input variables and to provide the best formulation with a minimum number of parameters. The results showed that the dissolved – particulate ratio, known as the Kd, could be described by the SPM concentration and the pH. Therefore, other parameters could be neglected. The formulation was then applied to the river model and compared to the simple fixed partition coefficient model and the complex WHAM model. Once validated, the sorption – desorption model could be implemented in SWAT to allow the simulation of full watershed export of TMs.

Keywords

Metals, rivers, sorption/desorption processes, SWAT model

Projeção de cenários de uso e cobertura da terra e sua influência no escoamento superficial com utilização do modelo Soil and Water Assessment Tool (SWAT) em ambientes semiáridos

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Abstract

Eventos de inundação, enxurradas, enchentes e alagamentos, bem como processos de perda de solos, transporte de sedimentos e contaminantes são condicionados por vários fatores; intensidade do escoamento superficial, declividade do terreno, geologia, cobertura vegetal e impermeabilização do solo. Em regiões de clima semiárido onde as precipitações são intensas e concentradas em um curto período, a intensidade do escoamento superficial potencializa riscos socioambientais tanto em bacias com ocupação urbana quanto agrícola. As estimativas de intensidade máxima de escoamento superficial também são importantes, por exemplo, em projetos de controle de erosão e inundação. O objetivo deste estudo foi analisar o escoamento superficial na bacia hidrográfica do rio Pontal, simulando diferentes usos e coberturas do solo e relacionando com valores de precipitações normais e acima da média. A área de estudo compreende a bacia hidrográfica do rio Pontal, localizada no sertão pernambucano. O modelo hidro-agro-ambiental *Soil and Water Assessment Tool* (SWAT) foi utilizado neste trabalho para analisar o escoamento superficial nos diferentes cenários de uso e cobertura considerados. Este modelo é alimentado por dados meteorológicos, hidrológicos, modelo digital de elevação, mapa pedológico e variáveis de uso e cobertura do solo. Os resultados mostram a relação entre as modificações na paisagem e intensidades das precipitações no escoamento superficial. A aplicação do modelo também permitiu identificar e mapear as áreas que necessitam de atenção quanto às praticas conservacionistas para controle do potencial de escoamento superficial

importantes para as práticas de planejamento e gestão dos recursos hídricos em bacias hidrográficas.

Keywords

Bacias hidrográficas, Escoamento Superficial, Modelo hidro-agro-ambiental.

Analysis of the Rainfall Interception Model Used in Swat

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Abstract

Forests play a major role in spatial and temporal rainfall redistribution. Many researches have been done in developing the SWAT model, but so far, none has verified the process of interception. The objective of this study was to analyze the interception process in the SWAT model by using observed interception data of an Atlantic Forest catchment in Brazil. The Araponga river experimental catchment (ARA) is located in southern Brazil and it is completely covered by secondary Mixed Ombrophilous Forest, subtropical Atlantic Forest. Atlantic Forest is an important biome and little is known about the characteristics of rainfall interception of this forest. The external precipitation (P) and throughfall (Tf) were monitored with an automatic gauge station. The accumulated P for the studied period was 350mm, distributed in 34 day. The maximum measured interception loss was 20.9 mm, and it ranged from 6.3% to 83.6% of total precipitation. By using observed data, the values of Storage capacity (canmx) was estimated as 5.13 mm. The model calibration of the variable canmx resulted in a value of 2.6 mm. The maximum Tf simulated was 67.51 mm while the monitored value was 51.31 mm. The mean relative error of the SWAT run with the measured value of canmx and the calibrated one was 34.2% and 29.4%, respectively. The relative errors found might be related to the model considering only the canopy storage values, disregarding the hourly loss by evaporation and empting the canopy storage only on a daily basis.

Keywords

Brazil, Interception Model, Mixed Ombrophilous Forest and Storage capacity

Analysis of the results produced by weather generators, in hydrologic design of hydraulic structures for water use and in extreme events

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Abstract

Hydrological applications using rainfall-runoff models require as input variables meteorological variables measurements, when the availability of these data is poor, synthetic series are generated by stochastic climate models called weather generators.

It is important to evaluate the performance of these weather generators for the hydraulic structures design, this paper develops an analysis, based on data available at the AASANA Meteorological Station in Cochabamba, Bolivia.

The weather generators evaluated are: WXGEN (Sharpley & Williams , 1990) which is a component of the hydrological model SWAT , CLIGEN (Nicks et al, 1995) forming part of the WEPP model, and LARS -WG - Long Ashton Research Station Weather generator (Semenov & Barrow , 2002).

The developed application uses measured rainfall data and data generated synthetically by these three stochastic models. The four series are transformed in flow with the SWAT model; afterwards water balance is performed to obtain a dam's hydrological height. The results obtained show that with the measured precipitated data the dam's height is ho = 23m, with the series of precipitation generated with WXGEN h1 = 22.8m is obtained, with CLIGEN is gotten h2 = 20.8m, with LARS -WG the required dam's height is h3 = 20.8 m , thus it's observed that WXGEN leads up to the dam's height nearest to the one obtained with measured data.

Given that rainfall daily series was available in all cases, the annual series of maximum daily precipitation is built. Using a desegregation methodology from daily rainfall to shorter time precipitations, Intensity-Duration-Frequency (IDF) curves were developed. It is observed that the IDF curve generated with WXGEN series shows the best approximation to the IDF curve constructed with observed data.

Keywords

Weather generators, stochastic generatorsmodels, rainfall-runoff, SWAT.

Climate Change Applications in Recife

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Abstract

Mudanças climáticas são alterações que ocorrem no clima geral do planeta Terra. Estas alterações são verificadas através de registros científicos nos valores médios ou desvios da média, apurados durante o passar dos anos. As mudanças climáticas são provocadas por fenômenos naturais ou por ações dos seres humanos. Neste último caso, as mudanças climáticas têm sido provocadas a partir da Revolução Industrial (século XVIII), momento em que aumentou significativamente a poluição do ar. Atualmente as mudanças climáticas têm sido alvo de diversas discussões e pesquisas científicas. Os climatologistas verificaram que, nas últimas décadas, ocorreu um significativo aumento da temperatura mundial, fenômeno conhecido como aquecimento global. Este fenômeno, gerado pelo aumento da poluição do ar, tem provocado o derretimento de gelo das calotas polares e o aumento no nível de água dos oceanos. O processo de desertificação também tem aumentado nas últimas décadas em função das mudanças climáticas. As alterações climáticas são já uma realidade: as temperaturas estão a aumentar, os padrões da precipitação estão a mudar, os glaciares e a neve estão a derreter e o nível médio das águas do mar está a subir. É de esperar que estas alterações prossigam e que se tornem mais frequentes e intensos os fenómenos climáticos extremos que acarretam perigos como inundações e secas.

A Framework for Incorporation of Alternative Uncertainty Sources Using the SWAT Model

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Abstract

Hydrological, sedimentation, and nutrient processes are simulated using a large number of physically or empirically based functions in most complex watershed simulation models. It has been shown that it is inadequate to assume that all uncertainty sources are attributed from model parameterization. Biased results and prejudiced conclusions are expected if one or multiple sources of uncertainty are not considered while conducting model calibration. In this study, a framework is developed to propagate uncertainty from input data, system parameters, alternative model structure, and calibration/validation data concurrently to investigate the potential influence against model calibration. Results indicate that input uncertainty initiated comparatively greater impact in terms of the width of uncertainty bands and the associated inclusion rate. In addition, more solutions are derived which satisfy intra-watershed responses with the incorporation of all targeted uncertainty sources simultaneously. The proposed framework can be implemented to identify the significance of different uncertainty sources for applications of various relevant topics.

Keywords

Model calibration, Error propagation, SWAT model, Bayesian Model Averaging, Uncertainty analysis

Searching for better model performance and reduced optimization time: different calibration methods on different watershed locations

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Abstract

Distributed and semi-distributed hydrological models involve a large number of calibration parameters to represent the spatial heterogenity of the watershed and its physical processes. Due to this complexity, manual calibration becomes a less feaseble option, since manually it is harder to visualize relationships between model parameters and watershed physical characteristics and requires a trained hidrologist with a good knowledge of the watershed and of the model used. However, when a large number of interactive highly complex parameters, most times with non-linear relantionships with model outputs, are adjusted, results can be unpredictable, in orther to help on this process there are automatic calibration methodologies, as the model calibrator: SWAT-CUP. This study aims to test different methods for flow calibration, to try to understand how much of an increase on model performance efficiency, and decrease of processing time, can be obtained with different calibration techniques. The calibration was conducted for different sites: 1) only for the watershed outlet; 2) three different regions with similar physical characteristics (as land use, geomorphology and climate) were identified and for these; three gauge stations were selected for calibration. Also different methods were chosen: a supervised calibration using a local optimization algorithm: the Sequential Uncertainty FItting (SUFI-2) and also a global optimization algorithm: Particle Swam Optimization (PSO), the PSO was used with the non-calibrated model, and also, after SUFI-2 calibration to see if there was an incremental improvement. All the results were compared with different statistical evaluations and number of runs, as also the uncertainties related and the variations in different points of the watershed. The performance of the model calibration and validation were evaluated using multiple statistical criteria, based on stream-flow, thought: Nash-Sutcliffe coefficient (NSE), determination coefficient (R^2), the ratio of the root mean square to the standard deviation of the observed data (RSR), percent bias (PBIAS), Mean Squared Error (MSE), and Normalized Mean Squared Error (NMSE). The model was calibrated for the Piracicaba watershed, 12,600 km^2, with ~4 million of people, the watershed is part of the Tietê watershed, the model performances of each one of the 6 different calibrations were evaluated at 16 gauge stations. The daily calibration overall presented good

results; with Nash-Suttcliffe varying from 0.60 to 0.90, and absolute PBIAS from 0 to 15. The calibrations with SUFI-2 presented good results and had the smallest number of runs, the improvement increment of running PSO afterwards did not seem very significant, and for the calibration with PSO only presented good results, but had a processing time of over 20 days. The results show that for flow calibration a local algorithm, but with inputs from the hydrologist, can result in faster method, with good and even better results then a global algorithm.

Calibration of simulation platforms including highly interweaved processes: the MAELIA multi-agent platform

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Abstract

The MAELIA project develops an agent-based modeling and simulation platform to study the environmental, economic and social impacts of various regulations regarding water use and water management in combination with climate change. An integrated modelling approach has been used to model the investigated social-ecological system. MAELIA combines spatiotemporal models of ecologic (e.g. water flow and plant growth) and human decision-making processes (cropping plan and crop management, water releases from dams, water use restriction), socio-economic dynamics (e.g. demography and land cover changes) and models of cognitive sharing among agents (e.g. weather forecast, normative constraints on behaviours).

Due to the diversity and the interweaving of the processes considered, the calibration and evaluation of such a multi-agent platform is a scientific challenge. Indeed, the most common calibration processes would be inefficient due especially to the interactions between formalisms, which have different forms (from classical differential equations to agent behaviour algorithms) and scales. Many parameters may reveal to be influent on the model outputs, with a high level of interactions between parameters impacts. In order to get an overview of the model behaviour and to screen influent parameters, multiple sensitivity analyses were performed, while considering some sub-sets of processes or not. This step-by-step sensitivity analyses enabled to disentangle the different influences and interactions, as a preliminary step to the calibration process. In our case, the calibration, which is a multi-objective (e.g. reproducing water flows and anthropic dynamics) and multi-criteria (e.g. joint use of L_2-norm with variance-covariance matrix and indices of squared errors on water crisis

temporality) optimization problem, was achieved thanks to metamodels built on an appropriated design of experiments.

Keywords

Multi-objective calibration; sensitivity analysis; multi-agent platform

Calibration of SWAT Model in a Small Watershed by Means of Measured Streamflow and Suspended Sediment Data

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Abstract

This research paper focus on the analysis of SWAT model calibration in terms of flow and sediment in Samambaia River Basin, a small watershed (32.78 km^2) located at Goiânia, Brazil. Streamflow and suspended sediment daily measurements have been carried out by February to December 2013 and climatic data were obtained from a weather station located inside the basin. Terrain data such as Digital Elevation Model (DEM), soil types, and land use were obtained from the Information and Statistics System of Goiás (SIEG). Analyzes were performed on the SWAT autocalibration tool as well as on SWAT-CUP software, which is a specific tool for automatic calibration. Initially, the simulation run in SWAT overestimated values of runoff peak and underestimated minimum discharges. However, the peaks were minimized and minimum discharges were adjusted to the observed flows after sensitivity analysis. By using different optimization schemes (GLUE, PARASOL and SUFI–2) in SWAT-CUP, an automatic calibration analysis has been done, which presented a better fit to the observed values (start with streamflow, than move to sediment). Statistical analysis using the coefficient of Nash-Sutcliffe efficiency (COE) resulted in 0.80 and 0.88 for runoff and suspended sediment, respectively, which are considered good fits between simulated and observed values. The CN parameter, which is related to soil type, land use, and infiltration, showed the highest sensitivity in the calibration. After that, the alpha factor of base flow was another which showed higher sensitivity. The higher value obtained for the Manning roughness coefficient allows runoff to be damped. With regard to sediment calibration, parameters of sediment from landscape (USLE_P and USLE_C) as well as parameters of sediment from channel (SPCON and SPEXP) have been used in the calibration, once that they have shown higher sensibility.

Keywords

Calibration; Streamflow; Suspended sediment, SWAT, SWAT-CUP.

Investigating the spatial scale effects on runoff simulation by using SWAT Model

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Abstract

In this paper, the SWAT model is used to investigating the effect of spatial complexity, watershed division level and rainfall spatial resolution on the runoff simulation, by using the Qingjiang river basin as the case study area. The effect of sub-division level of the studied area on the simulation accuracies was first investigated. The studied river basin is divided into 5 subbasins based on the existing five flow stations. The results showed that further division of the studied area into smaller subbasins has very little influence on the simulation results, which might be due to the temporal scale of the data (1 day) is too big for such a small and mountainous area. Secondly, the statistics method, station extraction method and hydrological modeling with SWAT model were used to investigate the effect of the rainfall spatial resolution on runoff simulation accuracies. The results show that the accuracy of runoff simulation increases with the rainfall spatial resolution (in terms of the number of rainfall gauges) in general. However, there exists a threshold of the number of rainfall gauges, which is 5, above which, further increase of the amount of rainfall gauges will hardly improve the runoff simulation accuracies.

Keywords

SWAT model, runoff simulation, spatial complexity, watershed subdivision, rainfall resolution

Application of SWAT model for streamflow simulation in the Una River Basin, Northeast of Brazil

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Abstract

This study evaluates the stream flow for Una River basin by using the SWAT model. The Una river basin has an area of 6.704 km^2 and is located in Northeast of Brazil. This basin has shown in recent years some events of flood, which caused a high economic loss and human life. The Una River Basin has two distinct climatic regions, the semi-arid climate and hot humid, with extensive area represented by crystalline rocks and poorly developed soils. The major land covers in the basin are: urban and industrial occupation, monoculture of sugar cane, livestock and patches of native. In order to overcome the difficult of lack of soil data, it was made a classification obeying a relation with the Hydrological Groups from the Curve Number Method. With this, three classes of soil and water have been identified. Stream flow data between 2000 until 2008 from six fluviometric stations were used. In order to evaluate the calibration and validation of the model, the time series was split in two periods of four years, from 2000 to 2004 for calibration and the rest of period for validation. Calibration of the model was performed on monthly basis using the SWAT-CUP for each of the sub-basins that contributes to the respective station. The calibration process for each stream flow station was satisfactory, in general, with values greater than 0.5 for Nash-Sutcliffe and R^2 coefficients for three of the stations, which could be indicated as the most important ones, as those has the largest areas of contribution. This first attempt in the application of SWAT within this basin will lead to others work, with more discretization and taking account the four dams that are under construction in order to prevent natural disasters from flooding.

Keywords

SWAT model, Una River Basin, Flood

Assessment of the applicability of the SWAT model to simulate the streamflow in a rural catchment in the Federal District (Brazil)

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Abstract

Hydrological modeling can help the understanding of physical processes and assessment of impacts on water resources and the environment caused by rural development and urban expansion in watersheds. However, modeling water systems requires essential steps for obtaining consistent and reliable results.

This study aims to evaluate the applicability of SWAT (Soil and Water Assessment Tool) to simulate the streamflow in a rural catchment in the Federal District, Center West of Brazil. It includes the analysis of hydrological dynamics simulation during the dry and rainy seasons.

The Descoberto Lake is responsible for 63% of the public water supply in the Federal District. The sub-basin Descoberto River flows in the lake, and is one of the main drainage area with about 114 km^2. SWAT model was applied and automatically calibrated by SWAT-CUP in the sub-basin Descoberto. Sensitivity analysis of the model was performed for 14 parameters chosen by degree of importance during the initial simulation and the observed difficulties in simulating the flows. The model was mainly sensitive to the saturated hydraulic conductivity of the soil, curve number, and available water capacity in the soil. The parameter calibration at daily basis for the hydrological years 2005 to 2010 for the River Descoberto was considered satisfactory. It led to a Nash-Sutcliffe Efficiency (NSE) of 0.40 and a coefficient of determination (R^2) of 0.44. The validation for the period 2010 to 2013 led to NSE of 0.48 and a R^2 of 0.46. In the rainy season (November to March) the NSE and R^2 coefficients were 0.28 and 0.42 respectively, indicating an unsatisfactory simulation when analyzing the statistical coefficients. During the dry season (June to September) the NSE and R^2 coefficients showed values of 0.39 and 0.74, indicating a satisfactory simulation. However, the percentage errors between the observed and simulated flow values during the hydrological years of 2005 to 2010, were 35% and 56% at the rainy and dry seasons, respectively. It was found difficulties to simulate the base flow during the dry season.

Keywords

Sensitivity analysis, Calibration

A flow forecast system for hydroelectric production

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Abstract

Brazil is highly dependent on hydroelectricity. MyWater European project (http://mywater-fp7.eu/) demonstrated a flow forecast system for hydroelectric production. Queimado and Tamega are presented as examples of application of SWAT on this system. It is possible to forecast flows using hydrologic models using precipitation from ETA model applied by CPTEC (INPE) with a correction that removes the bias from precipitation from ETA model. The methodology used consisted on calibrating the SWAT model with meteorological measurements and afterwards using the ETA model as input.

Sediment Yield Modeling Using an Alternative Environmental Scenario in Northwestern Rio de Janeiro – Brazil

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Abstract

The northwestern Rio de Janeiro (RJ-Brazil) area has been going through deep transformations in its soil use and occupation, which has contributed to increased sediment yield and changes in the soil-water-plant relationship. Because of this picture, this study aims at analyzing the effects of the environmental scenario using reforestation in the areas established by the Article 2 of the Brazilian Forest Code (*CFB*) on the average sediment yield in the period between 2005 and 2007, in relation to the current use and occupation at the Santa Maria creek experimental basin, located in the Municipality of São José de Ubá, in the northwestern Rio de Janeiro. The mathematical model So*il and Water Assessment Tool* – SWAT, version SWAT2005, named AVSWAT-X was used for sediment yield modeling because of its physical basis and capacity to simulate environmental scenarios. The Digital Elevation Model (DEM), cartographic data on the current soil use and occupation, soil spatialization and its physical-water characteristics, as well as daily and monthly climate and hydrosedimentologic data were needed for the modeling. The results showed that the environmental scenario using *CFB* minimizes sediment yield and the concentration of suspended solids at the Santa Maria creek basin.

Keywords

Brazilian Forest Code. Sediment Yield. Creek.

Experimental and Simulated Runoff by the Curve Number Model for Cassava Cropping Under Different Agricultural Practices

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Abstract

Runoff estimation is essential for water yield assessment in a watershed, flood risk analysis and planning measures for soil and water conservation. This study aimed to evaluate experimental runoff produced by a rainfall simulator and modeled by the curve number (CN) method in cassava cropping under different agricultural practices in a yellow Latosol. Simulated rainfall intensity varied in time (40 mm h^{-1}, during the first 90 minutes followed by an pulse of 90 mm h^{-1} intensity during 30 minutes), for a total of 2 hours rainfall and total rain depth of 105 mm, applied to plots of 3 m^2 . The following treatments have been considered: Cassava downhill spaced at 0.9 x 0.9 m single rows following the slope; cassava downhill with mulch cover (*Brachiaria decumbens*), 8 Mg ha^{-1} density; cassava in contour lines associated with cowpea (*Phaseolus vulgaris*) plus mulch cover, 8 Mg ha^{-1} density, spaced 2 x 0.6 x 0.6 m in double row; and cassava in contour lines associated with cowpea. The results showed that conservation practice of cassava in contour lines with cover and without cover and cassava downhill allowed runoff reduction, and mulch cover resulted in no runoff. The SCS usually underestimated runoff for the considered treatments.

Keywords

Conservation practices; SCS Method; cassava croping

Territorial Planning in River Uberaba's Watershed, Mg, Brazil

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Abstract

The objective of this work was to propose a new methodology to aid in the administration of watersheds. The watershed is, for law, the unit of territorial planning and, for that reason, the study of the morphometric characteristics of a basin is essential for the appropriate administration of the water resources and planning of any activities in an area. This work was accomplished for the municipal district of Uberaba, MG whose main river is Rio Uberaba. The Uberaba River covers five counties, including Uberaba. The studies conducted in this basin to date, always take into account the basin as a whole, ignoring the particularities of each municipality covered by it. Based on this context, the city of Uberaba was divided into hydrological compartments or sub - basins with the aid of GIS (Geographic Information System) ArcGis 10.1 and the SWAT (Soil and Water Assessment Tool) , more specifically its extension to ArcGis , the ArcSwat . The city was divided into 34 sub -basins and for each were obtained : area (hectares) , perimeter (hectares) , length of the main watercourse water (meters) , slope of the sub -basin (%) , length of ramp (meters) and the compactness coefficient (dimensionless) . The low slope (2.74 % - 8.85%) and long lengths of ramps (60m - 91m) reduce the propensity to floods in sub - basins. The high compactness coefficients agree with previous results (1.56 to 2.67). The situations of flooding in the city can be explained by the low soil impermeability, deficiency in urban drainage systems and clearing of permanent

preservation areas throughout the basin, especially the APA (Environmental Preservation Area) of Uberaba River.

Keywords

Water resources management; morphometry; GIS; remote sensing; ArcSwat

The hydrological environmental services of Permanent Preservation Areas (PPA): a case study with numerical modeling in the Ribeirão das Posses watershed

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Abstract

The Permanent Preservation Areas (PPA) constitutes ecosystems of great importance as concerns to the provision of water resources and flood attenuation. These benefits are known as hydrological environmental services. Despite this acknowledgment, there are few studies indicators that assess the hydrological environmental services provided by permanent preservation areas in Brazilian basins. Hence, we will present a case study that investigates the effect of reforestation of permanent preservation areas (riparian and steep areas) in water resources and hydrological pulses. The SWAT model was used to study the effect of these reforestations in the hydrological regime of the Ribeirão das Posses watershed. The model was calibrated against the measured streamflow and evaporative fraction for dominant ecosystems in the Ribeirão das Posses watershed. The results of scenarios with greater reforestation indicated a reduction of 24% in surface runoff and an increase of 2% in the baseflow. The reduction of surface runoff reduced extreme flood peaks up to 18% and did not adversely affect the streamflow during low-flow periods. The study indicates that the areas of permanent preservation, in the forms of riparian reforestation and in steep areas, are predominantly favorable promoters of hydrological environmental services. This gives credence to the designing of actions to conserve the water resources in the Ribeirão das Posses watershed and in watersheds with similar characteristics.

Keywords

Brazil, Permanent Preservation Areas, SWAT, Streamflow

SWAT's hydro-sedimentological simulations for the Brazilian semi-arid

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Abstract

The Brazilian semi-arid region covers about one million square kilometers, presenting a highly variable hydrological regime. A network of representative basins was established in the 1970's, some of which are still under operation. The data monitored in those basins have been very useful for hydrological regionalization so far. This paper presents a study on the parameterization of SWAT model for one of those basins, the Sumé Representative Basin (SRB), in an effort to obtain regionalized SWAT parameters for that region. This 130 km2 basin presents heterogeneous land cover, including native vegetation and agricultural parcels, shallow soils and almost no groundwater. Rainfall is concentrated in 2 to 4 months of the year and only intense events produce runoff and sediment yield. Evapotranspiration is very high. Soil, climate and landscape data as well hydrological records were used for model's parameterization and evaluation. The simulations were verified by comparing with observed runoff data. Simulations of runoff and sediment yield at sub-basin scale were consistent with the landscape characteristics and plot-scale observations at the same basin. The parameterization was then employed to simulate land conservation scenarios for a 11 km2 ungauged basin located within the same hydrological zone. Again, the simulated runoff and sediment yield rates were consistent with the observed behavior at plot-scale studies.

Keywords

Semi-arid, representative basins, Brazil, small basins

Hydrological Modeling of Cubatão Do Sul Catchment Using the Swat Model – Soil and Water Assessment Tool

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Abstract

The Cubatão do Sul catchment (BHRCS) supplies more than 85% of the Florianópolis Metropolitan Region water need. The objective of the study was to estimate the BHRCS water balance using SWAT model, using land use and soil database and weather data from the catchment region. The model was not calibrated but presented good results when compared with the ETA CASAN Montante gauge measured discharge data. For monthly averages, the R^2 and Nash-Sutcliffe efficiency coefficient were 0.75 and 0.78, respectively. The annual precipitation modelled for the catchment area was 1,872.8 mm where 47.2 % was estimated to be converted into evapotranspiration and 50.6% into total runoff.

Keywords

Water balance, SWAT, Cubatão do Sul

Assessing Water Availability in PoKo catchment using SWAT model, KonTum province, Vietnam

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Abstract

To utilize water resources in a sustainable manner, it is necessary to understand the quantity and quality in space and time. PoKo catchment, a tributary of Se San watershed, located in the Central Highland Region of Viet Nam with an area of about 3,210 sq. km, accounted for more than 33% of the total area of Kon Tum province. The PoKo river and its tributaries play a very important role to develop socio-economic as well as environment aspects in Kon Tum province. This study was initiated to evaluate the performance and applicability of the physically based Soil and Water Assessment Tool (SWAT) model in analyzing the influence of hydrologic parameters on the streamflow variability and estimation of water balance components at the outlet of PoKo catchment. The model was first calibrated for the period from 2000 to 2005 and then validated for the period from 2006 to 2011 using the observed stream flow data from Dak Mot stream gauge within this catchment. The determination coefficient of linear regression of the observed and simulated monthly stream flows (R^2) and Nash-Sutcliffe Index (NSI) was used to evaluate model performance. The calibrated SWAT model performed well for simulation of monthly streamflow. Statistical model performance measures, R^2 of 0.89, NSI of 0.82 for calibration and 0.90 and 0.75, respectively for validation, indicated good performance of the model simulation on monthly time step. Both calibration and validation results represented fluctuations of discharge relatively well, although some peaks were overestimated by SWAT. Mean monthly and annual water yield simulated with the calibrated model were found to be 167.26 mm and 1,087.21 mm, respectively. Overall, the model demonstrated good performance in capturing the patterns and trend of the observed flow series, which confirmed the appropriateness of the model for future scenario simulation. Therefore, SWAT model can be taken as a potential tool for simulation of the hydrology of unguarded watershed in mountainous areas, which behave hydro-meteorologically similar with PoKo catchment. Future studies on PoKo catchment modeling should address the issues related to water quality and evaluate best management practices.

Keywords

Water availability, PoKo catchment, SWAT model, KonTum province, Vietnam

Analysis of the São Lourenço watershed in Matão - SP using ArcSWAT

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Abstract

The morphometric characterization of a watershed allows a more practical way to understand the dynamics, thus facilitating the hydrological and environmental analysis, with the aid of Geographic Information Systems. The SWAT (Neitsch et al., 2005) model consists of a set of tools for watershed analyzes coupled to ArcGIS Geographic Information System. The study area includes the watershed of the São Lourenço River that was generated at the Digital Elevation Model (DEM) at a SRTM image of SF-22 - XD map provided by EMBRAPA (MIRANDA, 2005). The main objective was to analyze the soil, slope and morphometric characteristics of the watershed and subbasins to define better management practices. The model results has showed a satisfactory agreement between the slope and soil units and assess the impact of BMPs on sediment reduction using SWAT in different scenarios.

Keywords

Soil; slope; SWAT; land use

Anthropogenic Impacts to the Sediment Budget of the São Francisco River Navigation Channel using SWAT

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Abstract

The São Francisco River Basin - located in northeast Brazil - has undergone a significant amount of anthropogenic changes in the last several decades, such as agricultural expansion, irrigation activities, mining, and the construction of large dams. Together, these changes have altered the historic sediment budget and have led to an aggradation of sediments in the navigation channel, impacting the ability to efficiently ship commodities to regional ports. In an effort to aid decision makers in future waterway navigation planning a SWAT model of the 630,000 km^2 São Francisco River basin was developed, which was used to calculate both the historic and modern sediment budget within the navigation channel.

The SWAT model of the São Francisco River Basin was calibrated for hydrology and sediment loads. Monthly discharges were calibrated at 10 Agência Nacional de Águas (ANA) gages, with NSE values ranging from 0.52 to 0.72 for a six-year simulation. An additional 7 ANA gages were used to validate the model, resulting in NSE values between 0.51 and 0.88 for these additional gages. Sediment loads were calibrated to an ANA sediment gage located in the Middle São Francisco River Navigation Channel, with a PBIAS of -12.6. Based on model results, the aggradation rate of sediment in the São Francisco River and major tributaries has increased by approximately 20 fold since Pre-European settlement of the basin (from approximately 1.25 million tonnes per year to over 23 million tonnes per year). This increase has contributed to an impaired navigation channel due to shoaling of sandy sediments in the navigation channel.

Keywords

Sediment, Navigation, Transport, Sediment Budget, São Francisco River, Planning

Modelling of water availability and water management for the São Francisco Basin, Brazil

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Abstract

Climate change and land-use change impact studies for managed river basins require an adequate representation of both, natural processes as well as land and water management. The eco-hydrological model SWIM, using a number of approaches also applied in SWAT, was calibrated and validated for the highly managed São Francisco river basin (Brazil).

SWIM was modified to better account for regional-specific characteristics of land use (e.g. crop rotation) and water management (hydropower generation, irrigation withdrawals). Problems experienced during calibration and validation and their solution are discussed.

Scenarios of future water availability under climate change are presented. Results and consequences for water management in the river basin are discussed. These include the generation of hydropower at reservoirs and water availability for water users, especially irrigation agriculture.

An outlook on future work, including land-use change scenarios, e.g. increased irrigation, is given.

Keywords

SWIM, São Francisco, hydrology, water management, climate change

Hydrologic, Water Quality and Crop Productivity Impacts of Climate Change in the Ohio-Tennessee River Basin

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Abstract

Nonpoint source pollution from agriculture is the main source of nitrogen and phosphorus in the stream systems of the Corn Belt region in the Midwestern US. The eastern part of this region is comprised of the Ohio-Tennessee River Basin (OTRB) which is impacted by in-stream elevated nutrient, sediment and other pollution problems, and is also considered a key contributing area to the pervasive annually forming Northern Gulf of Mexico hypoxic zone according to the U.S. Environmental Protection Agency. A point of crucial importance in this basin is therefore how intensive corn-based cropping systems for food and fuel production can be sustainable and coexist with a healthy water environment, not only under existing climate but also under climate change conditions in the future. To address this issue, an OTRB integrated modeling system has been built using the Soil and Water Assessment Tool (SWAT) water quality model, which consists of a greatly refined subwatershed structure and is capable of estimating landscape and in-stream water and pollutant yields in response to a wide array of

alternative cropping and/or management strategies and climatic conditions. The effects of the following three agricultural management scenarios on crop production and pollutant loads exported from the crop land of the OTRB to streams and rivers were evaluated for both baseline and future climate conditions: (1) expansion of continuous corn across the entire basin, (2) adoption of no-till on all corn and soybean fields in the region, and (3) implementation of a winter cover crop within the baseline rotations. The effects of each management scenario were evaluated both for current climate (1981-2000) and seven mid-century (2046-2065) climate projections which were downscaled (bias-corrected) from global circulation models (GCMs). All scenarios behaved similarly under the historical and future climates, generally resulting in reduced erosion and nutrient loadings to surface water bodies compared to the baseline agricultural management, with cover crops causing the highest water pollution reduction. At the same time, corn and soybean yields in the region were negligibly influenced from the agricultural management scenarios. On the other hand, both water quality and crop yield numbers under the seven GCMs deviated considerably from those of the baseline climate. The analysis of the results reveals that all GCMs decreased corn and soybean yields by up to 20% on a mean annual basis, while water quality alterations were either positive or negative depending on the GCM. Overall, the study highlights the loss of productivity in the eastern Corn Belt under climate change and the value of SWAT as a tool to analyze the effects of climate change on several parameters of interest at the watershed scale

Keywords

Agricultural management scenarios, Climate Change, corn based systems, Non-point pollution, SWAT, Ohio-Tennessee River Basin

Coupling SWAT with land cover and hydropower models for sustainable development in the Mekong Basin

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Abstract

The Mekong is the largest river basin in Southeast Asia, covering an area of 795,000 km^2 where millions of people depend on local fish and rice for their subsistence. The basin is undergoing rapid hydropower development, which is altering water and sediment flows responsible for driving agricultural and ecological productivity in the lower Mekong. The highest rate of dam development is happening on the Sesan, Srepok and Sekong (3S) rivers, which contribute nearly one quarter of the Mekong's annual discharge. Development has focused on maximizing electricity generation, but long term basin-wide sustainable practices such as coordinated hydropower operations, watershed protection, and sediment management have not been implemented. The main purpose of this study is thus to quantify the effects of hydropower and land cover change on water and sediment flows and determine the extent to which sustainable hydropower practices could reduce alterations. To address this question, four numerical models were integrated: SWAT for runoff and erosion, Dinamica for land cover change, HEC-ResSim for hydropower operations, and SedSim for sediment transport and trapping. Results show that the full development of all proposed dams in the 3S could increase dry season flows by 63% and decrease wet season flows by 22%; most of these alterations could be lessened by adjusting hydropower operations. The dams, however, would trap 40-80% of the 16 million tons of sediment that the 3S discharge into the Mekong annually, assuming no land cover changes occur. However, subsequent future deforestation and infrastructure development would ultimately result in intensified erosion and reservoir sedimentation. These models and results have been developed and shared with regional and local institutions to help coordinate the implementation of sustainable hydropower practices in the Mekong.

Watershed scale environmental and biodiversity sustainability analysis of land use change and climate change using SWAT model

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Abstract

Environmental and biodiversity sustainability analysis is critical in policy decision making related to land use change impacts. Significant amount of land use and land management changes in US agriculture is expected with the Energy Independence and Security Act (EISA) which mandates US biofuel the goal of 36 billion gallons of annual ethanol production. The study aims to evaluate the applicability of Soil and Water Assessment Tool (SWAT) in environmental and biodiversity sustainability analysis with biofuel production under expected climate change scenario for a Midwest US watershed. Various plausible futuristic biofuel based scenarios were developed and evaluated using data from a 2000 km^2 agricultural watershed located in North-Central Indiana, USA. SWAT was used to estimate hydrology, water quality and soil quality based environmental sustainability indicators for these scenarios and compared with baseline scenario. A coupled model of SWAT and Species Distribution Models (SDMs) is developed to evaluate stream fish response to land use change associated hydrology and water quality changes is used to evaluate biodiversity sustainability indicators. Effects of climate change on sustainability analysis was evaluated using World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3): 3 models (GFDL CM2.0.1, UKMO HadCM3 3.1 and NCAR PCM 1.3) for each of three future emission scenarios (A1B, A2, B1). The study results indicated improved water quality with energy crop scenarios comparing to baseline with exception of stover removal that increased sediment and adsorbed nutrients load at watershed outlet. Water quality benefits due to biofuel based land use change are generally greater than the effects of climate change and variability.

Keywords

Climate Change, Environmental Sustainability, land use, biofuel, SWAT

Use of SWAT for optimizing irrigation strategies for sugarcane production on the Island of Maui, Hawaii.

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Abstract

The Hawaiian Commercial & Sugar Company (HC&S) on the Island of Maui, has an area of 184.3 km^2 under sugarcane production that depends heavily on irrigation. Due in part to ongoing climate change, the island has lost significant rainfall in the past few decades, which resulted in reduced water availability for agricultural uses, industrial and urban demands, and environmental flow demands for maintaining ecological functions of Maui's streams. The objective of this study was to perform a sensitivity assessment of sugarcane yields to various irrigation schemes. Analyzing the interrelations of crop yield and water supply provides comprehensive information for obtaining the joint goals of water conservation and profitable yields. The Soil and Water Assessment Tool (SWAT) was used to simulate a number of irrigation scenarios to quantify the changes in sugarcane yield and to calculate water productivity (WP) and water use efficiency (WUE). The scenarios included: 1) 100% of actual irrigation amount, 2) 75%, 3) 50%, 4) 25% of historical amount, and 5) automatic irrigation based on plant water requirement. Sugarcane yield and growth rate were found to be highly sensitive to water reductions. In addition, actual WP and WUE depended highly on the timing of irrigation. Automatic irrigation complements rainfall by irrigating the crop when water can be more effectively utilized by sugarcane to optimize biomass accumulation, yield, WP and WUE. Results indicate that SWAT can adequately estimate sugarcane growth under different water management situations; therefore, it can be used to support water management of sugarcane production in Maui.

Keywords

Irrigation; Water balance; Water use; Crop growth; Sugarcane; SWAT.

Characterization of dry and rainy years in the Alto do Ipanema Basin using the Quantile Method.

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Abstract

O conhecimento do comportamento climático de uma região tem uma importância fundamental na modelagem hidrológica, especialmente quanto à ocorrência de eventos extremos, ea investigação de cenários de mudanças climáticas. Análise de freqüência de chuvas desempenha um papel importante na avaliação hidrológica e econômica dos recursos hídricos em áreas semi-áridas. O semi-árido de Pernambuco mostra grande irregularidade das chuvas, com longos períodos de seca e picos de chuva em um curto período de tempo. A ocorrência de eventos extremos na região altera consideravelmente a produtividade dos agricultores locais. Assim, o comportamento de chuvas é muito importante para alternativas naturais e de gestão de recursos hídricos. Este estudo avaliou a climáticas normais de Pesqueira-PE, para séries temporais de chuva correspondente ao período 1984-2013. O estudo foi realizado em representante sub-bacia do rio Ipanema, investigado pela Rede Brasileira de hidrologia do semi-árido (REHISA) e está inserido na Bacia do São Francisco. O objetivo deste estudo é caracterizar a grande escala de tempo de chuvas, utilizando o método quantile, que classificou anos muito secos (P <349,8 milímetros), seco (349,8 milímetros ≤ P <641, 8 mm), normal (641,8 milímetros ≤ P < 835,2 milímetros), chuvoso (835,2 milímetros ≤ P <1.001 milímetros) e muito chuvosos anos (P ≥ 1,001 milímetro). De acordo com o método, a maior parte dos anos, podem ser classificadas como normais, 13,33% dos anos foram classificados como muito seco e 10% muito chuvosa. Períodos de chuvas anteriores antes de 1984 também são investigados.

Keywords

Frequency analysis; semiarid; Ipanema catchment

IWRM; A Goal-Based Performance Approach in Formulation of Adaptation to Climate Change in Karkheh Basin, Iran

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Abstract

The present study is focused on the adaptation formulation in water management under of a watershed using IWRM (Integrated Water Resources Management) approach. In a watershed based studies, a regional hydrological cycle is bounded by the watershed that is more appropriate spatial entity than an administrative boundary. IWRM approach looks for a framework, which addresses policy objectives and the physical state in the watershed. This approach recognises looks for the agreements between different water beneficiaries including agriculture, natural system and industry. The present study has been conducted to explore adaptation options to address implications on account of climate change impacts in Karkheh Basin (KB) - Iran. SWAT model has been used for impact assessment analysis. The results of climate change impacts were obtained by using the future climate condition with future 'PRECIS' and 'REMO' regional climate models dynamically downscaled from the latest GCMs. It has been found that there shall be explicit deficit in water and crop yield during the end century (2070-2099).

There are broad operations in IWRM approach that have been characterized for formulation of adaptation options. The priority of the IWRM was achieved based on questionnaire, SWOT (Strengths, Weaknesses, Opportunities and Threats), and Partial Order Analysis (POA) in four possible options: management operations for agricultural, management operations for natural system purpose, changing crop pattern, and changing the land-use.

Application of SWAT to water quality modelling in the Rietspruit sub-basin of South Africa

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Abstract

The Rietspruit River is located in the Upper Vaal basin of South Africa and it occupies approximately 1120 km^2. The Upper Vaal is a very strategic economic and urban environment as it contributes about 20% towards South Africa's gross domestic product. Its drainage system which includes Rietspruit sub-basin, routes effluent from mining activities and wastewater from inefficiently operated domestic and industrial treatment plants. The highly polluted effluent finally flows into the Vaal River where it exerts nutrient, chemical and microbial stresses on the aquatic ecosystem. This paper reports on on-going work whose aim is to develop catchment management tools that will enable the restoration of the overall Vaal basin to good health, one sub-catchment at a time.

For this paper, the Soil and Water Assessment Tool (ArcSWAT) for ArcGIS 10.0 was used to model nutrient flows as nitrogen and phosphorus. Data for flow, weather and water quality ranged from 2005 to 2012. The data were subset into calibration (2005 to 2007) and validation (2008 to 2010) sets. While a large part of the data was obtained in GIS and SWAT-enabled formats, LibreOffice 4.1 was used to format, edit and/or save dbf files. The delineation process used the SRTM 90 m digital elevation model. A user-defined soil data base (whose classes were constructed from SOTERSAF and DAFF data) for three soil types, was overlaid together with the landuse use map for 2009, using SWAT's defined landuse categories. Types of crops were obtained from South Africa's 2002 Statistics for Municipal cropping patterns. Rietspruit's nutrient flows (represented by nitrogen and phosphorus), were modelled in order to develop water quality management tools for pollutant sources and thereby protect the sub-basin from further deterioration.

Preliminary delineation produced 17 hydrological response units (HRUs) with minimum elevation of 1417 m and maximum elevation of 1800 m, mean elevation of 1540 +/- 70. The research is on-going while current phases are envisaged to incorporate other SWAT modules like QUAl2K to quantify relative impacts of alternative catchment management practices on

Rietspruit River's water quality. Less polluted water resources are a positive outcome for South Africa, which is currently categorised as a water-stressed country.

Keywords

Pollution, Rietspruit River, SWAT, urban, Vaal basin, water quality

Large Scale Energy Balance in the Juazeiro Municipality, Brazil

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Abstract

In the Juazeiro municipality, Brazil, the natural vegetation has been replaced by irrigated agriculture, highlighting importance for the energy balance quantification on a large scale. MODIS satellite images were used for modelling the components of this balance on a municipality scale throughout the SAFER (Simple Algorithm For Evapotranspiration Retrieving) algorithm. The daily net radiation (R_n) was retrieved throughout the Slob equation, allowing the quantification of the sensible (H) and latent (λE) heat fluxes on this time scale. The averaged fractions of R_n as H and λE varied according to the thermo-hydrological conditions along the year, being respectively 82%, and 18%. However, higher values of λE and lower for H were found in irrigated areas, with some cases of heat advection from the vicinities of the irrigated crops. The models applied in the current research, can subsidize the monitoring of the climate and land use changes effects on a municipality scale, being valuable tools for the water resources sustainability in the future.

Keywords

Remote sensing, Latent heat flux, Sensible heat flux.

A Model for Heavy Metal Dynamics Coupled with SWAT and Its Application in Liuyang River Upstream Basin in China

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Abstract

Transport and transform of heavy metals and the caused impact are highly concerned in the circumstance that mining occurs on the upstream of a river. Generally heavy metals in a watershed can be divided into four species, namely, labile species in soil, non-labile species in soil, soluble species in water and ligand-bound species in water, irrespective the details of the physicochemical form of each species. The authors argued that labile species, soluble species and ligand-bound species can reach equilibrium state in the real hydrologic processes, and formulated the heavy metal module by partitioning the three species metals with literature-supported kinetic parameters contingent on the hydrological situations. The heavy metal module was coded and integrated into the Soil and Water Assessment Tool (SWAT) model, whereby the modeling of all heavy-metal-involving processes including the point and non-point source, transformation in soil, movement with water and sediment in reach and reservoir became attainable.The SWAT model laden with the heavy metal module was used to simulate zinc (Zn) dynamics in Liuyang river upstream watershed from year 2008 to 2013, where a zinc ore mining has been active. The simulation results, though preliminary, indicated that the model agreed fairly with the monitoring results in terms of the aqueous phase zinc concentrations.

Keywords

Heavy metal, SWAT, Non-point source, Mining, China

On contrasting field evidences of water quality to perform physically-based SWAT simulations in challenging Brazilian biome under change

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Abstract

Hydrological models are essential tools to assist the decision-making process for best management practices (BMP), with regard to water-quality cycles and land use conversion which affect ecosystem services. For instance, sedimentation and erosion processes are strongly biased for how local, field evidences are linked to spatially-distributed modeling requirements. The main objective of this study is to outline how contrasting field evidences of water quality can better perform physically-based SWAT modeling in challenging biomes under change. Our working hypothesis is to address practical yardsticks for both SWAT-users and field hydrologists about non-linear behaviors of pollution loads. To quantify possible alterations on water quality modeling, our method is to collect field and experimental evidences through a nested catchment experiment (NCE) approach. This methodology is being applied at headwaters of the so-called “Cantareira System”, responsible of water-supply for 9 million inhabitants of the Sao Paulo Metropolitan Region (SPMR), and located at the Brazilian Atlantic Forest biome, with altitudes ranging between 900-1150 mamsl, and an annual precipitation of 1400-1750mm. Through the use of NCE, quali-quantitative field monitoring has been conducted from September 2013 until May 2014 at catchments with drainage areas from 12 to 130 km^2. This period corresponds to an uncommon condition of low-flows, with critical impacts and conflicts for the water-supply of the “Cantareira System”. Through NCE, we point towards preliminary inherent variability of nutrient loads of, e.g. Total Phosphorous (TP) and Nitrates (N-NO_3). Specific pollution loads of TP and NO_3, expressed as “the mean concentration times observed flow, divided by drainage area”, outline non-linear behaviors throughout spatiotemporal scales. Expected results from samples collected at three different NCE of Posses, Cancã, and Cachoeira dos Pretos present new challenges to modeling with SWAT. Firstly, for a more realistic model setup with incomplete water quality rating curves, further simulation outputs would be validated when compared against confidence intervals of

field evidences. Secondly, because low-flow conditions occupy a considerable part of duration curves and experimental evidences, calibration and validation steps are expected to use different weights of fitting observed flows and loads. Finally, this contribution highlights how conservation actions can link water quality settings and outputs from SWAT to depict ecosystem services. Researches on SWAT model concerning Brazilian biomes will bring more knowledge to help the government, other stakeholders, and people to protect valuable and scarce water resources.

Keywords

Sistema Cantareira; Brazilian Atlantic Forest; water quality; conservation practices; quali-quantitative monitoring; ecosystem goods and services

Comparison between Climate Forecast System Reanalysis (CFSR) weather data and data from meteorological stations in Brazil to evaluate the suitability of CFSR data for SWAT

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Abstract

The Climate Forecast System Reanalysis by the National Centers for Environmental Prediction (NCEP) is a statistically-generated, global 5 decimal degree grid weather dataset for 31 years (1979-2010). In this study, we have analyzed CFSR data for the Brazilian territory and compared them to weather data available from the Brazilian Weather Bureau (INMET). Each INMET station was compared to the closest CFSR station by calculating the anomaly of precipitation (ppt), maximum (Tmax) and minimum (Tmin) temperature (INMET subtracted from CFSR; positive values indicating overestimation by CFSR). We analyzed anomaly temporal means and standard deviations, and linear regressions between anomalies and time. The average anomaly for the 218 INMET stations available for the period 1980-2010 was close to zero for all three variables (zero was within the Q1-Q3 interval for ppt and Tmax, but slightly above Q3 for Tmin). Overall, very low R^2 for the linear regressions suggested high variability within each anomaly time series and the absence of a time trend. Slopes of linear regressions had very leptokurtic distributions for all three variables, with zero within the Q1-Q3 interval, what corroborated the lack of a time trend for anomalies. Intercepts of linear regressions of all three variables were likewise close to zero and in accordance with the means of anomalies. Based on the absence of time bias for the anomalies, we conclude that CFSR data for Brazil are consistent with available weather observations by INMET and suitable for the use in SWAT models. Further, differences in means and intercepts for anomaly linear regressions suggests overall small differences between CFSR and INMET data. Last, large differences for individual stations are not difficult to correct by correction factors in SWAT.

Keywords

CFSR; INMET; weather data; metanalysis

Spatio-temporal visualization for SWAT outputs using SWATShare

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Abstract

A thorough understanding of SWAT input-output structure and efforts are required for extracting SWAT results, subsequent analysis and visualization. While an advanced SWAT user is expected to have these capabilities, but it can hinder easy dissemination and sharing of SWAT results within the diverse user community ranging from students, educators, researchers to policy makers. Accordingly, there are some limited attempts to automate the process of visualizing SWAT simulation results. However, almost all of these recent tools are typically confined tosimple time-series plots of specific output variables. Considering this gap, a dynamic visualization system for SWAT model outputs has been introduced through SWATShare, which is a cyber-enabled platform for executing, calibrating, publishing and sharing of SWAT models on the internet. The novel feature of this SWATShare visualization system is that it provides an interactive interface for selecting and comparing a range of mutually related variables altogether, both in temporal and spatial scale. Temporally, the system creates time-series plots for all the hydrology and water quality related variables available along the reach as well as at watershed-level. Spatially, the system can dynamically generate sub-basin level thematic map for a selected variable for any user-defined date or date range; and thereby, allowing users to download the images for subsequent purposes. This paper demonstrates the design concept and various functionalities of this newly developed visualization system as well as its potential benefits to the SWAT user community.

Minimizing spatial error in HRU aggregation

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Abstract

Reducing complexity is a necessary evil for computationally efficient watershed models. This applies especially for large-scale applications combined with comprehensive inverse modeling approaches for model calibration, uncertainty analysis, and/or optimization-based scenario exploration - which require many thousands of simulations. In SWAT, complexity can be reduced by aggregating HRUs based on certain area thresholds for land use, soil, and slope during the model setup step “HRU definition”. The procedure includes removal of some (usually small) HRUs while inflating the remaining HRUs in order to add up again to the full basin area. So far there is no reasonable method available to objectively decide on aggregation threshold values: As a result, depending on the threshold combination land use/soil/slope, HRU aggregation can result in considerable spatial input data errors.

In our presentation, we will introduce an HRU aggregation analysis tool which calculates the deviation of aggregated areas for land use, soil, and slope for a multitude of different threshold combinations from the irrespective original non-aggregated distribution. With this, it is possible to identify the lowest spatial error at each level of aggregation (deflated number of resulting HRUs). We provide a tool (and reproducible procedure) for all SWAT users that want to reduce model complexity while keeping the spatial error at a low level.

Web-based Real Time Flood Forecasting using SWAT model

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Abstract

On 18 August 2008, heavy monsoon rains and poor maintenance caused a breach in the Kosi embankment and one of the most disastrous floods in the history of Bihar, an impoverished and densely populated state in India occurred. The Kosi river changed course and inundated areas which hadn't experienced floods in many decades. Flooding occurred throughout the Kosi river valley in northern Bihar, in the districts of Supaul, Araria, Saharsa, Madhepura, Bhagalpur, West Champaran and Purnea. The flood killed 250 people and forced nearly 3 million people out from their homes in Bihar. More than 300,000 houses were destroyed and at least 840,000 acres of crops were damaged. Villagers in Bihar ate raw rice and flour mixed with polluted water. Hunger and disease were widespread. In June 2013, a multi-day cloudburst centered on the North Indian state of Uttarakhand caused devastating floods and landslides in the country's worst natural disaster since the 2004 tsunami. As of 16 July 2013 more than 5,700 people were presumed dead. Today, with modern equipments and radars we should have been able to predict the floods and expected inundation much earlier and stopped these human disasters.Technical advancements over the years have allowed us to create input data files efficiently for distributed parameter hydrological models for faster accurate calculations. Soil and Water Assessment Tool (SWAT), a distributed parameter GIS-based model developed by the United States Department of Agriculture have been modified for its use as real-time flood forecasting model. Subroutines have been modified to capture the final conditions of the catchment at any desired instant. Integration of the time series analysis of errors with SWAT model outputs has helped miraculously for accurate forecasting. Present paper aims to develop a system to collaborate on web for exchange of required data for real time flood forecasting using SWAT model and providing information products to water managers for early warning. A real-time flood forecast application study of the Bagmati river basin in Bihar, India, using hydro-meteorological data downloaded from various websites has been demonstrated. Sub-hourly rainfall and water levels of Hayaghat gauge station for 2012 flood season were downloaded from websites www.imdaws, www.hydrology.gov.np and www.fmis.bih.nic. Discharge was calculated using stage discharge relationship. Analysis of web-based data indicates that rainfall in Nepal portion produces peak discharge at Hayaghat after a long time. The lead time at Hayaghat for rainfall of Nepal portion is very high 4-8 days. SRTM – DEM (90 m resolution),

landuse of global USGS (2 M), Soil of FAO Global soil (5 M), rainfall of rain gauges of IMD(Indian Meteorological Department) and stream flows of stream gauges of CWC (Central Water Commission) have been used for setting up of SWAT model. Aphrodite gridded rainfall data has been used for simulating monthly and daily flows of last 15 years for calibration and validation of model and observed data have been collected from CWC (Central Water Commission), WRD (Water Resource Department) and IMD (Indian Meteorological Department). Calibration was reasonable with Nash-Sutcliffe efficiency coefficient EF of 0.84 which indicates that simulated values are reliable. Validation of the modified SWAT model was also done using available measured data of year 2005.Nash-Sutcliffe efficiency for validation was found to be 0.7. which is indicative of high predictive power and accuracy of the model. Real time flood forecasting was done for year 2012 using sub-hourly rainfall down loaded from respective websites. Nash-Sutcliffe efficiency for forecasting was found to be 0.65 which is indicative of high predictive power and accuracy of the model.

Keywords

SWAT, GIS, WEB, simulation, callibration, validation, real time, early warning

Availability of crop residues and soil fertility in communities Pontal Project, Petrolina-PE, in the dry season.

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Abstract

Organic fertilization using residues found in the properties for soil fertilization and improvement of growth of plant species is one of the internationally recommended practices for a sustainable ecologically-based agriculture. The soils of most of the rain-dependent areas farms of the semiarid region of northeastern Brazil have low levels of elements such as nitrogen and phosphorus and difficult the achievement of results of production to the satisfactory maintenance of agricultural activity in these areas. As a result, year after year expected yields become increasingly rare and, with the aggravating water deficit, many farmers no longer believe in the viability of cultivation of some species, even those that have historically occupied spaces in these important properties, such as maize, beans and cassava. This study aimed to identify the main waste generating activities and soil fertility in communities in Projeto Pontal, in the dry season, between August and November 2013. Semistructured interviews and collection of soil were held in the communities Vira Beiju, Lajedo and Amargosa. Soil analyzes were carried out at Embrapa Semiarid and revealed the need to correct soil acidity in all communities (pH between 4,2 and 5,5), adding sources of phosphorus (P < 3,8 mg.dm^{-3}) , organic matter (<5,5 g.kg^{-1}) and zinc (< 6,95 mg.dm^{-3}), especially in community Vira Beiju. Various activities that generate agricultural waste that can be used in local agriculture were identified, but in this study period (drought) only goat manure was found in greater quantity (5,0m^{-3} per month), in all communities, being sold for income obtaining. Livestock was the most waste generating activity at the interview, and cote the most generation place of agricultural waste on the property during the study period (88.9 %). Although the crops were the most frequently reported as major generators of agricultural waste for most of respondents (89%), can only be used if stored in generation, in the rainy season. Other residues were also found, but in some significant quantities and require more detailed analysis in order to know its chemical composition and reaction in soil. Same assessment in the rainy season is also required when waste generation is more intense.

Keywords

Soil fertility, agricultural waste generation, soil characterization, dependent on rain area

Chemical characterization of agricultural waste found in communities Lajedo, Amargosa and Vira beju in Petrolina-PE during the drought period.

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Abstract

Low soil fertility in rain dependent areas prevent satisfactory yields and result in discouragement and financial imbalance for the family-based farmers. The soil correction or fertilizer has not been a common practice among farmers and the lack of family-based intervention that results in degenerative cycle of agriculture in these areas results to: not corrected or complements soil fertility - productivity is low - prevents that invest in soil improvement - resulting in low productivity. This cycle could be broken if they used some waste generated in these family farms. However, it is important to known that these residues are, how often are generated and the composition of the same to make a recommendation of their use based on more accurate information. The present study was carried out in order to chemically characterize the agricultural waste generated in three communities in Projeto Pontal in period of water deficit, between August and November 2013. Therefore, we conducted semistructured interviews and collected the waste generated in three communities: Vira Beiju, Amargosa and Lajedo, from August to November 2013. The residues were analyzed in the Laboratory of Embrapa Semiarid. Phosphorus (P- total) was determined by colorimetry with metavanadate. The determination of sulfur (S) was made by turbidimetry, wherein the turbidity is measured spectrophotometrically. Sodium and potassium were made from the flame emission spectrometry. Nutrients: Ca, Mg, Cu, Fe, Mn and Zn were determined by atomic absorption spectrometry (AAS). The analysis of trace elements was performed directly in the extracts. The analysis of boron was taken by colorimetry method azometina H. The determination of nitrogen was performed using the semi -micro Kjeldahl method using the technique of wet solubilization, followed by steam distillation and titration to quantify the NH4. In the study period, the residue found predominantly in all the properties was the goat manure. Other wastes were found in only one property, such as mesquite residues, cassava shoots and leftover bean crop. The goat manure, with production of approximately $5m^3$ per month on investments was the richest among chemically residue found, showing an average 16.04 $g.kg^{-1}$ of nitrogen, 1.76 $g.kg^{-1}$ phosphorus, 5.11 $g.kg^{-1}$ potassium 21,02 $g.kg^{-1}$ calcium 6.71 $g.kg^{-1}$ and 1.91$g.kg^{-1}$ sulfur. The other wastes have lower monthly generation values of the manure and chemicals also lower except crop residues mesquite that showed average 22.67

g.kg $^{-1}$ of nitrogen and 24.24 g.kg $^{-1}$ calcium. The cassava foliage showed levels of calcium (27.86 g.kg^{-1}) above the values of the same element in manure. Nevertheless, it becomes impractical the continued use of cassava foliage or other vegetables because they not used by local farmers for feed. Only the manure becomes a viable option for this purpose although in the dry season as all evaluated manure is sold to generate income for the family. Thus, it is necessary to evaluate the generation of waste in the rainy season and possibly suggest to store them for the purpose of use in soil fertilization of these areas.

Keywords

Agricultural waste, chemical analysis, soil fertilization

Key Factors That Influence Water Quality in Watersheds with Eucalyptus Plantation

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Abstract

Sampling is one of the most important aspects to be considered in the survey of water quality when evaluating environmental impacts. The combination of number and type of sampling variables has to detect the impacts as soon and with less samples as possible. These impacts should be identified to support sustainable actions in watersheds managed for timber production, especially for cellullose industry in Brazil, where there is constant criticism concerning environmental impacts of Eucalyptus plantations. The objective of this study was to identify the main natural and anthropogenic factors which affect the water quality in watersheds managed for timber production from Eucalyptus. Water quality was monitored in four watersheds located in the municipality of Aracruz, northern Espírito Santo State, Brazil. The monitoring was carried out from January to June 2012. Therefore, we analyzed the physical and chemical characteristics of superficial water as well as the presence of pesticides used in forestry. The collections were made after completion of each silvicultural activity in the watershed and after each rainfall event. We used principal component analysis and factor analysis to determine the most sensitive variables and those which most correlated with the activities of the forest management. It was possible to obtain four components that explained 70.1% of the total variance. The four components were correlated with 25 variables and the factors were defined as *mineral*, *solid*, *acid* and *pedological*. These factors explained 31.6; 18.5; 15.6; and 7.4% of the total variance of the data and are directly related to the salinity, presence of suspended solids, acidity and inorganic carbon in soil, respectively. In general, it is possible to reduce from 30 to 12 variables that must be monitored for the prediction of water quality, maintaining at least 70% of the precision of the estimates. We concluded that the water quality variation was related to the natural elements of the soil and that the silvicultural activities did not affect the water quality in the studied conditions.

Keywords

Forestry; water sampling; environmental impact

Effect of climate change on hydrological regimes of Sind River Basin, India using SWAT Model

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Abstract

This study assesses the potential impact of future climate change on hydrological regimes intended for water resources availability in Sind river basin, India using SWAT Model for the periods 2021- 2050 (Mid century) and 2070-2098 (End century). Future climate projections from PRECIS generated outputs under IPCC A1B Scenarios for local conditions at 0.44^0 x 0.44^0 spatial resolutions, extracted at IITM Pune; India has been fed in to SWAT Model. The average mean monthly stream flow data measured at three (Pachauli, Seondha and Bhind) spatially distributed Central Water Commission (MoWR) gauge stations has been used for calibration and validation. The model was calibrated during the period 1987 to 1999 with 3 years warm up and validated for next 6 years from 2000 to 2005. The model determined good to very good performance for stream flow prediction (R^2 values range from 0.80 - 0.89, NS from 0.66- 0.90 and RMSE from 19 to 83) between measured and simulated stream flow values during model calibration and validation. The model simulations for mid-century and end century when compared with the baseline (1961-1990) scenario for all three spatially distributed CWC gauge stations in the Sind river basin has been estimated an average monthly stream flow decrease (from 16 to 47%) and average monthly stream flow increase (from 47 to 95%) depending on the spatial characteristics of the gauge stations. Overall, the results indicate that streamflow may increase in monsoon season and will decrease in non-monsoon season due to projected future climate change on hydrological regimes.

Keywords

Streamflow; hydrological regimes; climate change; PRECIS; SWAT; Sind river basin

Simulation of green and blue water impacts caused by climate changes in Apucaraninha River watershed, Southern Brazil.

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Abstract

Climate changes may generate significant impacts in hydrological cycle. It is important to recognize modifications in green water (water stored in soil and then consumed by vegetation) and blue water (water that flows in rivers, lakes, wetlands and shallow aquifers) availability in consequence of climate change modifications. In this context, mathematical modelling is a useful tool to simulate hydrological processes in watersheds and the effect of climate change scenarios. Therefore, this paper aims to assess the impacts of climate change in blue and green water in Apucaraninha River watershed (504km^2), Southern Brazil, considering the climate scenario A2 (pessimistic about greenhouse gases emissions) and climate scenario B2 (optimistic about greenhouse gases emissions), developed by IPCC. SWAT model (Soil and Water Assessment Tool) was calibrated and validated using daily streamflow from 1987 to 2012. Climate scenarios A2 and B2 were used to simulate the hydrological conditions for the period 2071-2100. The model presented satisfactory fit compared to the observed data allowing the simulation of the current hydrological conditions, therefore permitting the simulation of future climate change impacts in green and blue water. Despite the increase in potential evapotranspiration of 19% and 12% for A2 and B2 scenario respectively, caused by the increase in temperature, the reduction in rainfall amount (19% for A2 and 23% for B2) induced a reduction in real evapotranspiration (16% for A2 and 33% for B2), which correspond to green water, and a reduction of 21% for A2 scenario and 17% for B2 scenario in blue water availability.

Keywords

Green Water; Blue Water; SWAT Model; Hydrological Modelling; Climate Change;

Climate change impacts on the streamflow of a semi-arid watershed, Northeast Brazil

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Abstract

The northeast region of Brazil is the most vulnerable region in Brazil to climate variability, having suffered from recurrent and severe droughts. To decrease the vulnerability of the water scarce region good water management and appropriate infrastructure are vital, especially for irrigated agriculture and municipal water supply. In this context, the assessment of climate change impacts in the water resources is very important in for planning; to establish adaptation measures to decrease the vulnerability to climate variability and change. An assessment of climate change impacts in the water resources of the semi-arid Jaguaribe watershed (73,000 Km^2), Ceará, Brazil is presented, using two climate change scenarios from the Intergovernmental Panel on Climate Change (IPCC) (A2 and B1) for 2041 to 2070 generated by a global circulation model from the National Institute for Environmental Studies, Japan, MIMR, from the Assessment Report 4 (AR4). The statistic downscaled scenarios Thiessen interpolated used are from Silva (2013). The Soil & Water Assessment Tool (SWAT) was used in this study to analyze the hydrologic responses to the current climate and the future climate change scenarios. The SWAT model for 1979 to 2000 was set using the SWAT's weather generator based on monthly data from four airport weather stations and daily data based on 124 local rain gauges, the model was calibrated using Sequential Uncertainty Fitting (SUFI-2) on the software SWAT-CUP (SWAT Calibration Uncertainty Procedures), for 7 years and validated for 5 years for monthly time-step, presenting Nash-Sutcliffe values of 0.78 for the calibration period and 0.72 for the validation period. The uncertainties of the scenarios were also assessed at SWAT-CUP. The simulated flows and volumes were compared at the reservoirs of the watershed and there was a significant decrease on the total volumes on both scenarios, being more pronounced on scenario B1.

Keywords

Climate change, uncertainty, Brazil, semi-arid.

Drought Assessment of future stream flow over the Sesan river basin in Vietnam

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Abstract

Central highland Vietnam is the source for perennial plantation which produces most of the coffee for Vietnam, to which, it serves as the world second most exported coffee next to Brazil. Additionally, this region is also one of the important source for hydropower of Vietnam and one of the main tributary for Mekong river at downstream. This region has been known prone to drought, especially during dry season. Therefore simulating drought for this area has a big meaning to study the water supply and water balance for the region in future planning. This study used a regional climate model Weather Research Forecast to derive present day and future climate variable which were used as input to assess the hydrological drought over Sesan river basin in Central highland, Vietnam. The semi-distributed hydrology model SWAT was calibrated and validated for the period 1980-2005 for the 2 sub-catchments of the Sesan river basin. Hydrological drought for the whole catchment is assessed by the Standardized Runoff Index. The trend for present day climate has been carried out using Man-Kendall trend test. Information from dynamical downscaling as an input to hydrology model will reveal the future drought situation over the study region.

Keywords

WRF, SWAT, SRI, climate change

Multi-site evaluation of APEX for crop and grazing land in the Heartland region of the US

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Abstract

The Agricultural and Policy Environmental Extender (APEX) is powerful and useful to estimate the edge-of-field impacts of management practices. A drawback is that it needs to be calibrated for each site, which requires resources and data. The objective of this study was to compare annual model performance for flow, sediment and phosphorus transport under two parameterization schemes: an out-of-the-box (OOTB) parameterization based on readily available data and a fully calibrated parameterization based on site specific soil, weather, event flow and water quality data. The analysis was conducted for 18 watersheds at five different sites representing hydrologic conditions ranging from well to poorly drained soils and management systems covering row crop under different tillage systems and grazing systems. Model performance was based on the Nash Sutcliffe efficiency (NSE), the coefficient of determination (r^2) and the regression slope between simulated and measured loads. Although the OOTB model performance for flow was acceptable (NSE = 0.5), calibration improved it (NSE = 0.6). Acceptable simulation of sediment and total phosphorus transport (NSE = 0.7 and 0.6, respectively) was obtained only after full calibration at each site. Analysis of the calibrated parameter sets is ongoing to define a regional APEX parameterization that will be further evaluated on additional sites. A regional parameterization will be beneficial to conservation and resource management agencies who consider using APEX as a management and prioritization tool and for regional analyses.

Keywords

APEX, calibration, flow, sediment, phosphorus, regional calibration

Improvement of the Variable Storage Coefficient Method with Water Surface Gradient as a Variable

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Abstract

The Variable Storage Coefficient method (VSC) has been used for stream flow routing in continuous hydrological simulation models such as the Agricultural Policy/Environmental eXtender (APEX) and the Soil Water Assessment Tool (SWAT) for more than 30 years. APEX operates on a daily time step and offer options for simulating processes on shorter time steps (e.g., hourly). However, APEX is not adequate for applications such as designing flood control structures or estimating flood damages because of a fundamental assumption in the VSC method: the normal flow condition. The Storage with Variable Slope method (SVS) and an enhanced Variable Storage Coefficient method (VSCe) are proposed as new routing methods for continuous simulation models that will improve flow routing and water quality simulation at subdaily time scales. This study describes the principle of the SVS method and the VSCe method and their performances against HEC-RAS unsteady flow results on various hydraulic and geometric conditions. Results show that the peak flow and the time to peak flow improved up to 20% with SVS and VSCe on mild slopes (less than 0.0005) and small time steps of less than one hour when compared to the conventional VSC method, though the difference narrowed down as channel slope and time interval increases. A case study on a small agricultural watershed in Texas indicates that both VSCe and VSC output are reliable in the watershed application, but the improvement in streamflow prediction can be marginal in watersheds with steep slopes.

Keywords

Streamflow routing, flood, continuous simulation, water surface gradient

Estimating plant available water for general crop simulations in ALMANAC/APEX/EPIC/SWAT

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Abstract

Process-based simulation models ALMANAC/APEX/EPIC/SWAT contain generalized plant growth subroutines to predict biomass and crop yield. Environmental constraints typically restrict plant growth and yield. Water stress is often an important limiting factor; it is calculated as the sum of water use from each soil layer divided by the potential plant evapotranspiration. The plant available water in each soil layer is estimated from the difference between water volume at field capacity and wilting point. Reliable estimates of the plant available water are essential for accurate estimates of plant growth and water use. Several pedotransfer methods have been developed to estimate field capacity and wilting. We tested the ability of three methods (Rawls, Baumer, Norfleet, Nearest Neighbor, and K-D Tree) to estimate field capacity and wilting point based on commonly measured soil properties (% sand, %silt, %clay, % organic carbon, bulk density, and cation exchange capacity). The Rawls, Baumer, and Norfleet methods compute field capacity and wilting directly from properties of the selected soil, whereas the Nearest Neighbor and K-D Tree methods lookup these values from a database using % sand, %silt, and % organic carbon. Each method was tested for 2,039 cropland soil profiles from the NRCS National Soil Characterization Database. The ability of the five methods to estimate wilting point and field capacity were assessed for accuracy and their relative processing speeds were compared. The relative value of these computational methods for process-based biophysical models will be discussed.

Keywords

Plant growth, plant available water, field capacity, wilting point

Integrating uncertainty in model parameters, input, and model structure in watershed modeling

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Abstract

Process-based watershed models often involve a large set of parameters. Parameter adjustments have been the conventional treatment of uncertainty in modeling applications. This study aims at facilitating simultaneous consideration of model parameters, input and model structural uncertainty using an input error model and Bayesian model averaging (BMA) along with an automatic parameter optimization technique. Specially, the focus is on extending the capabilities of the Agricultural Policy Environmental eXtender - auto-Calibration and UncerTainty Estimator (APEX-CUTE). The orginal APEX-CUTE is a parameter-calibration tool for APEX developed to enhance the accessibility for APEX users to conduct potentially tedious calibration work on the APEX model. This version of APEX-CUTE incorporates relevant uncertainty factors in hydrologic and water quality modeling. Users have options to include input uncertainty during the calibration process and to conduct BMA for optimal solution. A case study was developed using data from the Riesel watershed in Texas. APEX-CUTE is not only the comprehensive package in conducting APEX calibration, but it can also be implemented to address uncertainty associated with APEX modelling in a more reliable manner.

Keywords

Agricultural Policy Environmental eXtender; Auto-calibration; Hydrology; Sediment; Uncertainty analysis; Bayesian Model Averaging

Hydrological Impact of Large Scale Conversion of Rubber to Oil Palm Plantation

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Abstract

Oil palm and rubber plantations together with tropical rainforest form the major land cover of the upper part of Muar River watershed, canvassing an area of almost 3000km^2. The last 24 years however have seen the dynamics of land cover domination changed from forest to rubber then later on to oil palm, following the price of commodity. The successive changes in land cover at a scale this large have huge implications on the hydrology of the area that are manifested in the flows of the Muar River. More frequent flooding is just one of the manifestations. In order to completely understand the impacts of the land cover changes, SWAT was used to simulate the hydrological responses of the watershed within the last 24 years, using 42 years of climate data. Automated calibration and validation using SUFI-2 in SWAT-CUP successfully enhanced the performance of the simulations. The NSE index was used to assess the performance of calibration and validation simulations of monthly flows. The NSE indices showed encouraging values ranging from as low as 0.71 to as high as 0.85. Within the last 24 years that the watershed was simulated for, total surface water and total discharge had been increasing annually while controlling for the amount of rainfall. A strong correlation exist between the size of oil palm area and the flow discharge and runoff volume, with R^2=0.69 and R^2=0.50 respectively. This is due to various factors ranging from the physiology of oil palm itself to the management of the plantation. These factors are discussed in details in the paper.

Keywords

Watershed, runoff, SWAT, SUFI-2, oil palm, rubber

Water Balance Estimation in Rio Negrinho Basin, Southern Brazil.

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Abstract

The water balance is the force that governs all the processes that occur in a watershed, therefore knowledge of hydrological process provides a better understanding of water demands. In the last years, Rio Negrinho city, located in Santa Catarina state, has been suffering from extreme hydrological events, mainly by accelerated urbanization, soil sealing and occupation of risk areas. Hydrological modeling is a useful tool to predict the water dynamic behavior in a watershed. Hence, the objective of this study was to estimate the spatial varying water balance in the Rio Negrinho Basin (BHRN – 198,64 km^2), situated in the Northern Plateau of Santa Catarina state, Southern Brazil. The Soil and Water Assessment Tool (SWAT) was used to simulate all hydrological processes affecting water balance in the watershed. Data from three rainfall station in a period from 1990 to 2013 was used for simulation. The results indicated a high rate for surface runoff 50% and 50% for base flow; the stream flow, percolation, deep recharge and evapotranspiration were 60%, 32%, 2%, and 37% respectively. The results suggest that the SWAT model is a promising tool to assess the effects of land use changes in the water balance in Brazilian watersheds.

Keywords

Watershed modelling; water balance

Modelling Runoff with Satellite Data

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Abstract

Rainfall-Runoff modelling is crucial in analysing hydrological extremes for any watershed. These analyses are used to mitigate the negative effects of both floods and droughts. Effective modelling system requires both sound scientific basis and quality complete data. However, lack of sufficient meteorological data in terms spatial and temporal coverage is a major challenge to effective runoff estimation in many regions. Satellite weather data, which can be used to supplement ground data, are not calibrated to local conditions in these areas. The aim of this study was to develop a calibration technique for satellite-based weather data for better runoff modelling. The method was applied to a flood-prone data-scarce Nzoia River basin in Kenya. Both daily rainfall and potential evapotranspiration data were obtained from the United States Geological Survey (USGS) centre and Kenya Meteorological Department. The satellite data were calibrated through the quantile-perturbation approach before being applied to rainfall-runoff model, Soil and Water Analysis Tool (SWAT). The performance of the model was accessed through Relative Root Mean Squared Error (RMSE), Nash-Sutcliffe efficiency and graphical plots. Results show that calibrated satellite data can be valuable in runoff modelling in regions with scarce ground data. The study contributes to better early warning systems and design of flood control and protection structures.

Keywords

Calibration, Model Evaluation, SWAT Model, Quantile-perturbation, Rainfall-Runoff Modelling, Satellite Data

The role of the alluvial floodplain to modeling water discharge using SWAT model in the Amazon catchment

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Abstract

Swat model is applied to the whole Amazon watershed (8 Millions km^2) to simulate river discharge at monthly time scale for the period 1997 to 2012 at the Obidios gauging station. Simulations using standard parameters shows a good agreement with the observation at yearly scale, but at monthly scale the data are not fitting the observation. This first modelling permits to identify the influence of the amazon floodplain on the river discharge. First, we can quantify by inverse method the role of the floodplain on discharge. Then, we propose to integrate a new equation to take into account the role of the floodplain according with alluvial floodplain area. This work represents a start point for a forward application of the SWAT model to take into account the role of the alluvial floodplains at the catchment scale.

Water Production in River Basin Siriri-Sergipe

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Abstract

The need to know the hydrologic behavior of a watershed is critical to ensure the preservation and conservation of resources hídircos. Hydrological models are tools that allow to know the dynamics of a watershed in a short time and without spending costly. This study aimed to evaluate the spatial distribution of water production simulated by the SWAT model for river basin Siriri. The simulation was performed for the period 2000 to 2013, the procedure for calibration and validation were not performed due to lack of monitoring data flow. The sub-basins that produce more water are located in areas of greatest slope. These areas deserve special care with respect to its management since the increased water production is related to greater sediment production and consequently to erosive processes.

Keywords

Hydrological model, SWAT, water resources

Sensitivity analysis of soils parameters and their influences on streamflow simulation in a small watershed, Northwest RJ, Brazil

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Abstract

The physical and hydraulic properties of soils in the watershed vary temporally and spatially, having a direct relationship with the amount of water that infiltrates, flows and reaches to the river channel, influencing stream flow responses. The knowledge of input parameters in a hydrological model and its sensitivity is beneficial to understand how hydrological processes are estimated. The soils parameters adjustments in the SWAT model aims to improve the performance of processes simulations, reducing uncertainty and leading to a better representation of hydrological processes in reality. A simple approach to assess how and what parameters influence the response of the flow was proposed and applied in a small watershed (6km^2), with a predominance of Ultisols and hilly relief, in the northwest of Rio de Janeiro state. The methodology was divided into three stages: at first, the parameters have been listed in order of sensitivity; subsequently, the most sensitive parameters had their values changed individually while the less sensitivity parameters values were maintained. Finally, we assessed the influence of each parameter in flow simulation by SWAT model. The sensitivity analysis showed that parameters related to soil water content and hydraulic conductivity affect the generation of overland flow, consequently, the maximum flows in the main channel. The capacity of available soil water (SOL_AWC) had their values increased in 30%, and were adjusted according to land use. The Curve Number parameter (CN2) had their values reduced in 10%. The value of hydraulic conductivity of the soil (SOL_K) had their value increased 50%. Those changes increased the infiltration and water storage in soil, decreasing overland flow. With calibration values of NS = 0.75, PBIAS = 12.7% and R^2 = 0.51 and validation values of NS = 0.5, PBIAS = 13.02% and R^2 = 0.73, the good results obtained with the soil parameter values adjusted could be observed through graphical and statistical analysis.

The influence of different land cover and land use on hydrological response of Barro Branco Watershed, Rio de Janeiro, Brazil

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Abstract

The physical and biotic characteristics of a watershed have fundamental importance in the hydrological cycle processes, influencing the infiltration, the runoff, evapotranspiration and surface and subsurface flows. The soil erosion is directly influenced by surface hydrological processes and land management practices, through the sediment production, transport and deposition. In this work the spatial distribution of flow was analyzed in the Barro Branco watershed by SWAT (Soil and Water Assesment Tools) model. This watershed, with 6km^2 is inserted in the Northwest Region of Rio de Janeiro State, Brazil. The KOPPEN (1948) climatic classification is Aw, tropical climate with dry winters. The predominant soils are Gley soils and Ultisols. The land use and land cover are divided into: grazing, altered natural vegetation and bare soil. The hydrological processes modeling at catchment scale is an important tool for streamflow simulation. In order to carry out the simulations, the model employs a spatial databank of basin, made up of geographical, pedological, hydrological and climate data, as output data the model generates tables and maps. It was observed that, before calibration, the minimum flows estimated were below those observed, but the peak flows were overestimated. After calibration, the minimum flows had better correlations, while the peak flows were underestimated. The simulation results were compared to streamflow experimentally data observed in 2008. The Nash-Suctlife Efficiency Coefficient (NS), factor regression (R^2) and PBIAS was adopted in order to validate the model prediction. The main statistical indices showed significant improvement after calibration and remained satisfactory after validation. Being the NS after calibration of 0.7 and 0.5 after validation; R^2 Coefficient obtained after calibration was 0.5 and after validation 0.7, finally, the PBIAS calibrated was 12.7 and validated, 13.02. The model was sensitive to the parameters for the soils, first the entire amount of capacity of available soil water to the basin was converted in runoff. However, once the parameters that conditioned infiltration were calibrated, the simulated flow approached significantly to observed data. The SWAT model was able to simulate streamflow in Barro Branco watershed, since there were not many gaps in the monitored data, and also being able to simulate data from other periods for which the parameters were not adjusted.

Keywords

Watershed, Hydrological Modelling, Water and Soil Conservation, SWAT

Assessment of runoff in the Tapacurá River Basin (Pernambuco state, Brazil) using SWAT model

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Abstract

The Soil and Water Assessment Tool (SWAT) was used to simulate the runoff in the Tapacurá River Basin, Pernambuco State, in northeast of Brazil. This watershed in very important for water supply at Pernambuco state. The main objective was to validate the performance of SWAT and the feasibility of using this model as a simulator of runoff, and related processes affecting water quantity at a catchment scale. The investigation was conducted using a 12 year historical streamflow. Data from the period of 1997 to 2004 were used for calibration, and data from 2005 to 2008 were used to validate the model. In the present study, the study area was subdivided into natural sub-watersheds to preserve the natural flow paths, boundaries and channels for realistic routing of water. Since SWAT has a large number of parameters, a sensitivity analysis was first conducted to identify the set of parameters that have the most influence on simulated streamflow. Soil and land use maps at the scale of 1:500000 were obtained from previous studies and were associated with the soils and land uses database of the SWAT model. The results show that the most sensitive parameters were found to be the base flow, Manning factor, concentration time and soil evaporation compensation factor, which affects the catchment hydrology. The model calibration and validation were performed on monthly basis, and the stream flow simulation showed a good level of accuracy for both periods. The obtained R^2 and Nash-Sutcliffe Efficiency values for each period were respectively 0.85 and 0.79 for the period 1997-2004, 0.92 and 0.91 for the period 2005-2008. The result spatial distribution showed high runoff values in the sub-basins with high concentration of precipitation and in the sub-basin #8, which shows a strong soil sealing. The areas that had low surface runoff are located in the sub-basins that have a low concentration of rainfall and in the sub-basin #3, which presents forest cover.

Keywords

Representative basin; SWAT model; surface runoff

Application of SWAT Model to Evaluate the Influence of Bank Vegetation on Runoff and Sediment Yield in the Basin of Siriri River, Sergipe

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Abstract

In the Japaratuba river basin (1700 km^2) in the State of Sergipe, Northeastern Brazil, several activities have been put into practice over the last two centuries such as mining, cattle raising, pasture, and sugar cane cultivation. These activities have been impacting the water resources in the region, particularly in the Siriri river sub-basin (308 km^2). As a consequence, the natural vegetation, and particularly the bank vegetation, has been completely removed affecting the hydrologic processes, bank interactions and flood plains. Hence, an evaluation of the influence of bank vegetation on runoff and sediment load of the Siriri river basin would be of great help in the process of preserving the bank vegetation, and avoiding river sedimentation and flooding. In addition, the identification of the impacts on the processes of soil erosion and transport would help to figure out adequate land use for this basin. In the present study the model SWAT was applied at daily intervals to investigate the impacts of land use on runoff and erosion considering two scenarios: scenario 1- the land use and land cover existent in the year 2005; scenario 2- scenario 1 + a band of bank vegetation of 30m in width for each bank side . As there were no data on discharge for the second scenario, no calibration was conducted and the SWAT model parameters were defined as indicated for the conditions by the model. The results show that the model was effective in simulating the runoff, erosion, and sediment yield processes over the basin. In addition, the recharge to the groundwater increased from scenario 1 to scenario 2, and a reduction of the sediment load was observed for scenario 2 (about 9%),

showing the influence of bank vegetation on sediment load and suggesting the effectiveness of vegetation in preventing from floods and sedimentation.

Keywords

Siriri River; SWAT model; bank vegetation; erosion; sedimentation

Impacts of a specific soil database on streamflow simulation with SWAT in an experimental rural catchment of the Brazilian savanna

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Abstract

This study aimed to evaluate the impacts of using a specific soil database on streamflow simulation with SWAT model in an experimental rural catchment of the Brazilian savanna (Cerrado biome). In order to accomplish that, two soil databases were tested, one generated by data measured in the studied area (Sim1), and the other from literature (Sim2). The Upper Jardim Experimental River Basin (105 km^2), located in a rural zone of the Brazilian Federal District, due to this remarkable soil database, was chosen as the study area. Streamflow simulations were performed for two consecutive years (2006-2008), on a daily basis. No calibration was performed to make it possible to analyze the impact of the soil database on the first simulation, what is relevant mainly for ungagged basins. Even having better physical basis, the results obtained by Sim1 (NSE = -10.81) was worse than the ones generated by Sim2 (NSE = -6.15). The negative NSE values indicate that both simulations failed to represent observed data. Analyzing the hydrographs, it is noticed that: (i) both simulations underestimated baseflow during the dry season; (ii) both simulations overestimated streamflow peaks, but Sim1 presented higher (worst) values; (iii) during the rainy season, the baseflow simulation of Sim1 was satisfactory, while it was overestimated in Sim2. The results reinforce that the model is sensible to soil information, but it shows that it is still necessary more studies about other SWAT parameters, as the ones that control runoff generation.

Keywords

Hydrological modeling, model parameters, model calibration, Brazil

Análise do balanço hídrico sequencial em área de Caatinga

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Abstract

Na Região semiárida brasileira, a vegetação está condicionada ao déficit hídrico periódico, em virtude da irregularidade das chuvas. Nesta região a vegetação predominante é a Caatinga, a qual apresenta diversas adaptações morfofisiológicas às condições estressantes, tais como presença de espinhos, e um forte controle estomático, i.e. alta eficiência do uso da água. Deste modo, o presente estudo tem como objetivo analisar o balanço hídrico sequencial de uma área de caatinga, localizada no município de Petrolina, Pernambuco. Para tal, foram obtidos dados de precipitação, temperatura e evapotranspiração potencial de uma estação meteorológica localizada nas coordenadas 9° 4'S e 40° 19'W. Com esses dados foi realizado o cálculo do balanço hídrico sequencial para o período de 2011 a 2013, de acordo com o método de Thornthwaite e Mather. Com isso, constatou-se que em 2011 não houve excedente hídrico na região, em consequência das taxas elevadas de evapotranspiração atreladas a precipitação baixa. Além disso, nota-se que durante o período chuvoso o solo atingiu 80% de sua capacidade de armazenamento de água (CAD), porém a partir desse mês o armazenamento decresceu até atingir seu limite mínimo no final de outubro. Em contrapartida, em 2012, o balanço hídrico se caracterizou pelo déficit hídrico ao longo do ano, e o armazenamento de água no solo não ultrapassou 1% da CAD, em todo ano. Neste ano, a precipitação total foi de 132 mm, enquanto a evapotranspiração potencial foi de 1753 mm. Em 2013 o balanço hídrico seguiu padrão semelhante ao do ano anterior. Desta forma, sob estresse severo, a área foliar total pode diminuir através da redução ou parada total dos processos de brotamento de novas folhas. E com o estresse continuado, a senescência foliar pode ser acelerada através da morte dos tecidos.

Keywords

déficit hídrico; semiárido;

Morphometric characterization and precipitation data in watersheds using SWAT model for apply better practices management

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Abstract

The watershed is used as the basic unit for management the water resources and also for analyzing the river segments as protected areas, and as a subunit of the basin, which the planning will be set depending on the actions that intends to manage. The precipitation data are important to determine the seasonality of rainfall events in order to plan the agricultural practices. This work has as main objective to present the seasonality of rainfall in catchment areas in the region of Jaboticabal-Sao Paulo State, to use these data in hydrological models to be applied in the study area. The precipitation data was obtained on the website of ANA (National Water Agency), the Portal of the National Water Resources Information - SNIRH (http://www.ana.gov.br/portalsnirh/). The rainfall data were analyzed for seasonality. The stations were located in the area of interest and were recorded during periods of reduced precipitation and increased throughout the year. The morphometric analysis of hydrological compartments of the study area were done by the following characteristics: area, highest and lowest altitude, drainage density and length of the drainage network. Hydrological compartments showed morphometric differences and indicates further drainage areas upstream.

Keywords

Hydrological compartments, water resources, precipitation.

Aplicação do modelo SWAT para simulação dos impactos das mudanças climáticas sobre a vazão do rio Pontal no estado de Pernambuco

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Abstract

Nos últimos anos os debates envolvendo as causas e os possíveis efeitos das mudanças climáticas sobre a vida na terra ganharam força em diversos ambientes de discussões. Cenários projetados para o ano de 2100 apontam acréscimo de 2°C a 4,5°C na média global, com extremos de precipitação variando por região. As alterações na dinâmica global da temperatura média do ar e precipitação devem causar, entre outros impactos, o agravamento da crise da água no planeta, comprometendo a qualidade e a distribuição espaço-temporal desse recurso, indispensável para o consumo e desenvolvimento das atividades humanas. Nesse sentido, o objetivo deste estudo foi avaliar os possíveis impactos das mudanças climáticas sobre a vazão rio Pontal. Para isto utilizou-se o modelo hidrológico, SWAT, que foi abastecido com mapas, georreferenciados, de uso e ocupação do solo, mapa de solos, modelo digital de elevação do terreno, além de dados meteorológicos e hidrológicos observados para a bacia hidrográfica do rio. Os cenários projetados para o ano de 2040 foram criados com base no modelo de mudanças climáticas, ETA. Para calibração do SWAT foi aplicada uma série histórica de vazões para o período de 1976 a 1985, período em que a bacia ainda apresentava vazão natural. A acurácia do modelo foi medida com base no coeficiente de NASH e de determinação (R2), tendo-se obtido valores de 0.53 e 0.57, respectivamente. Segundo a classificação proposta para o modelo SWAT e com base nos valores obtidos, o modelo pode ser considerado satisfatório para simulação do comportamento hidrológico na bacia.

Keywords

Aquecimento global, modelagem hidrológica, recursos hídricos, semiárido

Calibration and validation of SWAT hydrological model for Sapucaí river Basin, Brazil

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Abstract

The Soil and Water Assessment Tool (SWAT) is a continuous time, physically based, and spatially distributed model, and has been used in different tropical watersheds in order to simulate the hydrological processes over these areas. In this study, SWAT model was applied for simulating the hydrological pattern of Sapucaí river basin (SRB), southern Minas Gerais state, considering monthly and daily time step approaches. SRB covers an area about of 7,330 km^2, draining into Furnas Hydropower Plant Reservoir which is one of the most important facility of Brazil. The sensitivity analysis showed that from 28 parameters, 12 effects the flow simulation, such as curve number (CN2) and the soil evaporation compensation factor (esco) which were the most sensitive for surface flow simulation. The base flow recession constant (alpha_bf), deep aquifer percolation fraction (rchrg_dp), threshold water depth in the shallow aquifer for flow (gwqmn), and groundwater revap coefficient (gw_revap) had the highest influence on streamflow simulation general way. Statistical analyses showed a Nash-Sutcliffe coefficient larger than 0.80, for monthly and daily flows which are considered good and acceptable. In addition, the results demonstrated that SWAT is able to simulate the hydrological characteristics of SRB properly.

Keywords

Calibration, hydrologic modeling, Nash-Sutcliffe, surface flow, sensitivity analysis

Use of the SWAT Model for Evaluation of Flow and Runoff in Hydroelectric Plant of Xingo

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Abstract

The hydrologic simulation is an important tool to support the management of water resources in river basins. Therefore, and considering the importance of the watershed of Sao Francisco for the development of the northeastern region, was chosen as the study the area of the Hydroelectric Xingó. The objective of this paper was to calibrate and validate the SWAT model (Soil and Water Assessment Tool) for the simulation of runoff and flow in the drainage area of the Xingó reservoir located in the physiographic region of the lower Sao Francisco. The model was run with georeferenced maps of actual land use, soil units and digital elevation model of the terrain, and meteorological and hydrological data. For this study applied a time series of flow rates for the last 30 years. The accuracy of the model was measured by the Nash-Sutcliffe coefficient (CNS) are having obtained values of 0.90 and 0.93 for the calibration and validation phases, respectively. According to the proposal for the SWAT model and classification based on the values of CNS as a reference, the model can be considered adequate for simulating the hydrology of the region.

Keywords

Watershed, SWAT, Hydroelectric

The impact of temporary data uncertainty on SWAT calibration results

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Abstract

Increasing problem of eutrophication causes many social problems and forces to specify the size of nutrients loads discharged into water bodies, including seas. The basis of such analysis are usually the monitoring measurement results carried out in each country. Moreover, these measurements are used in models in the of calibration, validation and verification processes of the water quality data. SWAT model is used to analyze the water quality in a catchment. It allows to simulate the nutrient loads on the selected control point as daily-mean, monthly-mean and annual-mean data.

Currently SWAT model calibration process is conducted as comparison of simulation results, in this case daily values, and instantaneous measurement. This may cause errors due to daily variation of nutrients loads. According to State Environmental Monitoring (SEM), measurements uncertainty for total nitrogen is assumed to be equal to 20%, and for total phosphorous to 10,5%. SEMs uncertainty takes into account uncertainty connected with mass chemical designation, samples volume, device errors etc. Additionally, it is valuable to include uncertainty connected with daily variability of nutrients loads. Total measurement uncertainty can have a significant impact on the interpretation of the results of calibration, validation and verification of simulation. The measurements carried out in Poland under the SEM are conducted with different frequency – once a month, once every two months or randomly even in longer period of time. It is a temporary measure carried out in the vicinity of a specific time.

The article analyzes the representativeness of a single measurement during the day to the daily variation of nutrient loads in river profile of pilot river. For this purpose the three cycles of side surveys were made. They were compatible with plants stage of growing. Measurements were carried out on the Rega river in the westpomeranian voivodship, Poland, water gauge profile - Trzebiatów. Rega is a River which drains into the Baltic Sea. Trzebiatów control point city is located on the 14.86 km of river. Measurement cycles were carried out in June 2012 (growing season), November 2012 (after the end of growing) and March 2013 (before the start of the growing season, during spring thaw).

The analysis gave interesting results. There was observed a significant change in the size of nutrients loads during the day (up to 67% for nitrogen and to 115% for total phosphorus). This

trend is maintained regardless of the stage of plant growth. After combining variability of measurement with uncertainty of measurement, the uncertainty range of benchmark for modeling is widened. It is very important to evaluate the adjustment the simulation results to the measurements in the processes of calibration, validation and verification of modeling. Therefore, it appears to be valid for calibration of water quality models to be based not on the simple measurement but on the continuous recording of the nutrients loads marked from samples collected during twenty-four hour.

Keywords

Data uncertainity, edaily variation, nutrients, calibration, SWAT

SWAT applications in eastern Amazonia: A case study of the Acará Mirim and Bujaru river basin in State of Pará, Brazil.

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Abstract

The Brazilian Amazon region, in particular the region of Pará state, went through a process of economic and social development disordered, which led to the development of a complex mosaic of soil uses and occupations, which brought a number of environmental, social and economic impacts. A negative impact of this occupation clutter process is silting and contamination of water resources, as well as obstruction of nascent due to the intensification of erosion and consequent loss of soil, reduced fertility and creation of gully erosion. Thus, it becomes necessary to plan the proper use of water resources and soil, since agriculture, industry, livestock, urban centers, mining and any activity needs and impacts directly or indirectly water resources. The National Policy of Water Resources in Brazil defines the Basin as a Basic Unit of Territorial Planning (Law No. 9433), recognizing the importance of water resources for society and the environment as a whole, besides putting the basins and sub-basins as territories favorable to the integrated soil use and occupation planning focusing on sustainable development. Environmental modeling has been an important tool in the study of environmental impacts of changes in the landscape of short and long term, contributing directly in decision-making and strategic planning of the territory. Application of Soil and Water Assessment Tool (SWAT) model provides the possibility to evaluate the impact of different land uses, as well as its dynamics, in the runoff and sediment yield. Given the importance of studying erosion caused by human activities to promote conservation of water resources, soil conservation and territorial planning, this paper aims to review the studies that applied the SWAT in the Amazon and present the preliminary results of the application of SWAT in sub-basins of the Acará-Mirim and Bujaru rivers located in northeastern of Pará State. These sub-basins are located in a region where the plantations of oil palm (Dendê) has

expanded rapidly, with large areas of pasture, successional forest, primary forest areas and to a lesser amount of family farming. The predominant soil is the Dystrophic Yellow Latosol, according to the Brazilian soil classification system, and annual rainfall of 2399 mm. Field trips are being conducted in order to better characterize the uses and soil quality in sub basins, as well as for field measurement data of stream flow). The work is being developed in partnership with Embrapa Instrumentation, Embrapa Eastern Amazonia and Federal Rural University of Amazonia, as part of the doctoral thesis developed in the Graduate Program in Environmental Engineering Sciences, School of Engineering of São Carlos, University of São Paulo.

Keywords

Environmental modeling; Erosive processes; Watershed Management; Water Resources; Eastern Amazonia.

Spectral response of winter maize producers mesoregions

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Abstract

Maize production is fundamental to the economy of Brazil. The 2nd harvest of maize (winter maize) has significant involvement in the production of grain and of fundamental importance for the Brazilian agribusiness. This study analyzed the time series of NDVI MODIS satellite. In general, the culture has a good development, as can be seen in the evolution of the NDVI mesoregions analyzed. Due to the variability of weather conditions in the regions, there are periods of change both planting and also the cycles of winter crops due to the dependence of the agricultural calendar of the first harvest of crops, especially soybeans. The results of this study are preliminary and need to undertake validation using control points of cultivated areas.

Keywords

Maize, mesoregions, geoprocessing

Simulating Discharge and Sediment Production Using SWAT in Chehelchai Watershed, Golestan Province, Iran

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Abstract

Comprehensive field measurement of runoff and sedimentation is hard to achieve because of time and budget limitations and accessibility issues. The aim of this study was evaluation of SWAT efficiency in modeling average daily discharge and sediment yield, testing and validation of the model for Chehelchai catchment in north east of Iran. To validate the model results, SUFI2 algorithm was used. Nash-Sutcliff metric was employed as target function in testing (2001-2005) and validation (2006-2009) and the result showed that NS of 0.5 and 0.4 for daily average discharge and 0.71 and 0.92 for sediment yield, respectively which are acceptable. As SWAT is a management tool and Showed good agreement which the measured data on this watershed, the model can be used for evaluation of the management practices effects in chechelchai watershed

Keywords

Calibration, SWAT, Validation

Assessment of the current soil erosion in Piranga River Basin, Minas Gerais state

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Abstract

The objective of the present study was to apply the Revised Universal Soil Loss Equation (RUSLE) using GIS tools to the Piranga River Basin (PRB), Zona da Mata region, Minas Gerais state, in order to assess the current soil erosion (CSE). The maps of soil erodibility (K), topographic factor (LS), and use and management of soils (CP) were developed from soils and their uses maps and the digital elevation model (DEM) developed for the basin. An Annual rainfall erosivity map (R) was derived from a geographical model adjusted for Southeastern Brazil, calculating an annual value for each pixel. In a GIS environment, the layers of the dynamic factors of RUSLE (R, K, LS and CP) were combined to create the current soil erosion map. It was observed that, in general, more than 77% of the basin presents soil losses smaller than 2,5 Mg ha^{-1} yr^{-1} being classified as "slight" current soil erosion, which mainly occurred due to the predominance of Latosols (i.e. low soil erodibility value) especially covered with forests (i.e. low CP values). Furthermore, high soil losses rates were observed in areas with the combination of high LS values and Cambisols covered with pasture, representing 1.69% of the basin area. The use of the RUSLE model integrated to GIS showed to be an effective tool for assessing the current soil erosion in a basin's scale, providing subsidies for adopting management and conservation practices of the soil and the water in PRB.

Utilização Do Modelo Swat Para Análise de Cenários Hipotéticos Na Bacia Hidrográfica Do Rio Brígida No Estado de Pernambuco

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Abstract

O movimento de ocupação do solo em bacias hidrográficas torna necessário que estudos sejam realizados no intuito de quantificar os possíveis impactos causados pela ação antrópica sobre os recursos hídricos. Impactos como a redução da capacidade de infiltração, aumento do escoamento superficial, erosão dos solos, diminuição da profundidade do leito dos cursos d'água, aumento de inundações, se tornam mais frequentes devido a modificações no uso e cobertura do solo em bacias hidrográficas. Entre os modelos hidrológicos utilizados no monitoramento das bacias, destaca-se o SWAT. O modelo pode ser aplicado em bacias hidrográficas de médio e grande porte, e permite a simulação de diferentes processos físicos. Nesse sentido, o objetivo deste trabalho é analisar o comportamento do escoamento superficial da bacia hidrográfica do rio Brígida a partir de cenários hipotéticos gerados pelo SWAT. O modelo foi alimentado com dados de uso e ocupação do solo, modelo digital de elevação do terreno, mapa pedológico, além de dados meteorológicos coletados por estações distribuídas ao longo da bacia. Séries históricas de vazão observada foram utilizadas para calibração e validação do modelo. Foram simulados cenários hipotéticos de diferentes tipos de uso, no sentido de analisar o comportamento do escoamento superficial ao longo da bacia. A eficiência do modelo foi medida com base na utilização do coeficiente de Nash-Sutcliffe (CNS), sendo a resposta do modelo considerada satisfatória. A análise evidenciou que a ação antrópica exerceu forte influência na resposta sobre o escoamento.

Keywords

Cenários, hidrologia, modelagem hidrológica, recursos naturais.

The Soil Water Assessment Tool to estimate the spatial and temporal patterns of soil erosion in the Vertentes do Rio Grande Watershed, Minas Gerais State, Brazil

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Abstract

The water quality of Vertentes do Rio Grande Watershed has been impacted by sediment from pasture lands. The water storage capacity of generate hydroelectricity necessary for water use during the dry season deficit is compromised by sedimentation, the result of erosion. Given this context, tools must be developed to support conservation and sustainable resource use planning, watershed management activities and risk forecasting. The Soil and Water Assessment Tool (SWAT), a physically based distributed simulation watershed model, is cost effective tool to analyze the quantity of water resources, in the planning, design and operation of water use, distribution systems and management activities.

To assess the ability of SWAT application for use in the context of the Vertentes do Rio Grande Watershed, the model was calibrated and validated for streamflow and sediment yield over a two year period (2011-2012) in the 40 km^2 pilot study area of the das Mortes River subbasin, an area of pasture lands. The model demonstrated good performance for weekly average simulated streamflow and baseflow (all Nash Sutcliffe coefficient = 0,72), generated little significant error, and demonstrated highly accurate predictions of annual cumulative water yield. Although SWAT was also able to simulate cumulative sediment yields with acceptable precision, the model was a poor predictor of monthly average sediment yield (calibration Nash Sutcliffe coefficient = 0,41). A qualitative and quantitative sensitivity analysis reveals that this is likely owing to the compound effects of a number of imprecise input parameters and data uncertainties, namely apropos the Modified Universal Soil Loss Equation (MUSLE) parameters for pasture lands. Overall, this study illustrates that SWAT could potentially be a beneficial support tool for use in the Vertentes do Rio Grande Watershed. However issues of data scarcity in the area will need to be resolved, including that of soil survey data, the spatial and temporal representativeness of streamflow and sediment yield field data, and estimates for MUSLE parameters.

Keywords

Soil erosion, sediment, watershed, pasture lands

Assessment of climate changes impacts on the hydrological cycle of the Garonne watershed.

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Abstract

Modeling works about impacts of climatic changes in hydrology, mostly focus on overland flows or, less frequently, on aquifer recharge. Our work try to offer a different point of view and takes into consideration the largest part of the water cycle as possible, applying the recent concept of integrated water resources management which divides water resources into two classes: green and blue waters. Blue water groups all "visible" resources, "usable" by society, such as runoff, groundwater, and stream flow. The residual green water is by default "unusable", mainly soil water content and evapotranspiration. This approach will be realized at large basin scale, trying to retain the better spatial and temporal accuracy as possible.

The SWAT model is used at the Garonne catchment (50 000 km2) scale to evaluate the evolution of blue and green waters. In order to create a project at this scale but accurate enough to realize this analysis in a climate change context, we had already focus on several facet of this project. 1) To be able to test the influence of climatic change, we need a model in which data's from regional climate models (RCMs) could be used. Our model was calibrating using SAFRAN, an 8 km by 8km re-interpolation grid where observations and RCMs data are available. 2) SWAT ability to model snow on the upper part of the catchment and its influence on the simulation downstream has been explored test and accurately calibrated and validated based on remote sensing data and field observations.

Use of SAFRAN offered good performance in terms of simulation: improving it on most of gauging station or at least offering identical performance. Over 14 gauging station, just one seems to be negatively impacted by the use of SAFRAN data. As regard to the snow simulation on the upper part, we conclude that the used of elevation bands on the snow dominated areas seems essential. Used of SAFRAN and elevation bands have already brought improvement in the project. Two next steps: improvement of the exchange on the alluvial plain and the calibration on climate change context will soon allowed us to complete this project.

Keywords

Key Words: Climate Changes, green and blue water, Swat model, Garonne River

Assessment of streamflow responses to different land use and land cover changes in a mountainous area of Rio de Janeiro, Brazil

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Abstract

Risk assessment of future land use changes is still an important activity for hydrology studies. In many parts of the world, forest management is the major land-cover change agent. Their replacement implies in changing of main channel regime. The application of hydrological models to quantify the effects of land use and land cover changes on streamflow response of watersheds can clarify the processes involved and support management decisions. Land use change is commonly observed in the mountainous region of Rio de Janeiro state, where watersheds have suffered intense replacement of its forest by agricultural activities, pasture and urban area expansion. In this context, the aim of this study is to assess the influence of land use/land cover changes on stream flow response of Bonfim watershed. Part of the watershed (approximately 75%) is located in the National Park of Serra dos Órgãos and contains 43% of his area covered by forest. The streamflow and four predictive scenarios of land use changes were simulated using the Soil and Water Assessment Tool (SWAT) hydrological model. Two recommended model evaluation methods were applied. The Nash-Sutcliffe coefficient of efficiency (NSE) and percent bias (PBIAS). Model simulation can be judged as satisfactory if NSE > 0.50 and if PBIAS ±25% for streamflow. In this study was obtained a NSE value of 0.73 and PBIAS 22% for calibration phase. Two extreme scenarios were applied, which include: replacement of 100% of forest to agriculture and replacement of 100% of forest to urban area. In a second stage, respecting the limits of the National Park, other two scenarios were simulated: replacement of 15% of forest to agriculture; replacement of 15% of forest and 100% of agriculture to urban area. Results showed that deforestation in the extreme scenarios changes significantly the stream flow response in the watershed. However, this behavior was not observed in the last two scenarios, where the land use changes not represented a significant change in streamflow response. It was possible to conclude the importance of the National Park to regularize the stream flow, where 75% of forests were preserved in scenarios simulation.

Keywords

Watershed; streamflow simulation; Hydrological modelling; SWAT

Evaluation of land uses for Piabanha River watershed in Rio de Janeiro, Brazil using SWAT

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Abstract

The Piabanha River watershed is located in the state of Rio de Janeiro, which one of the most densely populated states of Brazil (Censo, 2010). The watershed has three types of land use: urban area, agricultural and preserved forest. The environmental problems found in the area (e.g., landslides, flooding, water quality degradation in the rivers) are mainly related to its development. Therefore, the Geological Survey of Brazil (CPRM), in partnership with government agencies and universities, has been operating a hydro-meteorological network and developing studies in the area in order to understand its hydrologic behavior. The goal of this article is to evaluate the impact of these different land uses on the watershed using SWAT. SWAT was calibrated using mostly information provided by the CPRM project.

Keywords

SWAT, land use, Piabanha river watershed

SWAT application for Santa Maria of Vitória watershed, at Espírito Santo (ES), Brazil

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Abstract

The analysis of hydrologic processes that occur in a watershed, through simulations with rainfall-runoff models, is very important for water resources management. Considering that most of the existing models were developed and its parameters were adjusted to temperate conditions; these conditions are different from the tropical climate, in this manner it becomes fundamentally important to verify the applicability of these to Brazilian climatic conditions, since that the development of a model is quite costly in terms of time and resources, both from the point of view of data collection as to the different levels of knowledge involving the processes of the hydrological cycle. Given the high demand to use hydrologic models, still today there is little about the applicability of these in Brazilian soils and climate. In this way, both empirical models as those based on physical principles need to be evaluated and/or calibrated before being used extensively for the prediction of hydrologic events within a watershed. Given this, the aim of this study was to evaluate the applicability of the hydrologic model Soil and Water Assessment Tool (SWAT) on the estimate of streamflow for the Santa Maria of Vitória watershed (SMVW) (1,799.60 km^2). The SMVW is located at the central costal region of ES state, is highly populated exerting strong pressure on water resources, such as high loads of domestic waste; runoff from urban areas; industrial effluents and agricultural pollutant loads, among others. . A database with physiographic and hydrological data was created for an adequate application of the model on the watershed. Prior to the simulation, it was necessary to separate the rainfall and flow series in periods, the first two years (2006-2007) were set for warming up the model, and the later four-year period (2008-2012) was for the model validation. The model was not calibrated. The values obtained for NS and R^2 are respectively equal to -0.22 and 0.47, for daily simulation, and 0.60 and 0.74 for the monthly simulation. The average observed monthly flow is 19.53 $m^3.s^{-1}$, while the average simulated flow was of 13.54 $m^3.s^{-1}$. The results regarding the applicability of the model for flow simulation at daily time step were not satisfactory, but, on the other hand monthly values were more adequate. Even with an uncalibrated model, SWAT's potential to simulate streamflow in function of precipitation events for different soil types and land management practices was perceived. Despite of being a model developed in the United States, it is possible to use for Brazilian

conditions, there is a difficulty in obtaining all the information in Brazil, but they can be made viable.

Keywords

Applicability of SWAT, hydrologic models, flows.

Hydrologic Modeling in Ribeirão Padua Diniz Watershed, in Northwest São Paulo, Brazil.

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Abstract

The aim of this study was to measure the flow of the watershed through remote sensing techniques by Swat modeling. The study was conducted at River Padua Diniz's watershed, with an area of 332.43 km ^{2} and length of the main channel of 43.51 km, located in the northwestern region of São Paulo state, with centered coordinate systems, projected at latitude 7781328.77 meters N and longitude of 581,845.56 meters E, datum WGS84, UTM zone 22S, central meridian 51, comprising parts of municipalities: Indiaporã, Mira Estrela, Macedônia, Guarani d'Oeste and Fernandópolis. According to Koppen's classification the climate is Aw and average annual rainfall of 1378 mm. The biome found is rainforest and the vegetation in the region is characteristic of semideciduous forest. The soils of the area are: Oxisols Red dystrophic; Oxisols and Red Eutroferric dystroferric; Argissolos Red - Yellow eutrophic abrúpticos; Argissolos Red - Yellow eutrophic; Argissolos Red - Yellow eutrophic and dystrophic. Digital Elevation Model (DEM) was used, made the division of hydrological compartments in ArcSWAT and using data and maps obtained morphometrically analyzed area. The modeling allowed measure separately for each hydrologic flow compartment, increasing accuracy and physical description of the watershed's morphometric studies.

Keywords

GIS, ArcSWAT, Hydrological compartments

Application of SWAT to Lake Shinji watershed for estimating nutrient loadings from surrounding river basins

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Abstract

Lake Shinji is located in the eastern Shimane Prefecture, and is typical of brackish lakes in Japan. The water quality of the lake does not meet the expected environmental standards for total nitrogen (TN) and total phosphorus (TP), even though the national and Prefectural governments have tried to improve water quality by developing maintenance scenarios for sewage, plant effluent, agricultural activity, and forestry. Therefore, detailed information of nutrient loading to the lake from rivers is important to support strategies for improving the lake water environment. In our previous studies, we figured out that yields per unit area of SS, TN, and TP from upland areas were the greatest, whereas yields from forests were the lowest in Hii river basin. However, forests were the largest contributor of them in the basin, because of its dominant land area. Also, we found that total loads from small river basins may have large influences in total, though Hii River basin still has a larger impact to the lake. In this study, same as last, we focused on small watersheds around the lake along with Hii River basin to evaluate its influences against the water environment. Parameter values were calibrated at a daily time step at the outlet of the Hii River basin because of no observed data in small watersheds. As a result, SWAT could simulate fluctuations of river discharges and water qualities reasonably. But parameter values still need to be calibrated to get more accurate results for considering the influence of small watersheds, and an impact of the watershed management, especially in artificial forest, against the lake water environment.

Modeling of the Cachapoal river watershed as a tool to study precipitation change impacts on water availability for irrigation

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Abstract

The effect of climate change on the availability of water resources is crucial, especially in irrigated areas where agriculture depends on water. There is insufficient information to understand the response of watersheds to changes in climate which limits the possibilities for planning and adaptation of irrigation systems. In Chile, there is a decline in precipitation and there is probable that this trend will continue. Farmers use river water to irrigate crops and the amount of available water is strongly determined by precipitation. The Cachapoal River basin is located in central Chile, has a flat agricultural area, where irrigation is required, and foothills of the Andes mountains (349.789m E;.196.928m N, Datum WGS84, zone 19). The objective of this study is to quantify the effect of sceneries of different precipitation probabilities on the availability of water for irrigation in the basin of the Cachapoal River. A weather generator was developed for generate time series of daily precipitation which was selected and sequenced statistically to produce dry, medium, and wet daily series for 100 years. In addition, the SWAT model was calibrated and validated for the basin and then run for the possible scenarios of dry, medium and wet to provide a comparison of the effect of the different moisture scenarios with different probabilities of rain on surface water availability. A reduction of 25% was estimated under a dry stage average, concentrated in the summer months. Additionally, it was determined that available water increased streamflow by 25% for wet stage conditions.

Keywords

SWAT, hydrological modeling, irrigation, climate change

Simulation of Surface Runoff and Sediment Yield at Itaqueri River Watershed, São Paulo State, Brazil

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Abstract

Nowadays sediment yield and erosion processes are considered to be of great importance, occurring in large scale and causing environmental, economic and social damages. The present study´s objective is to perform a sediment yield modeling at the river Itaqueri watershed, located between the municipalities of Itirapina and Brotas on the state of São Paulo (SP), which has a length of 220 km^2. Provided of soil, land use, climatic and topographic data, the SWAT model simulated hydrology and sediment yield. The simulations indicated different hydrosedimentological within the watershed; presenting locations with an average annual sediment yield varying from almost null to 18 t/ha. Simulated average annual runoff was 521 mm in the basin. The river Itaqueri contributes with 65% of the reservoir´s total average annual incoming sediment. Specialized soil loss scenarios where successfully obtained, which are important tools for the watershed conservation management.

Keywords

SWAT, sedimentology, modeling

The modification of subdaily SWAT model and its application in Qingjiang river basin

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Abstract

As a typical distributed hydrologic model, the SWAT model was often used for runoff simulation in river basins. SWAT model was developed for the long term simulation, and it was suitable for continuous simulation in watershed. But for the urbanization or the basin with short concentration time, which often presents runoff patterns to be flashy and instantaneous. A model which is capable of simulating the subdaily hydrological processes is needed to effectively grasp the changes of the peak. However the SWAT model had limited capability to simulate hydrological processes at subdaily time scale, which limited the range of application of the model. Therefore, this paper focused on the modification of the model and improved the accuracy of subdaily modeling for runoff simulation in Qingjiang river basin in China. Subdaily flow data ({C}{C}=6h)with a time span of 3-year (1997-1999) were used use for this study. Where, data from 1998 were used for calibration and 1999 for validation. The results revealed that, the modified SWAT model performed a better simulation accuracy when compared to default model with subdaily time step. Representative station method and Thiessen areal precipitation method were used as model input for subdaily simulation. The comparative study showed that representative station method (Nash=0.76 for calibration and Nash=0.67 for validation) ignored the spatial variability of rainfall, and this was a shortage of the model. However the Thiessen areal precipitation method (Nash=0.82 for calibration and Nash=0.70 for validation) presented higher accuracy. The modified subdaily SWAT model is a hopeful tool for hydrology studies though much more research is still needed.

Keywords

SWAT model Model modification Subdaily simulation Daily simulation

Modeling of the hydrology and nitrogen fluxes in a semi-arid catchment area by SWAT model: the Tafna River in the North-West of Algeria

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Abstract

Water in Algeria is an increasingly invaluable resource due to high competition between agriculture, industry and drinking water supply, accentuated by a drought conditions in a semi-arid climate For a few decades, the demographic explosion, the development of agriculture and industry, have modified the biogeochemical cycle of nitrogen towards an increased production of nitrates in waters. In this context, hydrological modeling and the simulation of the transfers of nitrates in surface waters appear to be essential, for understanding the mechanisms of nitrogen fluxes, and thus determining the zones and the periods of the year presenting a risk to polluted surface waters. The main aim of this study was to evaluate the impact of current agricultural practices on the quality of surface waters, especially nitrogen fluxes in the Tafna watershed (7200 km2). By the application of hydro- agro environmental model SWAT (Soil and Water Assessment Tool). The historical fluxes and meteorological data for one year (January to December 2013), Daily data (Mars, June and August 2013) and monthly data (between January and October 2013) on Nitrogen and discharge were used to calibrate and validate the model. The data on the practices of management (crop rotation, the date of sowing, the quantity of manure and the irrigation) were included in the model during the period of simulation. Rivers

discharge is agree with simulations and varying from 0.001 m3/s to 107m3/s. The results show. Daily nitrogen ranged from 25.91 tons/year during high water periods to 0.5 tons/year at low water.

Keywords

Nitrogen fluxes, Discharge, SWAT, Tafna wadi

A statistically consistent determination of the antecedent soil moisture condition (retention parameter) of the SCS method

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Abstract

The SCS curve number system is an option for determining runoff in the SWAT model, but the role of the basin soil water content has to be prescribed through an empirical retention parameter, *S,* based on one of two different methods: the basin soil water content, *SW,* for deep soils or the previous retention parameter, S_{prev}, for shallow soils. With the goal of more accurate predictions of rainfall partitioning and runoff production at the basin scale, we evaluate SW considering a statistical distribution of soil water storage based on the full analytical solution of the stochastic soil moisture dynamics. We start at the point scale and expand to the watershed scale to find the SCS curve number relationship. In the process we redefine the retention parameter and maximum retention parameter in terms of the distributed basin soil water content. We compare our results to the existing SWAT procedure and provide a self-consistent method for determining the antecedent soil moisture value needed for the partitioning of rainfall in the SCS method.

Erosion Prediction using SWAT model in Córrego Tijuco Watershed, São Paulo State, Brazil

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Abstract

The erosion process in rural areas is concern to environmental quality due to agricultural inputs, which can be pollutants if not managed properly. This study manly focuses to determine the average of the LS of the Universal Soil Loss Equation, and to carry out the erosion caused by rainfall and runoff modeled with the Modified Universal Soil Loss Equation (MUSLE), (Williams, 1975), using the Soil and Water Assessment Tool (SWAT) in Córrego Tijuco Watershed, São Paulo State, Brazil. The process of configuring SWAT for modeling the watershed was developed in a geographic information system - ArcGIS, and the land use, topographic and soil data was translated in a digital data base. The study area increase the processing of the cultivate area by converting citrus orchards to sugar cane crop. And, the removal of topsoil can be a serious concern. So, this paper analized the sediment yield effect of land use and make detailed study about the watershed characteristics. Finding the land use and sediment yield, can make the best suggestion most suitable for better soil conservation practices.

Keywords

Erosion; watershed, SWAT, environment

Modeling of Sheet Erosion in Watersheds Using GIS: A Case Study of Watershed of River Uraim, Pará, Brazil

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Abstract

The hydrous erosion is a natural process that jointly with other processes are responsible for the modelling of the terrain. However the inadequate agricultural practices and the disordered occupation of the soil facilitate and accelerate this process turning it an agent of destruction of the primary productivity and of the fertility of the soil, in addition to impacting the hydrous bodies for the sedimentation on river bed action. In this scenery the mathematical models appear, fast and economical methods capable to esteem the erosion, among them the Universal Equation Loss Soil (USLE) that esteems the quantitative of loss soil by the correlation of the following factors: rainfall erosivity (R), soil erodibility (K), slope length (L), slope steepness (S), covering and handling (C), conservationist practices (P). In this sense the present work intended to measure the annual loss of soil in the micro watershed of Uraim river (relevant spring for the municipal district of Paragominas) for the years of 1984 and 2010, through the application of the USLE. Starting from the comparative analysis of the values in the two years of studying of soil loss, it was checked that even with considerable increase of the erosive processes which resulted in the elevation of the loss annual average of soil of 23,034 (t.ha-1.year-1) in the year of 1984 to 36,694 (t.ha-1.year-1) in the year of 2010, the annual classification of soil loss for the two analyzed years it was the same, medium (15 to 50 t.ha-1.year-1), because of the low values found to the erodibility of the soil (K) and topographical factor (LS).

Keywords

USLE. Environmental modeling. Geographic information system

Impacts of using different soil databases on streamflow simulation in the Pipiripau river basin

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Abstract

The purpose of this study was to analyze the influence of the soil database on streamflow simulation with SWAT model in Pipiripau's river basin (Brazil, Federal District), a 235km^2 experimental rural catchment of the Brazilian savanna (Cerrado biome).To achieve this goal, a soil database developed with measured data collected from an experimental catchment near the Pipiripau's river basin, whose soils have similar physical proprieties (SDB1), and another from the literature (SDB2) were tested. The evaluation was performed using a 10 years record of streamflow historical data (1989-1998) on monthly and daily basis. The analysis was made without calibration using only SWATs first simulation, in order to examine the improvement of the model's soil physical basis, which is very important, especially for ungagged basins, a common situation throughout the Brazilian territory. For daily simulation, the Nash & Sutcliffe model efficiency (NSE), the adapted Nash & Sutcliffe model efficiency (ANSE), and the Percent Bias (PBIAS) were, respectively,-11.88, -11.80, and -23,15% for the SDB1, and -9.94, -9.88, and -84.72, for SDB2. For the monthly simulation, the NSE, ANSE, and PBIAS results were, respectively,-1.78, -2.98, and -24,53% for SDB1, and -6.51, -9.88, and -84.72, for SDB2. The negative results of NSE and ANSE indicates that the simulations failed to represent observed data. However, the PBIAS analysis and the annual water budget results for the SDB1 simulations had better results. The study indicates the importance of developing soil databases for specific regions throughout Brazil and furthermore research on other parameters in order to improve SWATs physical basis.

Keywords

Hydrological modeling, model parameters, soil database, Brazil.

Hydrobiogeochemical fluxes and its relation to land use changes at small catchments in the Marapanim River Basin, Pará state, Brazil

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Abstract

The macro region "Nordeste Paraense" in Pará state is the oldest agricultural settlement area in the Eastern Brazilian Amazon and has been the location of widespread slash-and-burn agriculture for many years. We studied the biogeochemical changes of nine small catchments (~20-140 ha drainage areas) in the Marapanim River Basin: seven agricultural catchments and two remnant forest catchments used as references for the original landscape. Smallholder agriculture (cassava, corn, cowpea, pepper and passion fruit) is the dominant type of land use in these catchments, along with several medium-sized cattle ranches. Together, these uses form a land use mosaic that also includes large areas of fallow vegetation. Primary forests are rare and frequently restricted only to riparian zones. Each month over the period of one hydrological year, we measured instantaneous discharge and dissolved anions and cations, as well as pH, electric conductivity (EC), temperature, and dissolved oxygen (DO) in stream water of each catchment. The greatest change in biogeochemistry occurred in a stream draining an area of abundant pasture and no riparian forest, including decreases in DO and nitrate and increases in ammonium, pH, and EC. The collection site for this stream also was near an area where cattle frequently entered the stream to drink water. Moreover, large biogeochemical changes were found in a stream that had a slash-and-burn agricultural system for cassava near the stream, including decreases in DO and increases in calcium, magnesium, and potassium concentrations. In this region, riparian forest conservation can be an important management tool for mitigating land use change effects on water quality, together with agricultural conservation practices that avoid the use of fire to clear land for crops and pasture.

Keywords

Agriculture, Amazonia, fluvial hydrochemistry, nutrients, water quality

SWAT Modeling at Marrecas Watershed in Rio Grande do Sul, Brazil

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Abstract

We propose a SWAT modeling exercise of the 5,370 ha Arroio das Marrecas watershed, a tributary of the Taquari-Antas River Basin located in the state of Rio Grande do Sul in southern Brazil. Nearly 216 ha of the watershed is flooded from a dam constructed for a municipal water supply (total storage capacity 33 million m^3). The climate Is subtropical (Koeppen Cfb) and the nearest climate station is located 4 km from the study area. Vegetation in the watershed was originally subtropical forests and grasslands, but current land use is highly diversified, with the dominant land uses being agriculture/cattle grazing (60.9%) and forest (24.3%); horticulture is also practiced in smaller areas.

Water sampling campaigns comprising 10 sampling points in the basin were initiated prior to the environmental assessment study for the dam over four periods: (1) diagnostic phase to characterize the basin prior to damming (June to August 2007); (2) quarterly pre-flooding campaigns (July 2010 to October 2011), (3) quarterly flooding campaigns (November 2012 to February 2013), and (4) after the dam was operational (October 2013) including monthly sampling for at least 3 points, for streamflow and key environmental constituents (dissolved solids, phosphorus and nitrogen).

We present preliminary SWAT results for streamflow and the key environmental parameters noted above. We also discuss modeling problems encountered due to a relatively sparse monitoring data set and propose improvements in the monitoring frequency to overcome these problems.

Keywords

Watershed management, land use change, water quality

Seasonal variability of nutrients loads discharged into the Baltic Sea

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Abstract

The ongoing process of eutrophication of the Baltic Sea was the incentive for countries located in its catchment to take joint action to reduce discharges of nutrients, particularly nitrogen and phosphorus to the Baltic Sea. The results of the simulation of the amount of nutrients discharge from the pilot catchments to the sea from point and non-point sources were presented. The principal analysis concerns the variation of total nitrogen concentration and loads depending on the season and the stage of growing season taking into account the variability of the stream flow during a specified period and the size of the precipitation. Particular attention was paid to the phenomenon of temporary stabilization of nutrient loads discharged to the surface waters in summer and autumn, called "flattening". Analysis were performed for pilot catchments using Macromodel DNS (*Discharge Nutrients Sea*) with SWAT module (DNS/SWAT) which was calibrated and verified for three river basins: Reda (485,55 km^2) for years 2000-2005, Rega (2766,8 km^2) for years 1995-2009, and Middle Warta (6039 km^2) for years 2000-2009. After calibration, verification and validation, which were performed with daily time step, the DNS/SWAT was used to perform the simulation. The obtained results of simulation show a significant relation between the growing season and the amount of nitrogen compounds in the catchment area. This is confirmed by the occurrence of the phenomenon of "flattening" of the total nitrogen cumulative curves during the analyzed period. "Flattening" phenomenon represents a period of stabilization of nutrients loads in the outflow, which substantially coincides with the plant growing season. It was observed for both the Middle Warta River, whose waters do not have direct access to the Baltic Sea, and the Rega river, which is one of the eight rivers flowing directly into the Baltic Sea. The growing season in Poland lasts between 190 to 220 days and depends on the region and lasts from late March to early November. For the Warta river, which is not a river that flows directly into the Baltic Sea, the result of analyses are similar to results obtained for the Rega river. For the Reda river the phenomenon of “flattening” was not observed. This situation encourages further analyses of the amount of total nitrogen in catchments.

Keywords

Eutrophication, seasonal variability, nitrogen, water quality, flattening period, Macromodel DNS, SWAT model

Towards an Improvement of the Water Balance on Steep Slopes - Development of a Correction Algorithm of the Runoff Curve Number for Slope Angles up to 100%

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Abstract

The SWAT model is applied globally for a wide variety of research objectives in different environmental and landscape settings. One of the main concepts of the model is its applicability for the assessment of water balance components, and secondary processes, such as sediment, nutrient and pesticide dynamics as well as their reaction to climatic shifts or soil and water conservation measures in data scarce regions. The basis for the accurate representation of all these processes is the water balance calculation concept of SWAT, which determines the distribution of incoming precipitation into different flow components and which is the major driver for secondary processes. Hence it is of great importance that the components of the water balance are accurately estimated, even under strongly varying climatic and topographic conditions.

Recent studies have shown that especially in mountainous catchments, the water balance on steep slopes is not represented well in the model, which is indicated by decreasing amounts of surface runoff, and extremely high amounts of lateral flow with increasing slope angle of an HRU. To overcome this problem, an adjustment mechanism for the runoff curve number has been implemented in ArcSWAT. This adjustment algorithm, however, works sufficiently well only for slopes below 20%, resulting in large errors for predictions of surface runoff and sediment in catchments with much steeper slopes. Furthermore it does not account for the reduced soil water content induced by higher lateral runoff on steeper slopes.

In this study, a curve number adjustment method is developed for steep slopes up to the slope angle of 100% (i.e., 45 degree angle) with the slope effect on soil moisture compensated. Based on literature data from a multitude of plot experiments and investigations in small watersheds with different soil characteristics, rainfall intensities and vegetation covers, the behavior of the water balance components including surface runoff, lateral flow and soil water content with varying slopes was reproduced. This database serves as the basis for the correction algorithm of CN2 for slopes ranging from 0% to 100%. The validation of the algorithm is carried out using independent small watershed datasets, where the distribution of flow components is known.

Preliminary results indicate that a linear adjustment of CN2 yields a satisfactory prediction result. The parameterization of this linear model will continue especially for different soil characteristics, moisture conditions and vegetation covers, based on further field experiments to be able to derive reliable adjustment parameters.

Keywords

SWAT, water balance, slope, curve number

Improving the groundwater process representation by using SWAT3S and a multi-metric based model evaluation

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Abstract

SWAT is able to analyze present and future conditions of water quantity and quality. For this, the different discharge components have to be represented adequately in the model structure and in the calibration. The model behavior needs to be evaluated with different performance metrics which are capable to represent the different processes with its discharge phases. Several studies revealed that the SWAT model may cause satisfying model performance for high flows but lower model performance for low flow periods, which are mainly influenced by groundwater. The reason could be the complexity of the groundwater processes, which cannot be fully reproduced with one single contributing groundwater aquifer and the evaluation with high discharge focused performance metrics.

Thus, we present a new modification of the SWAT model. In this new SWAT3S version, the groundwater module is enhanced by dividing the shallow aquifer into a fast and a slow flow component of the groundwater. We used the deep aquifer to account for water, which percolates into deep geologic formations and does not contribute to the stream. For model evaluation, we applied the well known Nash–Sutcliffe efficiency together with additional signature metrics, which are based on the segmentation of the flow duration curve (FDC).

Our results show that the three-storage groundwater module of SWAT3S is more process-oriented than the original version due to the introduction of a fast and a slow groundwater flow component. The three-storage version includes a modular approach, because groundwater storages can be activated or deactivated independently for subbasin and hydrological response unit level. We conclude that the model structure adaptation lead to reasonable and enhanced process representation due to emphasized non-linearity for the groundwater processes. Furthermore, we highlight the relevance of additional performance metrics for model evaluation and model behavior. The combination of performance metrics for high flow conditions with low flow conditions lead to satisfying overall discharge reproduction.

Additionally, this study demonstrates the challenge of calibrating a model with a satisfactory performance in high and low phases simultaneously. We conclude that the enhanced groundwater process description of SWAT3S and an additional performance metric for very low flows should be included to improve the groundwater process representation in the SWAT model.

Keywords

Groundwater, model development, SWAT3S, baseflow reproduction

SWAT Modeling of Runoff Pollution Load in Sondu Watershed, Lake Victoria Basin

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Abstract

Introduction

Estimation of pollution load in Lake Victoria has always been hampered by scarce data and limited deployment of spatial related technologies. Geographical Information System (GIS) and remote sensing tools are options for improvement. The tools capture spatial and temporal varying environment attributes. This study used Soil Water Assessment Tool (SWAT) model, a GIS interface, to simulate river flow, sediment and nutrient load in Sondu watershed of surface area 3,508 km^2.

Materials and Methods

Remote sensing and field observed data were used to set up the model. Observed river flow and limited water quality data (sediments – TSS, nitrogen – TN and phosphorous – TP) were sourced from Kenyan institutions. Surface runoff, nutrients and sediments modeling parameters (26 No.) were selected based on their sensitivity. The model run (2000 to 2010) was calibrated for the period 2005 to 2007 and validated using year 2010 observed data. The model performance was evaluated based on R^2 and NSE statistics.

Results and Discussions

The CN2 and (ESCO) were the most sensitive parameters. However, less sensitive parameters such as RCHRG_DP were useful in calibrating for peak flows. The main land covers are agriculture and forest (67% & 29% respectively), and sediment and nutrients runoff mainly originate from agricultural land. The calibrated river flow model poorly captured observed low flows while simulated TSS had uniform pattern with simulated river flow but with frequent spikes. Despite the scarce observed TN & TP data, the model simulation fitted observed values with high R^2 of 0.9. The annual average simulated TSS (2005-07) was about three times less than those observed by Lake Victoria Environmental Management Project, LVEMP (2005) in 2003 while simulated TN & TP was about three times more compared with the same study.

Conclusions

Sediment and nutrient runoff sources were mainly from agricultural areas. Although the model simulation did not perfectly fit into observed values, it captured the patterns of low and high seasons. River flow temporal variation was in synchrony with that of TSS. Use of GIS tools in Lake Victoria basin provides a platform to model watersheds with improved spatial resolution. Continuous refinement of parameters and improvement of observed data collection would improve the SWAT model. Additionally, use of good performance models would inform management measures to contain excessive pollution load to Lake Victoria.

Keywords

Lake Victoria Basin, Scarce Data, Model Performance

Modelling climate change scenarios in a scarcely gauged lowlands catchment

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Abstract

To assure food security for future generations, one of the major near future challenges for agricultural production is to meet growing demand, sustainability and cope with climate change impacts. Lowlands are particularly vulnerable to climate change since events as floods or droughts can have serious consequences in these often highly exploited catchments. The SWAT model has been validated for streamflow at Quequen Grande river watershed (935.533 has) in Buenos Aires Province, Argentina, as part of an international bigger project focused on the evaluation of changes in water productivity against potential future scenarios of climate change. SWAT was chosen as watershed scale model since it constitutes a valuable tool to study the impact of potential climate and land use changes, as well as the impact of management practices and fertilizer and pesticide use on water sources, in agricultural watersheds. SWAT was calibrated for the period 1996-2000 and validated for 2001-2006. Model predictions for monthly and daily streamflow presented Nash Sutcliffe coefficients of 0.37 and 0.61 respectively, for the validation period. Daily predictions for this watershed were acceptable, since there was no representative network of rain gages to cover the entire watershed. The model also succeeds on predicting a significant change on average streamflow that increased from 16.57 m3/s during calibration period to 40 m3/s during validation period. In this paper, the hydrologic impact of potential changes in land use change and precipitations are discussed, based on model simulations for plausible future climate scenarios, at watershed scale.

Keywords

Hydrologic modelling, Lowlands, Climate Change, Climate Scenarios, Argentina

Impact of Climate Change on water resources of USDA- ARS experimental watershed

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Abstract

Experimental watersheds at different climatic regions of USA are maintained by United States Department of Agriculture-Agricultural Research Service (USDA-ARS). These watersheds have the well maintained long term hydrometerlogical database which can be used for the climate impact studies at watershed scale. Present paper, focus on the impact of climate change on the water resources of Walnut Gulch Experimental Watershed, Tucson, Arizona. NARCCAP climatological data has been used to study climate change impact in this watershed. The required climate data is clipped and bias corrected for the watershed using the R script. The model combinations used in the present study are CRCM-CCSM and RCM-GFDL. The maximum temperature, minimum temperature and precipitation are used in the SWAT model to run the simulations. The data 1971-1999 is used as a base period, and the year 2041-2070 is used as the future projection period. Analysis has been carried out for the observed runoff and simulated runoff for the simulated and projected period to assess the climate impact on the Walnut Gultch watershed.

Keywords

Climate change, experimental watershed, NARCCAP data, SWAT, water resources

Comparing the eco-hydrological model SWIM to conceptually different hydrological models in climate change impact assessments focussing on low flows

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Abstract

In the anthropogenically heavily impacted, e.g. by long-term lignite mining, Lusatian river catchments Spree and Schwarze Elster (Germany), the robust assessment of possible impacts of climate change on the regional water resources is of high relevance for a sustainable water management. Due to the susceptibility of the study region to more frequent low flows in the future, the aim of the study is a) to evaluate future low flow conditions under different climate projections and b) to account for uncertainties related to conceptually different hydrological models in climate change impact assessments.

Representatives of three different hydrological model types were chosen: the physically-based, fully spatially distributed model WaSiM-ETH, the process-oriented, semi-distributed model SWIM which is comparable to SWAT, and the conceptual lumped hydrological model HBV-light. For future climate projections, the statistical downscaling approaches (DAs) STAR and WettReg as well as the dynamic regional climate models (RCMs) REMO and CCLM were selected. As study areas serve mesoscale subcatchments (135-300 km^2) of the Spree and Schwarze Elster river catchments where anthropogenic impact on discharge is comparably low. This enables hydrological model calibration and validation on measured discharge. The annual minimum 7-day mean flow (AM7) and the 95 percentile flow (Q95) were chosen as representative low flow indicators.

The results of this study indicate that during hydrological model calibration WaSiM-ETH and HBV-light perform better than SWIM with regard to the statistical performance criterion “Nash-Sutcliffe efficiency using logarithmic discharges” which is suitable for evaluating a

hydrological model's ability to simulate low flows. The AM7 and Q95 of the measured discharged is, however, better represented by SWIM compared to WaSiM-ETH and HBV-light. These results highlight the shortcomings of statistical performance criteria and the importance of including different types of performance measures in model evaluation based on the overall study aim.

Concerning the susceptibility of the study region to changes in low flows for future climate projections, the results are highly inconclusive. Based on the dynamical RCMs, low flows become less severe while based on the statistical DAs, their severity increases considerably.

It has to be pointed out that the results of hydrological model comparison are conditional to the assumptions taken by the hydrological modeller and the characteristics of the study region. Therefore, a generalisation of the modelling results is complicated.

Effects of Atlantic Forest Patches on Water-Regulation Ecosystem Services

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Abstract

Land use and land cover change, in specific; deforestation and forest regrowth, have been causing gradual changes in the landscape as well as in water resources. Land cover directly affects hydrological processes in watersheds, which can be associated with provision of ecosystem services. Studies have shown, through observations of forest cover, a net gain in Atlantic Forest in the last 20 years, suggesting that the effects of specific ecosystem services could be in progress.

This study aims to simulate three different scenarios of gradual increase in forest cover and analyze the effects of these changes on hydrological metrics. These metrics can later be associated with benefits or losses in water-regulation ecosystem services.

SWAT model was applied to simulate hydrological effects of forest cover increase on the Piracicaba River Basin, located at São Paulo state, Brazil. A 2010 land cover map with a 1:50,000 scale was used, along with a 10 year time series of weather and hydrological data, for calibration purposes. Forest cover scenarios were created with Dinamica EGO software, using weight of evidence method. Scenarios were established as (i) “Status Quo”, where the previous 10 year forest trends were replicated; (ii) “Status Quo+”, where previous forest trends were also replicated, but without deforestation; and (iii) “Preservation”, where there was a forest regrowth in locations according to the Brazilian environmental legislation. Simulations were conducted for every 10 years, until 2050, using the same time series from calibration.

Simulated hydrograph outputs were later compared with the observed. Specific metrics were also compared to total forest cover simulations, with an attempt to observe potential synchrony between forest gain and water related ecosystem services.

Results show, in 2050, a maximum increase in forest cover of 0.67 percent points (pp) on a Status Quo scenario, while Status Quo+ increase was of 17.23 pp and Preservation was of 6.58 pp. Hydrological results are discussed as whether forest cover increase and spatial location have a significant effect on specific water-regulation ecosystem services.

Keywords

Land cover change, forest cover, water regulation, ecosystem services

Hydrological Modelling in Representative Catchments in Brazil Using the SWAT Model: the Experience of the REHIDRO Network

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Abstract

Experimental and numerical studies in Experimental and Representative Basins are essential for water resources planning and for hydrological processes analysis due to land use changes and climate change scenarios. This work presents comparative analysis among different catchments in the Brazilian semiarid, and the Cerrado Biome. The Hydrological Network REHIDRO funded by the Brazilian Government (FINEP) has been focused on developing joint hydrological studies, involving the Federal Rural University of Pernambuco State (UFRPE), the Federal University of Pernambuco State (UFPE), the University of Brasília (UnB), and the Brazilian Corporation for Agricultural Research (EMBRAPA Cerrados). Numerical simulation analysis will be discussed, applying the SWAT model for three representative catchments: The Tapacurá Representative Catchment has been studied by UFPE. It is one of the main sub-catchments that supply the Recife Metropolitan Region, northeastern Brazil. The Tapacurá catchment covers an area of about 470 km^2. Monitoring and modeling studies have been carried out on stream flow data from January 1997, using the data from a gauging station. The results show that the most sensitive hydrological parameters are the base flow, time of concentration and soil evaporation, which affect the catchment hydrology. The Ipanema catchment is part of the São Francisco River basin, and it is located in the Brazilian drought polygon. The São Francisco Basin has an area representing 8% of Brazilian territory. An representative (Mimoso) catchment has been monitored as part of the network by the UFRPE, in the Pernambuco State. The study area of UnB research Group is part of the contribution area of the Descoberto reservoir. The Descoberto reservoir is responsible for 63% of the urban water supply of the Brazilian Federal District. The Descoberto reservoir basin has an area of about 420 km^2 and the main tributary river has an area of about 114 km^2. Flow, rainfall, sediments and nutrient loads has been collected at the main tributary rivers. Six sub-basins have been investigated and monitored, with areas ranging from 16 km^2 to 114 km^2. The Upper Jardim Experimental River Basin covers an area of about 105 km^2, and is located in a rural

zone of the Federal District, Brazil, in the core region of the Cerrado biome (Brazilian savanna). Since 2001, in order to generate a database to support hydrological studies in a typical rural catchment of the Brazilian savanna, EMBRAPA Cerrados (Savannas Agricultural Research Center), in partnership with the University of Brasilia (UNB), and other institutions, has intensively characterized and monitored this area. Comparative hydrology is discussed, mainly addressing SWAT parameters sensitivity analysis.

Keywords

REHIDRO; comparative hydrology; water scarcity

Application of SWAT: Assessing environmental efficiency of various land use scenarios in Haean catchment, South Korea

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Abstract

This study focuses on a small 60 km^2 catchment in Haean, South Korea. The Haean catchment is a bowl shaped valley surrounded by steep topographic mountain slopes. The catchment is highly influenced economically by small scale agriculture. This leads to production oriented agriculture that ranges from intensively managed rice paddies in low land areas to dry land crops such as cabbage, radish, potato, and other perennial crops in high elevation hill slopes. Intensive agriculture, various land management practices, and changes in land use due to urbanization and deforestation continue to export large amount of nutrients. These processes occur largely because of excess fertilization and sediment additions, along with high surface runoff during the monsoon season. The study of reducing nutrient and sediment inputs from different land uses is of great concern to improve environmental ecosystem structure and the services they provide. The main objective of this study was to evaluate the environmental efficiency of the predominantly agricultural Haean Catchment (agricultural yields vs. environmental impacts on water quality and sediment) as influenced by climate, land use and agricultural management. The methodological approach of this study was to apply the SWAT model to quantify surface runoff, sediment and crop yield. Previously, we synthesized the required data for the application of a SWAT model to study flow partitioning of the catchment. However, the model was explicitly calibrated and validated for discharge and sediment. The comparison of observed and simulated results for discharge and sediment were within the

acceptable range of Nash Sutcliffe efficiency (NSE) and coefficient of determination (R^2) with values higher than 0.5. After calibration, the model was simulated for several dry land crop expansion scenarios considering cabbage, potato, radish and soybean from the baseline scenario. Based on these scenarios, the land use systems were optimized for environmentally efficient land use that has the capability to produce minimized surface runoff and sediment. The model results showed that the optimized land use system for minimizing surface runoff and sediment produce in average annually 545-548 mm of surface runoff and 10.2-11.7 tons/ha of sediment which were less than that produced from land use systems optimized for maximum yield and income (surface runoff: 553-563 mm, sediment: 14.8-14.9 tons/ha). The maximum crop yield and income from the optimized land use system for maximum yield and income were 4.8 tons/ha and 67.4 Million Won/ha (1 Korean Won=0.000866 US dollar in 2010), respectively, whereas the maximum crop yield and income from the optimized land use system for minimum surface runoff and sediment were about 1.8 tons/ha and 60 Million Won/ha, respectively. The income for a particular land use system was calculated based on the econometric approach of crop price and production cost (survey data) for every farm. Hence, different land use systems were identified, which were environmentally beneficial in reducing sediment yield and surface runoff and economically profitable with maximum yield and income. However, tradeoffs exist between the optimized land use systems. This research can be extended to future studies with the implementation of best management scenarios and environmental indicators such as, nutrient leaching.

Keywords

SWAT model, Environmental ecosystem, Optimization, Land Use Scenario, Sediment, Surface Runoff, Crop yield

Development of Sediment and Nutrient Export Coefficients for US Ecoregions.

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Abstract

Water quality impairment due to excessive nutrients and sediment is a major problem in the US. An important step in the mitigation of impairment in any given water body is determination of pollutant sources and amount. The sheer number of impaired waters and limited resources makes simplistic load estimation methods such as export coefficient methods attractive. Unfortunately export coefficients are typically based on small watershed monitoring data, which are very limited and/or often based on data collected from distant watersheds with drastically different land use and hydrologic conditions. In this research we seek to improve the accuracy of these nutrient export estimation methods by developing a national database of localized export coefficient by land use for each ecoregion in the US. A stochastic sampling methodology loosely based on the Monte-Carlo technique was used to construct a database of 45 million SWAT simulations. These simulations consider a variety of climate, topography, soils, weather, land use, management, and conservation implementation conditions. Extensive effort was invested in successfully validating the SWAT model simulations with edge-of-field monitoring data. Simulated nutrient export coefficients compared favorably with previously published studies. Specifically, the distribution of predicted export coefficients exhibited considerable overlap with observed distributions derived from literature summaries. These export coefficients may be used to rapidly estimate nutrient loading for any small catchment in the US provided the location, area, and land use distribution are known.

Spatial Distribution of Corn Water Requirements in the São Paulo State, Brazil

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Abstract

The visible and near infrared bands from Landsat satellite images together with agrometeorological data were used for actual evapotranspiration (ET) acquirements and crop coefficient (K_c) modelling in irrigation pivots, composed by corn crops for grains and for silage. For grains, the ET averaged values were in the range from 1.1 tod 4.4 mm day^{-1}, while for silage they were between 2.8 and 3.3 ^{mm} $day^{-1,}$ while the K_c values found inside the buffered pivot areas were between 0.3 and 1.2 considering both commercial situations. After developing relationships between K_c and the accumulated degree days (DD_{ac}) they were applied in the entire São Paulo state to obtain the large scale water requirements (WR). Growing regions were analysed during a growing season from March to August. Highlights are for Presidente Prudente, with the highest averaged WR values of 400 and 350 mm for respectively grain and silage productions. The lowest corresponding ones were for Itapetininga, with the corresponding averages of 310 and 255 mm. The results from the current research are useful for planning corn water productivity improvements according to the commercial purpose, for both, irrigation and rain fed conditions.

Keywords

Evapotranspiration, degree-days, crop coefficient

Characterization of the Wine Grape Thermo-Hydrological Conditions in the Brazilian Semi-Arid Region

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Abstract

Over the last years, the Brazilian semiarid has been highlighted as one of the new tropical wine production regions. The joined effect of rising air temperature and decreasing precipitation makes it important to quantify the thermo-hydrological conditions of the commercial vineyards. The aims of the current research were to classify and delimit these conditions for the winemaking processes. Considering different pruning periods along the year in the Petrolina/Juazeiro growing region, bioclimatic indices were applied, indicating that the thermal effects may affect the wine quality according to the period of the year. It was concluded that the best pruning dates are when they are done from May to July, as a consequence of the better thermal and hydrological conditions. In general, more care should be taken for pruning done in other periods of the year, regarding the effect of increasing thermal conditions on wine quality. The classifications and delimitations done in the current research, joined with other ecological characteristics, are important for a rational planning of the commercial wine production expansion, mainly in situations of rapid land use changes and rising water competition along the years in the Brazilian semiarid conditions.

Keywords

Bioclimatic indices, evapotranspiration, vineyards.

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