Book of Abstracts

INTERNATIONAL SOIL & WATER ASSESSMENT TOOL CONFERENCE

JULY 27-29, 2016

Beijing Normal University, China

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.

swat.tamu.edu | facebook.com/swatmodel | twitter.com/swat_model

Foreword

The organizers of the 2016 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 Beijing Normal University along with the organizing committee 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; the EPIC/APEX modeling system; 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.

Organizing Committee

Zhenyao Shen (Conference Chair) — Beijing Normal University, China

Raghavan Srinivasan (Conference Co-Chair) — Texas A&M University, USA

Jeff Arnold (Conference Co-Chair) — USDA-ARS, USA

Xuesong Zhang (Conference Co-Chair) — Pacific Northwest National Laboratory, USA

He Chen (Conference Secretary) — Beijing Normal University, China

Lei Chen — Beijing Normal University, China

Ruimin Liu — Beijing Normal University, China

Yong Liu — Peking University, China

Hongbin Liu — Institute of Agricultural Resources and Regional Planning, China

Jaclyn Tech — Texas A&M University, USA

Scientific Committee

Karim Abbaspour — EAWAG, Switzerland

Jeff Arnold — USDA—ARS, USA

Claire Baffaut — USDA—ARS, USA

Katrin Bieger — Texas A&M AgriLife Research, USA

José María Bodoque Del Pozo — UCLM, Toledo, Spain

Pierluigi Cau — CRS4, Italy

Pedro Chambel Leitão — IST—MARETEC, Portugal

Indrajeet Chaubey — Purdue University, USA

He Chen — Beijing Normal University, China

Lei Chen — Beijing Normal University, China

Jarosław Chormański — Warsaw University of Life Sciences, Poland

Prasad Daggupati — Texas A&M University, USA

Yihun Dile — Texas A&M University, USA

Nicola Fohrer — Christian—Albrechts—University, Kiel, Germany

Philip Gassman — Iowa State University, USA

A.K. Gosain — Indian Institute of Technology, India

Fanghua Hao — Beijing Normal University, China

Jaehak Jeong — Texas A&M AgriLife Research, USA

C. Allan Jones — Texas A&M AgriLife Research, USA

Valentina Krysanova — PIK, Germany

Hongbin Liu — Institute of Agricultural Resources and Regional Planning, China

Junguo Liu — Beijing Forestry University, China

Ruimin Liu — Beijing Normal University, China

Shiliang Liu — Beijing Normal University, China

Yong Liu — Peking University, China

Antonio Lo Porto — IRSA—CNR, Italy

Venkatesh Merwade — Purdue University, USA

Balaji Narasimhan — Indian Institute of Technology—Madras, India

Javier Osorio — Texas A&M AgriLife Research, USA

Wei Ouyang — Beijing Normal University, China

Yiannis Panagopoulos — Iowa State University, USA

Mikołaj Piniewski — Warsaw University of Life Sciences, Poland

Hendrik Rathjens — Purdue University, USA

Ali Sadeghi — USDA—ARS, USA

José Miguel Sánchez—Pérez — CNRS—ECOLAB, France

Sabine Sauvage — CNRS—ECOLAB, France

Zhenyao Shen — Beijing Normal University, China

Raghavan Srinivasan — Texas A&M University, USA

Robin Taylor — Texas A&M AgriLife Research, USA

Ann van Griensven — UNESCO—IHE, Netherlands

Martin Volk — Helmholtz Centre for Environmental Research — UFZ, Germany

Guoqiang Wang — Beijing Normal University, China

Hirozumi Watanabe — Tokyo University of Agriculture and Technology, Japan

Mike White — USDA—ARS, USA

Luo Yi — CAS,

Xuesong Zhang — Pacific Northwest National Laboratory, USA

Xu Zongxue — Beijing Normal University, China

Hydrology prediction in Poyang Lake Ungauged Zone Using SWAT Model

Ling Zhang*[1], Jianzhong Lu[2], Xiaoling Chen[3], Sabine Sauvage[4], José-Miguel Sanchez Perez[5]

1. State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University, Wuhan 430079, China. Email: zhangling_fly1104@163.com (corresponding author)
2. State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University, Wuhan 430079, China.
3. Key Laboratory of Poyang Lake Wetland and Watershed Research, Ministry of Education, Jiangxi Normal University, Nanchang 330022, China.
4. CNRS/INPT/UPS; Laboratoire Ecologie Fonctionnelle et Environnement (EcoLab), Avenue de l'Agrobiopole, 31326 Castanet Tolosan, France.
5. CNRS/INPT/UPS; Laboratoire Ecologie Fonctionnelle et Environnement (EcoLab), Avenue de l'Agrobiopole, 31326 Castanet Tolosan, France.

Abstract

Poyang Lake Ungauged Zone (PLUZ), a buffer area around Poyang Lake, has not been gauged so far. However, hydrology prediction in PLUZ is important to predict the volume of water resource and analyze the water balance for the Poyang Lake basin. In this study, the SWAT (Soil and Water Assessment Tool) model was applied to the whole Poyang Lake basin to simulate the streamflow in PLUZ and the total streamflow in PLUZ was calculated by accumulating that from each subbasin in PLUZ. The SWAT model calibration and validation show a great agreement between the simulated data and the observed data with determination coefficient R^2 and efficiency coefficient E_{ns} larger than 0.71. Monthly water yield in PLUZ in time series from 1981 to 2014 reveals significant seasonality, which demonstrates that the streamflow reached maximum in flooding period (mostly from March to July) and minimum in dry period (mostly from October to next February). The cumulative annual water yield in PLUZ totals 15.2km^3, occupying 11.4% of that from the Poyang Lake Basin in average, indicating a huge amount of water which can not be ignored to predict the volume of water resource and analyze the water balance in the Poyang Lake basin. The annual comparison between the simulated inflow (the sum of the simulated streamflow in PLUZ and observed streamflow from the five major subbasins) and the observed outflow at Hukou gauging station shows a close agreement with E_{ns} of 0.99, R^2 of 0.99, indicating that storage capacity of Poyang Lake stays constant in terms of inter-annual variation. However, for monthly comparison, there is not a good relationship between the inflow and outflow with somewhat low value—E_{ns} of 0.66, R^2 of 0.75, indicating Poyang Lake's role in storing water at high flow period and contributing water at low flow period. The study is aimed at predicting streamflow in ungauged area using SWAT model. The outcome of the paper will benefit hydrological engineers and scientists to study the extreme droughts and floods in the Poyang Lake basin.

Keywords

hydrology prediction, ungauged zone, Poyang Lake, SWAT

Studying of Perennial Changes of River Flow Regime in a Highly Managed Watershed, UK Case Study

Salam A Abbas*[1], Yunqing Xuan[2], Dominic E Reeve[3]

1. PhD Student, Swansea University. Email: 802170@swansea.ac.uk (corresponding author)
2. Senior Lecturer, Swansea University.
3. Professor, Swansea University.

Abstract

The streamflow modelling can be considered as a basic tool for the flood risk assessment and water resources management. Apart from the complexity of river basin, accurate prediction of river flow is fundamental part for resourceful planning of water resources system especially, for complex and highly managed watersheds. In this study, the Soil and Water Assessment Tool (SWAT) is utilised to simulate river flow in Dee River watershed in the United Kingdom. The streamflow modelling of this catchment is quite challenging process for many reasons: the main river flow is controlled releasing water from reservoirs in the upstream part of this basin (Highly managed catchment), runoff reduced by various types of abstractions (mainly public water supply and industrial withdraws), regulation from surface and groundwater abstractions, runoff increased/reduced by groundwater recharge/abstractions and runoff increased by effluent return.

Three Scenarios have been created: scenario including reservoirs released water and surface water abstractions, scenario considering reservoirs as natural lakes with surface water abstractions and finally scenario considering reservoirs as natural lakes without surface water abstractions. The reason for that is to separate effects of Reservoir, surface water abstractions and natural process in this catchment. The model is calibrated in daily bases for the period of 1995-2000, and validated for period of 2001-2003 using SUFI2 procedure and the results show a good performance based on NSE, R^2 and PBIAS in different locations in the catchment. The statistical technique of quantile regression, at quantiles of 5% (drought condition) and 95% (flooding situation) is used in this study to investigate the trend of river flow at each sub-basin for the current management practice. This method can be used to check how the current management practices effect on the river flow for flooding and drought conditions.

Keywords

SWAT, Highly managed, Dee Catchment, Quantile regression, Trend analysis, River flow regime

The analysis of culverts effect and river longitudinal connectivity based on SWAT model in Mayi River

Baoxiu Xing*[1], He Chen

1. Email: hansuu@126.com (corresponding author)

Abstract

Mayi River Basin is of significant importance to Songhua River concerning water resources aspects and fish resources of the area. However, culverts can impede fish passage and affect the longitudinal connectivity of rivers in the area. The first objective of this study was to assess the performance and applicability of the SWAT model for prediction of average daily stream flow in Mayi River Basin. The calibration and uncertainty of the model were performed with SUFI-2 (Sequential Uncertainty Fitting version 2). The model evaluation statistics for average stream flow prediction show that there is a good agreement between the measured and simulated flows.

The second objective was to quantify the culvert effect on 4 main potamodromous fishes and river longitudinal connectivity in Xiliushu River which is a tributary of Mayi River. River longitudinal connectivity was calculated by Dendritic Connectivity Index (DCI). The fish passability was modeled by FishXing software. The prediction of average daily stream flow was used to obtain low and high flow value in Xiliushu River. The culvert basics were from the investigation in 2015. Our results indicate that *Leuciscus waleckii* and *Esox reicherti* are much affected by the culvert than *Carassius auratus gibelio* and *Cyprinus carpio haematopterus*. Meanwhile, the Dendritic Connectivity Index cannot fully reflect the river longitudinal connectivity.

Keywords

SWAT, average daily streamflow, culvert, DCI, FishXing

Characteristics of nitrogen and phosphorus losses under extreme rainfall conditions in southern China

Lianhua Liu[1], Wei Ouyang[*2], Fanghua Hao[3], Xiang Gao[4], Peng Wei[5]

1. Docter/ State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University.
2. Vice professor/State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University. Email: wei@bnu.edu.cn (corresponding author)
3. Professor/State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University.
4. Docter/ State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University.
5. Docter/ State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University.

Abstract

Extreme rainfall event is predicted to be increasing and intensified due to global climate change, thus it has become urgent to understand the effects of extreme rainfall events on N and P losses. The objectives of this study were to analyze the properties of N and P losses under extreme rainfall conditions and to provide guidelines for nonpoint source (NPS) pollution control. SWAT model was used to evaluate NPS loads, and the characteristics of N and P losses under extreme rainfall conditions were investigated from 2001 to 2014 in Dongjiang River basin, southern China. Results showed that N and P losses were positively correlated with precipitation, and major diffuse N and P peaks occurred during extreme rainfall events. More than 50% of annual N and P losses were exported between April to September when rains were frequent and intensive. N and P losses during extreme rainfall events accounted for approximate 30% of annual losses. In years which had more extreme precipitation events, the nutrient losses were much higher than 14 year's average value. In conclusion, extreme rainfall events have profound impact on diffuse N and P losses, and more effective managements should be taken in extreme rainfall periods to mitigate nutrient losses and soil erosion.

Keywords

Extreme rainfall events; Nitrogen loss; Phosphorus loss

Physically-based Watershed Health, Resilience, and Priority Assessment of Han River Basin in South Korea

So Ra Ahn[1], Ji Wan Lee[2], Chung Gil Jung[3], Da Rae Kim[4], So Yeon Kim[5], Seong Joon Kim[*6]

1. Ph.D. Candidate, Konkuk University.
2. Doctoral Student, Konkuk University.
3. Doctoral Student, Konkuk University.
4. Graduate Student, Konkuk University.
5. Researcher, Konkuk University.
6. Professor, Konkuk University. Email: kimsj@konkuk.ac.kr (corresponding author)

Abstract

The watershed health, vulnerability and resilience for protection and restoration priorities were assessed for Han River basin (34,148 km^2) in South Korea. Six components, including watershed landscape, stream geomorphology, hydrology, water quality, aquatic habitat conditions, and biological conditions, were used to evaluate the watershed health (basin natural capacity). The SWAT (Soil and Water Assessment Tool) was utilized to examine the hydrology and water quality components in the study basin, which includes 237 sub-watersheds (called "standard watersheds" of Korea Hydrologic Unit Map) and three multipurpose dams, one hydroelectric dam, and three multifunction weirs. The SWAT with each dam and weir operation was used to calibrate (2005–2009) and validate (2010–2014) flux tower evapotranspiration, TDR soil moisture, and groundwater level data for hydrology and sediment and total phosphorus and total nitrogen data for water quality. Four components, namely, the future impervious areas by CLUE-s (Conservation of Land Use and its Effects at Small regional extent), future climate condition of Representative Concentration pathway (RCP) climate change scenarios, future water uses from the Korean government's water demand scenarios, and recent land covers from official statistical data, were used to evaluate the watershed vulnerability to artificial stressors. The financial stability, gross regional domestic product (GRDP), and number of water management public officers were considered for each sub-watershed to study the social factors affecting the watershed management. We determined the protection and restoration priorities by evaluating and comparing the health and vulnerability of each sub-watershed. The 67 sub-watersheds among total of 237 were classified to have restoration priorities with high recovery potentials.

Acknowledgement
This research was supported by a grant (14AWMP-B082564-01) from Advanced Water Management Research Program funded by Ministry of Land, Infrastructure and Transport of Korean government.

Keywords

Watershed health, Vulnerability, Resilience, Protection and restoration priority, SWAT

Evaluation of CO2 Treatment and the Impact on Watershed Hydrology in SWAT Using Terra MODIS GPP

Chung gil Jung[1], Ji wan Lee[2], So ra Ahn[3], Won jin Jang[4], Seong joon Kim*[5]

1. Ph.D. Candidate, Konkuk University, Dept. of Civil and Environmental System Eng..
2. Doctoral Student, Konkuk University, Dept. of Civil and Environmental System Eng..
3. Ph.D. Candidate, Konkuk University, Dept. of Civil and Environmental System Eng..
4. Undergraduate Student, Konkuk University, Dept. of Civil and Environmental System Eng..
5. Professor , Konkuk University, Dept. of Civil and Environmental System Eng.. Email: kimsj@konkuk.ac.kr (corresponding author)

Abstract

Emissions of greenhouse gases and aerosols from human activities continue to alter the climate and likely will have significant impacts on the watershed hydrological cycle and stream water quality. We applied Soil and Water Assessment Tool (SWAT) to evaluate CO_2 impact on watershed hydrology. This study is to evaluate the potential CO_2 change impact on hydrologic components in a forest dominant Seolma-cheon watershed (8,48 km^2) of South Korea. Using Terra MODIS image, the CO_2 flux was estimated as the sum of GPP (Gross Primary Productivity) and Re (ecosystem respiration) by Lloyd and Taylor method (1994). The SWAT modeling with CO_2 concentration can be a better understanding for evapotranspiration and soil moisture in future watershed management.

Acknowledgement
This research was supported by a grant (16AWMP-B079625-03) from the Water Management Research Program funded by the Ministry of Land, Infrastructure and Transport of the Korean government.

Keywords

SWAT, CO2, Terra MODIS, Gross Primary Productivity, Lloyd and Taylor, Flux data

Evaluation of land use, land management and soil conservation strategies to reduce non-point source pollution loads in the Three Gorges Region, China

Alexander Strehmel[*1], Britta Schmalz[2], Nicola Fohrer[3]

1. M.Sc., Department of Hydrology and Water Resources Management, Kiel University, Germany. Email: astrehmel@hydrology.uni-kiel.de (corresponding author)
2. Dr., Department of Hydrology and Water Resources Management, Kiel University, Germany.
3. Prof. Dr., Department of Hydrology and Water Resources Management, Kiel University, Germany.

Abstract

The construction of the Three Gorges Dam in China and the subsequent impoundment of the Yangtze River have induced a major land use change in the Three Gorges Reservoir Region (TGR), which fosters increased inputs of sediment and nutrients from diffuse sources into the water bodies. In this study, the eco-hydrological model SWAT (Soil and Water Assessment Tool) is used to assess the effects of changes in fertilizer amounts and the conditions of bench terraces in the Xiangxi catchment in the TGR on diffuse matter releases. As basis for this assessment, an innovative method to generate spatially-distributed data sets on land management and terraces based on sparse field data is introduced. The study aims at identifying efficient strategies for the reduction of diffuse matter loads, whose enforcement should have priority within the framework of the existing management plans and programs for the region. The results show that a reduction of fertilizer amounts cannot reduce phosphorus loads considerably without inhibiting crop productivity. The situation of terraces in the catchment has a strong impact on soil erosion and phosphorus releases from agricultural areas. Hence, if economically feasible, programs focusing on the construction and maintenance of terraces in the region should be implemented. Additionally, intercropping on corn fields as well as more efficient fertilization schemes for agricultural land were identified as potential instruments to reduce diffuse matter loads even further. While the study was carried out in the Three Gorges Region, its findings may also beneficial for the reduction of water pollution in other mountainous areas with strong agricultural use.

Keywords

Three Gorges Region; non-point source pollution; sediment; phosphorus; agricultural management; terraces; watershed management

Forest cover required for sustainable water flow regulation in a watershed with rapid oil palm expansion

Suria Tarigan*[1]

1. Dr. . Email: surya.tarigan@yahoo.com (corresponding author)

Abstract

The impact of continuing rapid expansion of oil palm plantations in South East Asia on hydrological functioning and other ecosystem functions remains uncertain. The vast majority of the local residents in our study area, representing one of the hotspots of Indonesia's recent oil palm boom, believe that the increase of plantations in a watershed was the reason for the more frequent water shortages problem the dry season. To prevent further loss of water ecosystem services in such a landscape, the scientific community proposes land sparing and land sharing approaches in order to balance the ecologic and socio-economic functions of the landscape. The objectives of our study was to determine the required proportion of forest cover in a watershed as example of land sparing approach for sustainable water flow regulation as an important ecosystem service. We employed the SWAT model to simulate forest ecosystem service of water flow regulation at a watershed scale. We utilized the runoff coefficient (C) and baseflow index (BFI) as indicators of water flow regulation at the watershed scale. Our study showed a strong correlation between indicators of the ecosystem service of water flow regulation (C and BFI values) and forest cover and agricultural plantation areas.

Keywords

forest cover; oil palm expansion; runoff coefficient; water flow regulation; water scarcity problem and mitigation

Implications of Different Nutrient Load Estimation Techniques for Testing SWAT: An Example Assessment for the Boone River Watershed in North Central Iowa

Philip Gassman*[1], Calvin Wolter[2], Keith Schilling[3], Steve Mickelson[4]

1. Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, USA. Email: pwgassma@iastate.edu (corresponding author)
2. Iowa Geological Survey, Department of Earth and Environmental Sciences, Trowbridge Hall, University of Iowa, Iowa City, Iowa 52242 .
3. Iowa Geological Survey, Department of Earth and Environmental Sciences, 115 Trowbridge Hall, University of Iowa, Iowa City, Iowa 52242 .
4. Agricultural and Biosystems Engineering, 1340B Elings Hall, Iowa State University, Ames, Iowa 50011-1098 .

Abstract

Verification of hydrologic and/or pollutant output is commonly performed for applications of the Soil and Water Assessment (SWAT) ecohydrological model. Testing of SWAT can be performed using a variety of approaches, and is often conducted using separate calibration and validation phases depending on data availability. In-stream pollutant levels are typically measured in the form of concentrations, which are often converted to a mass basis using streamflow discharge observations to provide the ability to compare SWAT output with measured loads. This is a necessary step for conducting Total Maximum Daily Load (TMDL) assessments and many other water quality analyses. A variety of methods and software have been developed to estimate pollutant loads based on in-stream concentration measurements including the U.S. Geological Survey (USGS) Survey (USGS) Load Estimator (LOADEST) software, which has been used for numerous SWAT studies reported in the peer-reviewed literature. Recent research published in the Journal of Hydrology (J. Hydrol.) and accepted by the Journal of Soil and Water Conservation (JSWC) reveal that LOADEST can greatly overpredict nitrate loads for stream systems that drain parts of the state of Iowa, which is located in the western part of the Corn Belt region in the United States. The JSWC study further shows that different methods may be needed for estimating loads for different constituents, rather than relying on the same technique to estimate loads for all pollutants that are simulated in a given SWAT application.

The importance of these load estimation findings are demonstrated here in the context of a SWAT application for the Boone River watershed (BRW), which drains an intensively cropped region dominated by corn and soybean production that covers over 2,300 km^2in north central Iowa. Crop production in the BRW is representative of typical Iowa cropping systems and elevated levels of nutrients exported from the BRW replicate nutrient pollution problems across much of the state. Nitrate discharged from the BRW stream system is of primary concern, much of which escapes the cropland via subsurface tiles that drain the predominantly flat landscapes that characterize the watershed. Phosphorus export to stream systems in the BRW is also a problem of considerable concern.

The following outcomes will be presented for the BRW study: (1) the range of load values resulting from different methods used for estimating nitrate, total phosphorus and sediment loads, (2) the best choice of load estimation method for testing SWAT for each of the three different constituents, and (3) the broader implications of the study results for Corn Belt region streams and streams in other regions.

Keywords

SWAT, cropping systems, nutrient pollution, tile drainage, nutrient concentrations, load estimation techniques

Analysis of check dam effectiveness in reducing sediment using SWAT model

Said Karim[1], Nora Herdiana Pandjaitan[*2], Asep Sapei[3]

1. MSi at Dept. of Civil and Environmental Engineering Department, Bogor Agricultural University, Indonesia.
2. Dr. and Head of Civil and Environmental Engineering Department, Bogor Agricultural Univ.. Email: noraherdiana12@gmail.com (corresponding author)
3. Prof. at Dept. of Civil and Environmental Engineering.

Abstract

A lot of watershed in Indonesia have erosion problem and more than 50 watersheds are in critical conditions. One of the erosion impact are sediments. If erosion become worse, sediments will increased and will decrease water quality at downstream area. It is necessary to analyze sediments volume in a watershed and to find a solution for sedimentation problem. By reducing sediments, water quality will become better and water can reuse again for irrigation or other agriculture activities. The objective of this study were to analyze sediment volume at Upper Citanduy Watershed and to find sediment control strategies using check dam. In this case check dams was used as sediment control structure. Analysis was done using SWAT model. Check dams were designed at several places and was chosen according to topographyc condition and several criterias. The result showed that sediments volume at the outlet of Upper Citanduy Watershed was 81,351,783.23 ton/year. Using check dam as sediment control structure, the sediment could be settled more than 60%.

Keywords

check dam, sediment, sediment control, SWAT model, Upper Citanduy Watershed

Spatial Distribution Variation of the Generation and Export of Diffuse Source Pollution of a Typical Watershed in Yunnan Plateau Lakes Area

Wenchao Li*[1], Limei Zhai, Qiuliang Lei, Shen Liu, Wanli Hu, Hongbin Liu, Tianzhi ren

1. Email: dachao279@126.com (corresponding author)

Abstract

It is great help of knowing the spatial distribution of nitrogen and phosphorus loss for identifying the critical areas of diffuse pollution. This work studied the spatial distribution of the generation(emission to river) and export(emission from the watershed) of diffuse nitrogen and phosphorus from a typical watershed in Yunnan plateau lakes area using SWAT(Soil and Water Assessment Tool), furthermore, evaluated the role of chemical transformation in reaches in the spatial distribution of diffuse pollution. The results showed that areas with high generation intensity of total nitrogen and phosphorus were coincided with hydrological sensitive areas and soil erosion sensitive areas. In addition, the area with high generation intensity of total nitrogen was bigger than that of total phosphorus. However, the spatial distribution of export of total nitrogen and phosphorus differed from the generation. Not only did the hot areas of export reduce but also the load decreased compared to the generation. The retention effect of reaches that the chemical or physical transformation of nutrient generated from landscape during the delivery process dominated the changes. Furthermore, the variations of transporting processes of nutrient in different sub-watersheds caused the retention coefficients of nitrogen range from 10% to 80% and that of phosphorus range from -12% to 44%. Based on these results, there was a conclusion that the spatial distribution of export of diffuse pollution was the coupled effect of generation and transformation in delivering process.

Keywords

diffuse pollution; generation; export; spatial distribution; SWAT

The integration of export coefficient method and SWAT model for identifying the contribution of different agricultural sources for non-point pollution in the Three Gorges Reservoir Area

Hua Lingling, Li Wenchao, Zhai Limei*[1], Liu Hongbin, Chen Lei, Ren Tianzhi, Zhang Fulin, Liu Shen, Lei Qiuliang, Cui Chao

1. Email: zhailimei2011@163.com (corresponding author)

Abstract

Agricultural pollution is the dominant pathway for the accelerated eutrophication of surface water in many important lake basins. Export coefficient method is commonly used to estimate the content of non-point pollutant loss, but it ignores the pollutant migration process from the pollutant production to the watershed outlet. Soil and Water Assessment Tool (SWAT) model has been successfully used to simulate the exportation of non-point pollutant at the basin scale and has a comprehensive consideration of the pollutant migration process finally releasing into reservoir area. This study integrated the export coefficient method and SWAT model to identify the contribution of different agricultural sources for non-point pollution. Agricultural production statistic data was utilized to estimate the pollutant production from different agricultural sources in each sub-basin. Combined with the pollution export coefficients, the pollution contribution from each sub-basins were separately calculated. The SWAT model was used to simulate the pollutant migration process from the pollutant production in sub-basins to the watershed outlet and obtained the pollution contribution coefficients of each sub-basin. Finally, the pollutant load contribution of different agricultural source for non-point pollution was the pollution contribution content from each sub-basin multiplying their pollution contribution coefficient respectively. We illustrated this method in the Xiangxi river basin of the Three Gorges Reservoir Area, Hubei province, China. Total nitrogen (TN) and total phosphorus (TP) pollution from agricultural source were identified. The quantitative results indicated that TN and TP load releasing into the reservoir area from agricultural source were 1229.5 t a^{-1} and 82.4 t a^{-1}, accounted for 40.2 and 37.6 percent of the whole contribution content, respectively. Livestock breeding was the main source of TN load, accounted for 81.7 percent of agricultural TN load in the study area. However, livestock breeding and cropland farming were the main source of TP load, accounted for 52.3 and 41.5 percent respectively. This research proposed a more comprehensive method to identify the contribution of different agricultural source for non-point pollution to the reservoir area or lake basin.

Keywords

SWAT model; Nonpoint source pollution; Nitrogen and phosphorus; Three Gorges Reservoir Area

Linking regional climate simulations and hydrologic models for climate-change impact studies – A case study in central Indiana (USA)

Hendrik Rathjens[1], Indrajeet Chaubey[*2], Raj Cibin[3], Raghavan Srinivasan[4], Jeffrey Arnold[5]

1. Purdue University, Earth, Atmospheric & Planetary Sciences.
2. Purdue University, Department of Agricultural and Biological Engineering. Email: ichaubey@purdue.edu (corresponding author)
3. Purdue University, Department of Agricultural and Biological Engineering.
4. Texas A&M University, Biological and Agricultural Engineering.
5. USDA-ARS, Grassland Soil and Water Research Laboratory.

Abstract

Quantifying the effects of future changes of climatic drivers such as precipitation and temperature is a key challenge in assessing the impact of climate change on hydrological systems and their ecological status. Despite the increasing availability of regional climate model simulations, their application in hydrologic models is still challenging due to the risk of considerable biases. Climate models do not always accurately simulate daily precipitation or temperature within a watershed. Due to spatial averaging and systematic model errors the output of a climate model grid cell does not necessarily be representative for a climate gauge within a watershed. Bias correction methods are often used to reduce biases. These methods use a transformation algorithm to adjust simulated climate data by identifying possible biases between observed and simulated climate variables.The aim of the study was to evaluate different bias correction methods for simulated precipitation and temperature data and to assess their influence on resulting SWAT water balance and streamflow simulations. The methods analyzed are (1) linear scaling, (2) local intensity scaling, (3) power transformation, (4) variance scaling, and (5) distribution mapping. The methods were evaluated based on comparisons between observed and simulated climate drivers for a time period from 1985 to 2009 in a watershed in Indiana (USA). In a second step, the influence of the bias correction methods on resulting SWAT water balance and streamflow simulations was assessed for a time period from 1990 to 2009. Results show that monthly mean climate data can be corrected robustly with all methods, but there are differences in the ability to correct statistical properties such as variance or extreme event frequency. Streamflow simulations using bias-corrected climate model data fit observed values better than simulations using raw climate model data.

Keywords

climate change; bias correction; CMIP; hydrologic impact study

Introducing Climate Change Toolkit (CCT) and online CMIP5 database

Saeid Ashraf Vaghefi*[1], Karim C Abbaspour

1. Email: saeedashrafv@gmail.com (corresponding author)

Abstract

In recent years, climate change analysis has been implemented broadly using Soil and Water Assessment Tool (SWAT) in the fields of water resources planning and management. Climate change studies require 1- dealing with big data sets, 2- bias correcting and downscaling of global data, and 3- Interpolating of climate data to finer resolution. Moreover, analysis of the impact of climate change on extreme events, such as droughts and floods are of interest in many studies. In this paper we demonstrate the software Climate Change Toolkit (CCT) and its linkage to CMIP5 database. CCT is linked to an online archive of a global historic (CRU, 1970-2006) and five future (2006-2100) GCM models of four carbon evolution scenarios each. The big database of precipitation and max-min temperature consists of daily data at 0.5° grid resolution. The format of the database is compatible with SWAT and after temporal and spatial extraction for a desired region, data can directly be used in a SWAT model. CCT provides separate modules to perform all repetitive tasks necessary in a climate change study. The modules consist of : i) temporal and spatial extraction of climate data, with SWAT format, from the main global database, ii) bias correction and statistical downscaling of the global data using the local CRU or observed climate data , iii) interpolation of the 0.5° gridded data into finer resolution climate data, and iv) calculation of continuous dry- and wet-day periods based on rainfall, temperature, and soil moisture for analysis of drought and flood risks.

Keywords

Interpolation and downscaling, global GCM data, extreme hydrological events

Impact of climate change on Water Resources of Krishna river basin

Tirupathi Chanapathi*[1], Shashidhar Thatikonda[2]

1. Research Scholar,IITH. Email: ce16resch01002@iith.ac.in (corresponding author)
2. Associate professor,IITH.

Abstract

Assessment of water resources under future climate is important for decision makers for better planning and management. The Krishna river basin, which is the fourth largest river basin in India, has been studied for the water resources assessment using SWAT. This basin falls under semi-arid regions, where stress on water resources is expected under future climate change. Data related to Digital Elevation Model, soil map, land use/land cover map, slope map and weather data were used for modelling. Model was run for observed data (1975 – 2015), historic climate data of various models like CCCMA_CGCM3, CNRM_CM3, GFDL_CM2_0, GFDL_CM2_1, and MRI_CGCM2 (1965 -2000) and future scenarios. Sequential Uncertainty Fitting (SUFI-2) algorithm in SWAT-CUP (SWAT-Calibration and Uncertainty Programs) has been used for uncertainty analysis and model calibration. Calibration of the model has been carried out for the period (1975 – 1995) and validation of the model has been carried out for the period (1996 – 2005). The values of R^2 and NSE are 0.72 and 0.7 respectively, which indicate the good co-relation between observed and simulated flow. Comparison has been made between various climate models. The prediction result shows that runoff will increase 38% in the mid-century (2049 – 2064) and it again increase by 45% at the end century (2084 - 2100) under climate change scenarios. It also shows that mid and end centuries follows similar trend.

Keywords

Climate change, Runoff, SWAT, SUFI-2, Uncertainty.

Changes in climate and land use and their impacts on water and sediment yields in the Huangfuchuan River baisn, China

Depeng Zuo*[1], Zongxue Xu[2]

1. Lecturer, College of Water Sciences, Beijing Normal University. Email: dpzuo@bnu.edu.cn (corresponding author)
2. Professor, College of Water Sciences, Beijing Normal University.

Abstract

The Huangfuchuan River is the primary tributary located in the sediment concentrated regions in the Middle Yellow River in China. Significant decreases in runoff and sediment load has been observed in this River. In this study, impacts of land use and climate changes on water and sediment yields were investigated in the Huangfuchuan River basin, China. Trends and abrupt changes in precipitation, air temperature, runoff, and sediment load were analyzed by non-parametric Mann–Kendall and Pettitt tests. The impacts of climate and land use changes on water and sediment yields are studied by using the Soil and Water Assessment Tool (SWAT) and scenarios analysis method. The results showed that significant decreasing trends were detected in both runoff and sediment loads, while slightly decreasing and significantly increasing trends were explored in precipitation and air temperature, respectively. The year 1984 was identified as the abrupt change point for the hydrometeorological variables. Land use changes were examined with land use transition matrix and ArcGIS. The land use changes showed significant effects of the Grain for Green Project in China. Both climate and land use changes had greater impact on the decline of sediment yield than that of water yield. Water and sediment yields showed more significant reductions in the upstream region than those in the downstream region under different scenarios. The results obtained in this study could provide useful information for water resource planning and management, and soil and water conservation in the Loess Plateau region.

Keywords

SWAT, Climate change, Land use, Water yield, Sediment yield, Loess Plateau

The SWAT Calibration during Drought Years in a Rural Small Catchment

Ji Wan Lee[1], So Ra Ahn[2], Chung Gil Jung[3], Seong Joon Kim[*4]

1. Doctoral Student, Konkuk Univ.
2. Ph.D Candidate, Konkuk Univ.
3. Doctoral Student, Konkuk Univ.
4. Professor, Konkuk Univ. Email: kimsj@konkuk.ac.kr (corresponding author)

Abstract

This study is to evaluate the SWAT (Soil and Water Assessment Tool) parameters for a drought periods in a small rural catchment. Generally, the SWAT has been calibrated for conditions of dry, average, and wet years with averaged parameters. In this study, SWAT was applied for a 1.17 km^2 small rural catchment to calibrate the SWAT parameters for drought years (2014-2015). The most sensitive parameters for drought condition were the physical soil properties such as bulk density, available water capacity, and hydraulic conductivity. For the droughts, the average Nash and Sutcliffe mode efficiency and determination coefficient were 0.79 and 0.68 respectively. An identification of drought parameters was necessary especially during severe drought periods.

Acknowledgements
This research was supported by a grant (16AWMP-B079625-03) from Water Management Research Program funded by Ministry of Land, Infrastructure and Transport of Korean government.

Keywords

SWAT, Parameterization, Modeling, Drought year, Small catchment,

Improvement of model evaluation by incorporating prediction and measurement uncertainty

Lei Chen, Shuang Li, Yucen Zhong, Xiaosha Zhi, Zhenyao Shen*[1]

1. Email: z.y.shen@163.com (corresponding author)

Abstract

Increasing researches have been conducted in assessing uncertainty in hydrological prediction, but few studies have incorporated prediction and measurement uncertainty in model evaluation. In this study, two new approaches, in terms of Cumulative Distribution Function Approach (CDFA) and Monte Carlo Approach (MCA), were developed by incorporating both prediction and measurement uncertainty. For the CDFA, the traditional point-to-point comparison is replaced by the distance between cumulative distribution function and an interval distant has been established to replace the traditional error term. The MCA, which is based on the data sampling, is used to deal with the conditions when those dispersed measured or predicted data exist. Then, those new approaches were tested in combination with the Soil and Water Assessment Tool in a typical watershed in the Three Gorges Region, China. Compared to traditional point-to-point method, new approached provided more accurate goodness of fit indicators for model evaluation. Based on the results, the goodness of fit indicators are good for runoff, sediment and total phosphorus predictions if measured errors were less than 9%, 16% and 26%, respectively. However, if the measurement errors were more than 36%, 102% and 221%, the goodness of fit indicators become very poor so the model calibration is useless. In this sense, when the measured error is small and the number of measured data is enough for a specific distribution, the CDFA and MCA methods can be extended to other model applications for a better evaluation.

Keywords

uncertainty analysis; Cumulative Distribution Function Approach; Monte Carlo; Soil and Water Assessment Tool; the Three Gorges; nonpoint source pollution

Time-varying analysis of parameter sensitivity at multiple evaluation scales for hydrologic and sediment modeling

Hui Xie, Zhenyao Shen*[1], Lei Chen, Guoyuan Wei

1. Email: zyshen@bnu.edu.cn (corresponding author)

Abstract

Assessing the time-varying parameter sensitivity of watershed models has become a useful tool for improving the understanding of processes and their representation in a model structure. This paper investigates the temporal dynamics of parameter sensitivity of stream flow and sediment at multiple time scales. We estimate first order sensitivity indices using the Fourier Amplitude Sensitivity Test (FAST) method at different moving windows. A typical semi-distributed watershed model, Hydrological Simulation Program Fortran (HSPF) was tested. The results show that hydrologic parameters related to base flow and gravity drainage are significantly sensitive across the wet and dry periods, whereas the appropriate window sizes for identification vary. Interflow parameters are dominant in the peak and recession phases. Soil evapotranspiration parameters dominate in baseflow and resaturation periods and are only identifiable at window sizes of more than 60 days. Soil detachment and wash off parameters are important at the time corresponding exactly to storm events with a wide windows size range for identification, whereas parameters in the reach module for deposition and scour show little variation. The presented analysis can be extended to other watershed models such as the Soil and Water Assessment Tool (SWAT), to assist in diagnostic model evaluation and spot data sampling campaigns in ungagged watersheds.

Keywords

sensitivity; time-varying; hydrology; sediment; watershed models

Evaluation of SWAT Hydrological Model for Streamflow Simulation in Yasu River Basin, Japan

Baobab Kimengich*[1], Junichiro Takeuchi[2], Masayuki Fujihara[3]

1. Student Graduate School of Agriculture, Kyoto University, Japan. Email: baobabkibet@gmail.com (corresponding author)
2. Assistant Professor Graduate School of Agriculture, Kyoto University, Japan.
3. Professor Graduate School of Agriculture, Kyoto University, Japan.

Abstract

Modelling is inevitable as far as strategic planning and decision making is of concern. However, natural systems such as hydrology tend to be complex when it comes to modelling. Coupled with many variables and numerous uncertainties, hydrological modelling presents an enormous task especially on distributed or semi distributed models. This study applied soil water assessment tool (SWAT) 2012 model for streamflow simulation on Yasu river basin in Japan. The basin has a catchment area of 387km^2 and is of great significance as it forms the largest river draining in to Lake Biwa, the biggest fresh water lake in Japan. Specific aim of this study was to conduct model calibration, validation, sensitivity and uncertainty analysis. ArcGIS 10.2 was used as an interface to run the SWAT model. Simulation period ranged from the year 1990 to 2010 inclusive of a two year warm up period for both daily and monthly stream flow. Two optimization programs, Sequential Uncertainty fitting Algorithm (SUFI-2) and Generalized Likelihood Uncertainty Estimation (GLUE) were used for model calibration, Validation, Sensitivity and Uncertainty analysis. Calibration was carried out from 1992 to 2002 whereas validation was conducted from 2003 to 2010. The performance of the model was determined by coefficient of determination (R^2) and Nash-Sutcliffe (NS). Monthly calibration results for SUFI-2 yielded a performance of 0.85 for R^2 and 0.82 for NS whereas validation outcome for R^2 was 0.63 and 0.62 for NS. Daily calibration period had R^2 of 0.71 while that of NS was 0.70. Validation period yielded 0.62 for R^2 and 0.61 for NS. GLUE generated almost similar results to that of SUFI-2 with monthly and daily performance of 0.85 R^2, 0.82 NS and 0.71 R^2, 0.70 NS for calibration respectively. Validation had 0.64 R^2, 0.53 NS and 0.60 R^2, 0.59 NS for monthly and daily period in that order. The sensitivity of parameters in the model varied based on the optimization program as well as on daily and monthly time period. Among the most sensitive parameters included, soil conservation service curve number (CN2) and base flow recession alpha factor (ALFA_BF). For Uncertainty analysis with SUFI-2, the percentage of observed data enveloped by the model results (P-factor) for monthly calibration was 0.86 as compared to 0.82 during validation whereas the uncertainty range (R-factor) was 0.77 and 1.03 for calibration and validation. Daily analysis had a P factor of 0.90 and 0.94 while R factor was 0.56 and 0.71 for calibration and validation respectively. GLUE optimization program had a P factor of 0.74 and 0.66 with an R factor of 0.58 and 0.78 for monthly calibration and validation period. Daily calibration and validation gave a P factor of 0.80 and 0.88 whereas R factor was 0.45 and 0.58. SWAT provided a suitable platform for hydrological modelling of Yasu River basin with reasonably good performance on both monthly and daily streamflow simulation. The model therefore, can be utilized for critical decision making on efficient utilization and management of water in Yasu River basin.

Keywords

Modelling, hydrology, Yasu river basin, simulation, Calibration, Validation, sensitivity, uncertainty

Effect on Water Environment Due to the Conversion of Land Use at Xiangxi River Basin and Pollution Control Measures

Qingrui Wang, Fei Xu, Cong Men, Ruimin Liu*[1]

1. Email: liurm@bnu.edu.cn (corresponding author)

Abstract

With the rapid development of the control technology of point source (PS) pollution, non-point source (NPS) pollution has become the main factor contributing to the water pollution. Conversion of land use will change the natural condition and humanity factor in the area and is one of the most important factors affecting the non-point source pollution. The research used the mathematical model—the Conversion of Land Use and its Effects at Small regional extent (CLUE-S) to predict the changes of land use from 2010 to 2020, and then simulated their effect on water environment by Soil and Water Assessment Tool (SWAT) model at Xiangxi River watershed， one of the main tributaries in the Three Gorges reservoir . The results revealed that there would be a great conversion on the land use between the year 2010 and 2020, and the area of agricultural land and urban area would increase by 22.10% and 261.84% respectively, which would result in the increase of the amount of total nitrogen (TN) and total phosphorus (TP) by 11.82% and 15.34% respectively in 27 subbasins. The southwestern plains which concentrated the agricultural land and urban area had the highest NPS pollution load. The comparison between the conversion of land use and the distribution of TN, TP showed that there was a close relationship between the change of the amount of TN, TP and the conversion of land use. The areas where the pollution increased were just the regions which had a conversion of land use, such as the change from forest to agricultural land. Solutions could be put forward based on the results simulated by SWAT. The research makes it possible to control water pollution before it occurs by adjusting the plan of land use. What's more, it can provide a reference for related pollution control measures and policy making.

Keywords

non-point source pollution; conversion of land use; CLUE-S model; water environment; SWAT model

Assessment of Hydrological Responses using Arc SWAT

Prabhakar Shukla*[1], Raj Mohan Singh[2]

1. Research Scholar, Department of Civil Engineering, MNNIT Allahabad, India. Email: yaahoo.india@gmail.com (corresponding author)
2. Associate Professor, Department of Civil Engineering, MNNIT Allahabad, India.

Abstract

Water is vital for economic development, agricultural growth and industrial development. To deal with water management issues, it is imperative to analyze and quantify the different elements of hydrologic processes. Hydrological processes have direct relation to weather, topography, geology and land use of watershed. Simulating the hydrological processes help to asses hydrological responses in a watershed and irrigation command areas. In present study, Arc SWAT has been used for assessing the hydrological responses in terms of surface runoff, groundwater recharge, evapotranspiration, potential evapotranspiration, and lateral flow.

The Arc SWAT model is developed for Sai-Gomti interfluve irrigation region located in Uttar Pradesh, India. The model has been calibrated with datasets of period 1971-2002 (31 years). Model calibration and uncertainty analysis are performed with sequential uncertainty fitting (SUFI-2). Calibrated model is validated with datasets of period 2003-2005 (2 years). Developed model indicates a good performance statistics for both calibration (R^2=0.78, Nash-Sutcliffe coefficient= 0.75) and validation periods (R^2=0.72, Nash-Sutcliffe coefficient= 0.71) between observed and simulated rainfall values. The calibrated and validated model is further employed for accessing hydrological response of Sai-Gomti interfluve region for the period 2006-2012.

Keywords

Arc SWAT, SWAT-CUP, SUFI-2, hydrological response

Impacts of Manure Application on SWAT Model Outputs in the Xaingxi River Watershed

Fei Xu*[1]

1. Email: bnuxf@foxmail.com (corresponding author)

Abstract

The impact of livestock manure application on SWAT model outputs hasn't been well studied. The objective of this study was to investigate the effects of livestock pollution based on SWAT model in Xiangxi River watershed, one of the largest tributary of Three Gorges Reservoir in China. Three manure databases were created and applied to different subbasins based on the actual livestock manure discharging amount. The main findings were obtained by comparing the SWAT model outputs of organic nitrogen (ORGN), organic phosphorus (ORGP), nitrate nitrogen (NO_3-N), ammonia nitrogen (NH_4-N), inorganic phosphorus (MINP), total nitrogen (TOT-N) and total phosphorus (TOT-P) produced by subbasins auto-fertilized and fertilized according to the maximum capacity of livestock manure per hectare. The study found: (1) Nitrogen and phosphorus pollution loads produced by subbasins fertilized according to the maximum capacity of livestock manure per hectare were all larger than those auto-fertilized. (2) Xiakou (subbasin 25、 26 and 27) produced the largest pollution loads although the amount of manure application was the smallest among the three towns (covering 12 subbasins). (3) Manure application showed more effects on TOT-N and ORGN, and the largest difference values (D-values) of TOT-N and ORGN produced by subbasin 27 where basin export existed were 424.82t and 381.20t, respectively, accounting for 25.5% and 25.7% of the loads produced by subbasins auto-fertilized. The results indicated that manure application influenced the pollution outputs greatly, which required detailed plan of fertilization when livestock manures were applied, especially in the downstream of the watershed. Administrative division was first combined with watershed delineation in our study. The conclusions of this study would be instructive for livestock pollution control, and then favorable for non-point source pollution prevention in watershed scale.

Keywords

livestock; manure application; non-point source pollution; SWAT

Development of climate, soil, plant growth and management data to support the use of SWAT in México

Jesus Uresti-Gil*[1], Diana Uresti-Duran[2], Roberto Lopez-Escudero[3], Alejandro Muñoz-Aldape[4]

1. Doctor in Agricultural Science. Email: uresti.jesus@inifap.gob.mx (corresponding author)
2. Agricultural engineer.
3. Master of Science.
4. Master of Science.

Abstract

In Mexico, in recent years; the use of the Soil and Water Assessment Tool (SWAT) model has increased considerably to study hydrological processes in several watersheds under different scenarios of land use, to study water pollution and to quantify the potential for crop production, biofuel production and the impact of climate change on agricultural productivity. Each of these studies, scattered throughout the country, has used its own databases developed from different sources. However, in Mexico; nationwide, there is basic information that can facilitate the use of SWAT in each of the 159 basins or 1,908 sub-basins, that the National Water Commission (CNA) divides the country. The National Weather Service (SMN) manages a national network of 5,460 weather stations across the country; the National Institute of Statistics and Geography (INEGI) has soils and actual land use maps (scale 1: 250,000) across the country; as well as the physico-chemical data for 1,383 different soils according to the World Resourse Base (WRB) classification of FAO. The National Institute of Forestry, Agriculture and Livestock (INIFAP), has developed technology packages (tillage, planting and harvesting dates, plant densitiy rates, fertilization, weed, pests and diseases control, among others) for the production of annual crops, grass and forage crops, fruits, industrial crops and forest trees; likewise, it has information on the main and most sensitive parameters of plant growth (Radiation use efficiency, leaf area index, harvest index, optimal temperature, base temperature, maximum crop height, maximum root depth and maximum biomass production) used in SWAT. The aim of this paper is to report on the development and availability of climate data, soil, plant growth parameters and management to support the use of SWAT in México. The climate database developed in the format required by SWAT corresponds to 3,329 meteorological stations located across the country, with daily data of maximum and minimum temperature, rainfall, solar radiation; and the average monthly statistics for 1912-2012. The soil database developed, includes information on the physico-chemical characteristics, as required by SWAT, of the 1,383 different types of soils, which covers the 63,794 polygons of the soil map. The map of actual land use includes a total of 122,810 polygons, distributed in 179 different types of vegetation and/or land use. The developed basic database of parameters for plant growth and management, includes 55 sets of data distributed as follows: 16 for annual crops, 6 for grass and forage, 7 for fruit, 18 for industrial crops and 6 for forest trees, all of them from tropical areas. According to the above, basic SWAT formated climate and soil data bases are available across México. Basic plant growth and management data is available for the most important crops of the tropical area; and it is necessary to further develop database sets for plant growth and management under temperate and desert climates. The developed basic data bases may allow a widespread use of SWAT in México.

Keywords

Databases, Watershed, Simulation models, Management of natural resources, Decision making

Plug-in water quality modules within the SWAT model

Zhonglong Zhang*[1], Xinzhong Du[2], Billy Johnson[3]

1. Senior Scientist. Email: zzhang@limno.com (corresponding author)
2. Post-doctor.
3. Civil Engineer.

Abstract

This paper presents plug-in aquatic nutrient and contaminant simulation modules in the SWAT model. The Nutrient simulation module (NSM) and contaminant simulation module (CSM) have been developed for a variety of hydrologic and hydraulic (H&H) models. They were written as dynamic link libraries (DLLs). The NSM models algae and benthic algae, simplified nitrogen, phosphorus and carbon cycles, organic matter, carbonaceous biochemical oxygen demand, dissolved oxygen and pathogen using 16 state variables. Water quality state variables included in NSM can be individually activated or deactivated. The CSM can model any user-defined contaminants through ionization, multi-phase partitioning, degradation, photolysis, hydrolysis, volatilization, generalized second-order reaction and transformations. It computes internal source and sinks for a wide range of contaminants for both water column and underlying sediment layer. Various kinetic processes and equations in NSM and CSM have been critically tested and verified before. This presentation focuses on the integration of water quality modules with the SWAT model. The SWAT - NSM and SWAT – CSM were applied to the Little river watershed for evaluating in-stream water quality processes and new SWAT model capabilities.

Keywords

SWAT, water quality module, in-stream transport, nutrients, contaminants

Effects of rainfall and topography on total phosphorus loss from purple soil under simulated rainfall conditions

Xiaowen Ding*[1], Ying Xue[2], Ming Lin[3], Baodeng Hou[4]

1. Key Laboratory of Regional Energy and Environmental Systems Optimization, Ministry of Education, North China Electric Power University, Beijing 102206, China. Email: binger2000dxw@163.com (corresponding author)
2. Key Laboratory of Regional Energy and Environmental Systems Optimization, Ministry of Education, North China Electric Power University, Beijing 102206, China.
3. Key Laboratory of Regional Energy and Environmental Systems Optimization, Ministry of Education, North China Electric Power University, Beijing 102206, China.
4. State Key Laboratory of Simulation and Regulation of Water Cycle in River Basin, China Institute of Water Resources and Hydropower Research, Beijing 100038, China.

Abstract

Nowadays, effects of rainfall and topography on the process of nutrient transport have become a focus in field of water pollution control. In this study, a field experiment is conducted to reveal the effects of rainfall and topography on total phosphorus loss from purple soil. The rainfall is simulated under various precipitation, rainfall duration (0 to 40 min) as well as rainfall intensities (30, 60, 90 and 120 mm h^{-1}) conditions, and topography is presented by different slopes (5, 10, 15, 20 and 25°). The results indicate that the concentration of total phosphorus is stable in different rainfall intensities levels. Meanwhile, the total phosphorus loss is relatively steady at the rainfall intensities of 30 and 60 mm h^{-1} whereas it is fluctuant at those of 90 and 120 mm h^{-1}. For precipitation, the result shows there are positive linear relationships between total phosphorus loads and precipitations at different rainfall intensities with the correlation coefficients of 0.9446 to 0.9721. As for rainfall duration, concentrations of total phosphorus show fluctuation varieties in the processes of rainfall. As far as slope is concerned, the total phosphorus loss increases with the slope increasing from 5 to 15°, and decreases with an increase from 15 to 25°. This research will provide theoretical support for decision-makers on the watershed management and a reference for relative researchers.

Keywords

phosphorus loss; simulated rainfall; precipitation; topography

Effects of land use changes around a reservoir on sediment transport yields: HPP Itumbiara, Brazil

Marta Luz*[1], Lindsay Beevers, Alan Cuthbertson, Gabriela Medero, Diego Tarley, Viviane Souza

1. Email: martapluz@gmail.com (corresponding author)

Abstract

Soil erosion and deposition mechanisms, and associated mitigation measures, play an indispensable role in assessing the sustainability of both the existing reservoirs and newly planned projects. Land use is rated as one of the most important factors influencing water quantity and quality, as well as sediment transport yields, outflowing from surrounding watersheds into reservoirs. Therefore, appropriate land use management strategies are needed to ensure direct influenced by the reservoir of a hydroelectric power plant can provide the lessening of the capacity of power generation due to loss of useful volume. In Brazil because of the large dimensions of the reservoirs of hydroelectric plants, low-cost alternatives should be prioritized. Therefore this paper analyses the case of Itumbiara Hydropower Plant - Brazil, the sixth largest Brazilian hydropower plant. Four different scenarios were proposed: buffer with 20 m, 40 m, 100 m and 200 m of Indian grass at the edge of a stretch of the watershed area contained in the area of direct influence by the reservoir. SWAT software was used to perform the modelling of scenarios, with support from other softwares. As a result it may notice that occurs reduction of sediments transported to the reservoir, between 0.2% and 1.0 % per year and this value along the HPP Itumbiara life may be relevant.

Keywords

Erosion. Sediments. Reservoir. SWAT.

The simulation of watershed-scale effectiveness of agricultural best management practices in a drinking water resource area of Beijing, China

Jiali Qiu[1], Zhenyao Shen[*2]

1. Ph.D student, Beijing Normal University.
2. Professor, Beijing Normal University. Email: zyshen@bnu.edu.cn (corresponding author)

Abstract

Non-point source (NPS) pollutants, particularly from agricultural activities, which include nitrogen and phosphorus that have been released into aquatic environments. In this study, the Soil and Water Assessment Tool (SWAT) model was used to assess the NPS pollution loads applying multi-subarea simulation method and to assess the effectiveness of best management practices (BMPs) in the Miyun Reservoir Watershed in Beijing, China. Then the spatial distributions of soil types, land uses, precipitation, evaporation and agricultural activities were analyzed to explain the pollution situation in this watershed from 1990 to 2010. The observed and simulated data for runoff and pollutant loads were in good agreement, indicating that the SWAT model has good applicability in this area. The simulation results demonstrated that the NPS pollution exhibited apparent tempo-spatial heterogeneity. The runoff from agricultural land had a seriously high nutrient content. The variation rule of monthly pollution loads indicated a minimum level in the dry season, little increase in the normal-flow period and a sharp increase in the wet period. The serious pollution problem in this watershed along the river indicated that conservation practices and nutrient management should be implemented to control pollution. The results of conservation practice modeling showed us that the contaminant removal efficiency of structural BMPs such as filter strip, grassed waterways, constructed wetland and detention pond was better than that of non-structural BMPs such as converting cropland to for forest, soil testing and fertilizer recommendation, conservation tillage, contouring, strip cropping and so on. The efficiency of each BMP varied in the different sub-basins of the watershed. These results would provide useful information for targeted water quality management.

Keywords

Nonpoint source pollution; Soil and Water Assessment Tool; Spatial distribution; Temporal distribution; Miyun Reservoir Watershed; Best management practices

Nitrate leaching characteristics in typical high-yielding production area under different irrigation and fertilization management practices in the North China Plain

Shufeng Chen[1], Chengchun Sun[2], Wenliang Wu*[3]

1. Assistant Researcher.
2. Assistant Researcher.
3. Professor. Email: 13811782920@163.com (corresponding author)

Abstract

Nitrate contamination is a common problem in groundwater of the North China Plain (NCP) owing to irrigation and overuse of fertilizers. Improved water and nitrogen management practices are considered as best management practices (BMPs) to decrease nitrate leaching into groundwater. To evaluate the pollutant reduction effects of different fertilization and irrigation managements on nitrate leaching in the typical wheat-maize rotation system in the North China Plain (NCP), field experiments were carried out in Huantai County from 2006 to 2008. Four treatments were designed, including: 1) traditional Nitrogen (N) fertilization and irrigation treatment (N_1I_1); 2) traditional N fertilization and optimized irrigation (based on real-time soil moisture monitor) treatment (N_1I_2); 3) optimized N fertilization (based on soil testing) and traditional irrigation treatment (N_2I_1) and 4) optimized N fertilizer and optimized irrigation (N_2I_2). Water and nitrate flux throughout the soil profile at depth 2.0 m were analyzed. Field results showed that the amounts of N input play a great role in affecting nitrate concentrations in the soil solutions. For less N fertilizer rate, N fertilization based on soil testing could effectively decrease N leaching amounts and prevent groundwater contamination. But timely N supplement might be need in applying this treatment. Less water inputs of the optimized irrigation treatment can increase nitrate concentrations in the soil solutions but it can also reduce N leaching amounts, especially in the winter wheat season. The optimized irrigation treatment should be the best management practices and should be considered first in groundwater pollution reduction modeling.

Keywords

Nitrate leaching; Best management practices; Optimized N fertilization; Optimized irrigation

Comparison of water leakage and nitrate leaching under three land use types in the North China Plain

Shufeng Chen[1], Chengchun Sun[*2], Wenliang Wu[3]

1. Assistant Researcher.
2. Assistant Researcher. Email: shandong.baozi@163.com (corresponding author)
3. Professor.

Abstract

Nitrate losses from agricultural activities mainly fertilizer applications, would substantially enrich the groundwater in nitrates. Land use affects groundwater resources through changes in recharge and by changing demands for water, and further affects groundwater quality. Water leakage and nitrate leaching losses to groundwater from three land use types were quantified and compared during a 1-year study. Results showed that the total water leakage amount in the vegetable system (315.07mm) was much higher than that in the wheat-maize rotation system (93.54mm). Reversely, an upward moving trend of water in the soil was observed in the woodland for less water input, indicating shallow groundwater consumed by crop evaporation. N leaching processes were similar to those of water drainage. The vegetable cropping system had the highest nitrate loss, and the value was up to 204.51 kgN·ha^{-1} (leaching rate=12.04%), as much as 4.3 times of that (leaching rate=7.52%) of the wheat-maize cropping system. At the end of this experiment, the amount of soil nitrate contents generally kept stable in the three systems. The traditional vegetable land use might aggravate groundwater nitrate contamination. So would the wheat-maize system. But if woodland was the cropping system, the groundwater would face less risk. Assessing the relative impact of land use change on water and nitrate leaching to groundwater through our experiments would be a validation or a candidate for application of the modeling method, which is relatively complicated in deriving parameters and data collection.

Keywords

land use change; water leakage; nitrate leaching; irrigation, N fertilization,, North China Plain

Watershed-scale modeling of the Fate and Transport of Polycyclic Aromatic Hydrocarbons (PAHs)

Sangsoo Baek[1], Mayzonee Ligaray[2], Hye-Ok Kwon[3], Sung-Deuk Choi[4], Kyung Hwa Cho[*5]

1. Ulsan National Institute of Science and Technology.
2. Ulsan National Institute of Science and Technology.
3. Ulsan National Institute of Science and Technology.
4. Ulsan National Institute of Science and Technology.
5. Ulsan National Institute of Science and Technology. Email: khcho@unist.ac.kr (corresponding author)

Abstract

PAHs are potentially carcinogenic substances that are persistent in the environment. Increasing concentrations of PAHs were observed due to rapid urbanization, thus; monitoring PAHs concentrations is necessary. However, it is expensive to conduct intensive monitoring activities of a large number of PAHs. This study addressed this issue by developing a multimedia model coupled with a hydrological model (i.e., Soil and Water Assessment Tool (SWAT)) for Taehwa River (TR) watershed in Ulsan, the industrial capital of South Korea. The hydrologic module of the SWAT was calibrated, and further used to simulate the fate and transport of PAHs in soil and waterbody. The model demonstrated that the temporal or seasonal variation of PAHs in soil and waterbody can be well reproduced. Meanwhile, the spatial distribution of PAHs showed that urban areas in TR watershed have the highest PAH loadings compared to rural areas. Sensitivity analyses of the PAH soil and PAH water parameters were also able to determine the critical processes in TR watershed: degradation, deposition, volatilization, and washoff mechanism. We hope that this model will be able to aid the stakeholders in: regulating PAH concentrations emitted by various sources; and also apply the model to other Persistent Organic Pollutants (POPs).

Keywords

PAHs, Soil and Water Assessment Tool, Multimedia model, Watershed-scaling model.

Review on Modeling Fate and Transport of Fecally-derived Microorganisms at the Watershed Scale.

Kyunghwa Cho[1], Yakov Pachepsky*[2], David Oliver, Richard Muirhead, Yongeun Park, Richard Quilliam, Daniel Shelton

1. Ulsan National Institute of Science and Technology.
2. USDA-ARS. Email: Yakov.Pachepsky@ars.usda.gov (corresponding author)

Abstract

Natural waters provide habitats for various groups of fecal indicator organism (FIO). A number of watershed modeling have been published in an attempt to have a better understanding to the fate and transport of FIOs in watersheds, as well as to determine whether microbial water quality standards can be satisfied under meteorological and/or management conditions. Overall, modeling FIO fate and transport in watersheds made a substantial progress during last 10 years. Here, we intensively review FIO modules for soil (survival, adsorption, and runoff), waterbody (survival), sediment (survival and resuspension), and groundwater contribution in watershed-scale modeling, then consider the process-modeling systems that had currently been made, and finally propose an outlook of research needs and application feasibility for modeling microbial quality of surface waters. We hope that this review could provide future direction to improve the FIO models in surface water and assist policy-makers in developing appropriate risk management strategies.

A Heavy Metal Module Coupled in SWAT Model and Its Application in the Upstream Basin of the Liuyang River in China

Lingfeng Zhou[1], Yaobin Meng[*2], Chao Lu[3], wan Ye[4], Ganlin Wu[5]

1. postgraduate, Academy of Disaster Reduction and Emergency Management, Beijing Normal University, Beijing 100875, China..
2. associate professor, Academy of Disaster Reduction and Emergency Management, Beijing Normal University, Beijing 100875, China.. Email: yaobin-meng@bnu.edu.cn (corresponding author)
3. Ph.D Candidate, Academy of Disaster Reduction and Emergency Management, Beijing Normal University, Beijing 100875, China..
4. postgraduate, Academy of Disaster Reduction and Emergency Management, Beijing Normal University, Beijing 100875, China..
5. postgraduate, Academy of Disaster Reduction and Emergency Management, Beijing Normal University, Beijing 100875, China..

Abstract

Severe heavy metal pollution in soil and water requires the modeling of the migration and transformation of heavy metals at the watershed scale for a better understanding of their potential impact on the ecosystem and humans. Generally, heavy metals are transported in the watershed vertically through percolation and evaporation-induced rise as well as horizontally through soil erosion and surface/subsurface runoff. Meanwhile, a heavy metal usually has four chemical species: the labile and the non-labile in the solid phase, and the free ion and the complex with the ligands in the aqueous phase. Based on the knowledge of speciation and transformation of heavy metals in soil, a heavy metal module was developed which assumes that the reactions in soil among labile species and aqueous metal species of a heavy metal are faster than hydrological processes. This quick equilibrium assumption decouples the chemical reaction process from the physical movement process and simplifies the modeling of heavy metals. The heavy metal module was combined with the well-established SWAT (Soil and Water Assessment Tool) model to model the transport and transformation of heavy metals in a watershed. As a demonstration, the heavy metal module was used to simulate zinc (Zn) and cadmium (Cd) dynamics in the upstream watershed of the Liuyang River, which has been impacted by mining activities with considerably high Zn and Cd concentration in soil. The modeled evolution of the two metals in the watershed was found to align with the monitored results reasonably. In particular, the dramatic rise of the metals' aqueous concentrations with precipitation events was well represented, demonstrating that Zn and Cd in the waste and soil were washed into the channel through rainfall. This initiative effort of developing a heavy metal module combined with SWAT has a strong potential to be applied in environmental risk analysis and pollution control.

Keywords

Heavy metal, Mining, Modeling, Risk, China

Development of Bacteria Transport Model for SWAT for Predicting In-stream Bacteria Concentrations

Pramod Pandey*[1], Michelle Soupir[2], Chris Rehmann[3]

1. Assistant Specialist, Department of Population Health and Reproduction, School of Veterinary Medicine, University of Californai Davis. Email: pkpandey@ucdavis.edu (corresponding author)
2. Associate Professor, Department of Agricultural and Biosystems Engineering, Iowa State University, Ames, Iowa.
3. Professor, Department of Civil, Construction, and Environmental Engineering, Iowa State University, Ames.

Abstract

Elevated pathogen/pathogen indicator concentration in rivers is a serious public health issue, and controlling it requires improving our existing understanding of bacteria transport at watershed scale. To improve in-stream bacteria predictions, a sub-model, which involves resuspension, deposition, and growth/decay of bacteria, was developed for the Soil and Water Assessment Tool (SWAT). The model uses bottom shear stress based resuspension, and Stokes's law based new formulations for predicting in-stream bacteria resuspension and deposition, respectively. Integrating these new models provides capability to predict bacteria concentrations in water column as well as in stream bed sediment using SWAT. The model was programmed in FORTRAN, and integrated with SWAT 2009 model. To validate the model predictions, an extensive *E. coli* monitoring (in water and sediment) was executed in an agricultural watershed in Iowa, and the observations were compared with the SWAT predictions. Predictions were well matched with the observations of *E. coli* in water and sediment of the stream. Results showed that the proposed model will help improving bacteria predictions using SWAT, and hence developing Total Maximum Daily Loads (TMDLs).

Keywords

bacteria transport, model, stream, public health, SWAT, sediment

Quantifying Surface Water and Groundwater Resources in the Middle Bosque, Texas Watershed using the Coupled SWAT-MODFLOW Model

Seonggyu Park*[1], Ryan Bailey[2], Katrin Bieger[3]

1. Ph. D. Candidate, Dept. Civil-Env. Eng., Colorado State University, Fort Collins, CO, United States. Email: envpsg@colostate.edu (corresponding author)
2. Assistant Professor, Dept. Civil-Env. Eng., Colorado State University, Fort Collins, CO, United States.
3. Assistant Research Scientist, Blackland Research & Extension Center, Texas A&M AgriLife, Temple, TX, United States.

Abstract

Combined use of groundwater resources and surface water resources is essential to provide reliable water supply in the coming decades. In addition, water quality (for example, nutrient concentrations in groundwater and surface water) also is of great importance in determining the quantity of water available for consumption. In a watershed setting, the hydrologic processes and management strategies that affect total water quantity and water quality both can be assessed through the use of models, with an accurate quantification of hydrologic and of solute transport processes between the surface and groundwater domains essential for integrated water management and adaptation. This presentation provides the methodology whereby available surface water and groundwater resources can be quantified in semi-arid regions using the recently developed SWAT-MODFLOW modeling code. A SWAT-MODFLOW model is built for the Middle Bosque watershed (area of 471 km^2) in the Texas-Gulf region of central Texas. The climate is semi-arid, with hot summers and mild winters (mean annual precipitation = 750 mm). The MODFLOW model is based on the hydrogeology of the region, and incorporates multiple geologic layers, groundwater/surface water interaction, and groundwater pumping. A stand-alone SWAT model also has been constructed for the watershed. The MODFLOW model currently is being coupled with the SWAT model, and then the coupled model will be calibrated and tested against available groundwater monitoring data and streamflow at the watershed outlet. The coupled model will be used to quantify surface water and groundwater resources under the combined impacts of projected climate conditions, land use changes, and groundwater development scenarios.

Keywords

Hydrologic processes, solute transport processes, SWAT, MODFLOW, SWAT-MODFLOW

Application of satellite based precipitation for discharge measurement of middle Indus River, Pakistan using SWAT model

Syed Zubair*[1], Muhammad Majid[2]

1. Institute of Geographical Information Systems, School of Civil and Environmental Engineering, National University of Sciences and Technology, Islamabad, Pakistan. Email: hsmzubair@gmail.com (corresponding author)
2. Institute of Geographical Information Systems, School of Civil and Environmental Engineering, National University of Sciences and Technology, Islamabad, Pakistan.

Abstract

The impacts of floods and droughts are intensified by climate change, lack of preparedness and coordination. The average rainfall in study area is ranging from 200 mm to 400 mm per year. Rain gauge generally provides very accurate measurement of point rain rates and the amounts of rainfall but due to scarcity of the gauge locations provides very general information of the area on regional scale. Recognizing these practical limitations, it is essential to use remote sensing techniques for measuring the quantity of rainfall in the Middle Indus. This research uses satellite remote sensing of Tropical Rainfall Measuring Mission 3B42V7 estimates in terms of rainfall occurrence, quantity and its spatial distribution for Middle Indus river Basin. In order to use TRMM satellite data for discharge measurement, its accuracy is determined by statistically comparing it with in-situ gauged data on daily and monthly basis. The daily R^2 value (0.42) is significantly lower than monthly R^2 value (0.82), probably due to the time of summation of TRMM 3-hourly precipitation data into daily estimates. Daily TRMM data from 2003 to 2012 was used as input forcing in Soil and Water Assessment Tool (SWAT) hydrological model along with other input parameters. The calibration and validation results of SWAT model give R^2=0.72 and 0.73, NSCE= 0.69 and 0.65 respectively. Daily and monthly comparison graphs are generated on the basis of model discharge output and observed data. The results of this research can be used by various stake holders, such as Pakistan Meteorological Department, Federal Flood Commission and other planning and development authorities to investigate, plane, and analyze of climate change, floods, droughts and weather conditions.

Keywords

TRMM 3B42V7, Middle Indus Basin, NSCE, SWAT model, Calibration, Validation.

Black Soil Loss Simulation and Prediction Using the Soil and Water Assessment Tool in the Middle Reaches of Ashihe

Yu Zhao*[1], Li Wang

1. Email: yuzhao@neau.edu.cn (corresponding author)

Abstract

The problem of black soil degradation is serious in the northeast of China. The aim of the present work is to evaluate the black soil loss due to water erosion in the 228,030 ha area of Ashihe river. The 20 years data, including daily climate data, detailed soil and land use map, are used as the soil and water assessment tool input data to analyze the black soil loss quantitatively in the specific area. The Model is calibrated using runoff for the year 1996-2005. According to the modeling and simulation, the hierarchy of black soil erosion is established, and soil loss key path is obtained. The black soil loss rate and spatial distribution of soil erosion are analyzed through land use change and climate factors. Using soil loss path and sensitive parameters adjusting, a management scheme is put forward to protect black soil and to evaluate the benefit of management measures.

Keywords

black soil loss, SWAT, runoff

Modeling the Impacts of Climate Change on Streamflow Using the Soil and Water Assessment Tool (SWAT)

Ömer Güngör*[1], Kadir Özdemir[2]

1. Research Assistant, Department of Environmental Engineering, Bülent Ecevit University. Email: omergungor@outlook.com (corresponding author)
2. Assistant Professor, Department of Environmental Engineering, Bülent Ecevit University.

Abstract

In recent years, integrated watershed management studies have gained importance in Turkey. In the adaptation of European Union full membership process of Turkey, integrated watershed management plans need to be established. In this regard, there are many hydrological watershed models available that are able to determine the water quantity and quality in these studies. The Soil and Water Assessment Tool (SWAT) is one of the most widely used watershed scale models that incorporate both quantity and quality of water. The aim of the study is to evaluate the impacts on hydrology under future climate change scenarios. Mengen Creek watershed with a drainage area of 764 km^2 has been chosen as the study area. Forest is the primary land use and accounts for 61 % of the available area. Climate change has also been an issue recently in the study area and it will be more under the anticipated climate change influences in future.

The model is calibrated for a period from 1994-2000 with Nash Sutcliffe model efficiency (NSE) and coefficient of determination (R^2) values as 0.81 and 0.66 respectively for monthly streamflow simulations. Future climate data from 2046-2064 and 2081-2100 were obtained from the downscaled global climate model simulations (CMIP3). Coupled Global Climate Model (CGCM3) is used as a scenario SRES A1B which is more representative of the study area. The results showed a decrease of 25% for 2046-2064 and 27% for 2081-2100. Thus, the hydrological behaviors of the watershed may be affected negatively, especially during drought periods.

Keywords

SWAT model, climate change, streamflow, CGCM3

Assessment of Ecosystem services under present and future Climate scenarios for Godavari basin

Amarnath C R[*1], Shashidhar Thatikonda[2], Raghavan Srinivasan[3]

1. Research scholar, Indian Institute of Technology Hyderabad(IITH). Email: amar@iith.ac.in (corresponding author)
2. Associate Professor, Department of Civil Engineering, Indian Institute of Technology Hyderabad..
3. Professor,Texas A&M University and Texas AgriLife Research.

Abstract

Evaluating the ecological impacts of climate change on water resources is an integral part of hydrological and ecological investigations, land and resource management in the twenty-first century. Global climate models (GCMs)/regional climate models (RCM's) downscaled data is used as input to hydrologic model to simulate the corresponding future flow regime in the catchment. High resolution climate projections were obtained using Statistical downscaling technique. In particular weather generation has been carried out by using hybrid downscaling technique**.** In addition to assessing the downscaled parameters, study also focussed on possible impact of climate change on river flow and with/without reservoirs, effects of alternative best management practices (BMPs) and water quality of river Godavari. SWAT and INVEST models were used as tools to quantify Ecosystem services and identify their providing units in the landscape. This study can provide information about how changes in ecosystems are likely to lead to changes in the flows of benefits to people and also discusses integral perspective linking ecosystem services with human welfare based on spatial and temporal scale. It can be a basis for future applications in the area, regarding social or economic valuations, in order to support environmental assessment and decision making processes.

Keywords

Ecosystem services, INVEST, SWAT, Godavari basin, Statistical Downscaling.

Assessment of climate change impacts on hydrology and nitrogen flux in the Miyun Reservoir Catchment

Tiezhu Yan[1], Zhenyao Shen[*2]

1. Beijing Normal Unversity.
2. Beijing Normal Unversity. Email: zyshen@bnu.edu.cn (corresponding author)

Abstract

Abstract: Alterations in climate variability and change will lead to changes in hydrological cycle, thus influencing the fate and transport of nitrogen pollutant. This impact assessment study evaluated the long-term changes in annual water yield and nitrogen loading in the Miyun Reservior Catchment, which is the important source of drinking water for the Beijing City, China. The Soil and Water Assessment Tool (SWAT) was calibrated and validated during the baseline period (1999-2005) and future climate scenarios (2021-2050) were generated using two general climate models (CanESM and GFDL-ESM2M) from the fifth Coupled Model Intercomparison Project Phase 5 (CMIP5) under two emission scenarios (RCP 4.5 and RCP 8.5). Results showed that predicted precipitation change ranged from 2 to 8% while the mean temperature increased 1.1~2.5℃. The SWAT-predicted streamflow increased from 5 to 10 % on an average annual basis at the watershed outlet with significant monthly variation. The nitrogen loading pattern was found to vary widely from a increases of 0.1 kg/ha to 0.7 kg/ha at the sub-basin level, with an average increase of 0.45 kg/ha over the entire basin. The results of this analysis provide a scientific basis for effective support of decision makers and strategies of adaptation to climate change.

Keywords

Climate change, Nitrogen Loading, Miyun Reservoir Catchment, SWAT, CMIP5

Evaluation of the Effects of Agricultural Conservation Practice Scenarios on Water Quality in the Pacific North West Basin

Santhi Chinnasamy*[1], CEAP Team[2]

1. Reseearch Scientist. Email: csanthi@brc.tamus.edu (corresponding author)
2. Modelers.

Abstract

A modeling study was undertaken recently to determine the effects of agricultural conservation practice efforts on water quality in the Pacific Northwest Basin (PNWB). The field-scale model, Agricultural Policy Environmental Extender (APEX) was used to simulate the conservation practices on cropland and Conservation Reserve Program (CRP) land and assess the edge of field water quality benefits. The watershed scale model, Soil and Water Assessment Tool (SWAT) was used to simulate other land uses, watershed processes, and estimate the instream water quality benefits. After calibration for streamflow, sediment and nutrient loads at six main gauges, models were used to estimate the effects of current conservation conditions and future conservation practice strategies on edge of field and instream water quality in the PNWB. Model predictions indicated that 14.4 million tonnes of sediment, 185,900 metric tonnes of nitrogen, and 28,100 metric tonnes of phosphorus loads were discharged to the Pacific Northwest Coast from their draining watersheds. Model predictions indicated that currently established conservation practices on cropland reduced the sediment, nitrogen and phosphorus losses from edge of field within each 8-digit watersheds by 56%, 56%, and 52%, respectively. These practices in turn reduced the instream sediment, nitrogen and phosphorus loads entering the Pacific Ocean from PNWB by 6%, 17%, and 9%, respectively. Additional conservation treatment efforts can help to further reduce the loads within the PNWB and to the Pacific Ocean.

Keywords

SWAT, APEX, Conservation Practices, Pacific Northwest, Sediment, Nitrogen, Phosphorus

Estimation of flow for ungauged watersheds in Pranhita of Godavari river basin in India using SWAT

Shuvra Sangeeta*[1], Debajit Basu Ray

1. Email: shuvra.san@gmail.com (corresponding author)

Abstract

The long term records of hydrological observation, being a prerequisite to the design of any water resource project are mostly found to be inadequate or non-available. The current paper is an attempt to apply the physically based, spatially distributed SWAT (Soil Water Assessment Tool) model for estimating hydrologic budget for remote locations from an ungauged perspective and prediction of response with an acceptable uncertainty measure. The proposed model framework combines spatial and temporal input data of terrain, landuse, soil and weather. The present approach demonstrates that the comprehensiveness in the model's interrelationship after calibration at gauged locations incorporating the spatio-temporal heterogeneity of climate and landscape properties in a basin, can successfully be used to predict flow at watershed scale ungauged locations.

The Pranhita sub-basin is located in the central part of India, covering the states of Andhra Pradesh and Maharashtra. The catchment belongs to Godavari basin, comprising of rivers Wainganga, Penganga and Wardha draining an area of 1,09,079 km^2. The SWAT model has been developed for the Pranhita sub-basin. The model is tested for streamflow, calibrated at sub-basin level viz. Wardha, Penganga and Pranhita at gauging stations Ghugus, P G Bridge and Tekra respectively. The task of calibration is faced with the challenge of incorporating existing utilization as the basins are highly regulated from major and medium irrigation projects in the catchment. The problem is further compounded due to the impact of human induced changes to the land surface and climate, occurring at the local and regional scale during various phase of simulation period considered.

The calibrated SWAT model is tested for validation. The spatial heterogeneity in the parameter settings for ungauged watersheds are tested at 16 CWC monitoring gauge locations within the sub-basin for ungauged sites. The results indicate that SWAT can capture the amount and variability of streamflow acceptably well both at annual and monthly time scale. R^2 values range between 0.72 and 0.99 and NSE between 0.94 and 0.58 at annual level. Similarly, at monthly time scale, R^2 values range between 0.77 and 0.94 and NSE between 0.93 and 0.54. The low statistics of some stations revealed incomplete information about the utilization details from reservoirs and dams within the watershed. An analysis of wetter than normal years and drier than normal years show that the model gives better results in wetter years than drier years. For example, the monthly NSE's for yield are 0.94 for the three wet years and 0.58 for the four drier years.

Overall, the SWAT model can satisfactorily predict hydrologic budget for the ungauged basins in Pranhita with calibration at basin scale. The results further emphasize the importance and prospects of using accurate and better resolution spatio-temporal input for ungauged flow assessment. Given further information about the watershed's physiographic characteristics, it is expected that there is scope for reducing predictive uncertainty, especially on a monthly temporal scale.

Keywords

Hydrological Budget, sub-basin, ungauged, Godavari, assessment, watershed, simulation, prediction, uncertainty

Hydrological and water quality modeling for the Missouri River basin

Zhonglong Zhang*[1], May Wu[2]

1. Senior Scientist. Email: zhonglong.zhang (corresponding author)
2. Principal Environmental System Analyst .

Abstract

Soil and Water Assessment Tool (SWAT) is designed to simulate runoff, erosion, sediment and nutrient yields from large watersheds and the impact of land management practices on water quality. Importantly, most of the non-point source water quality problems are related to hydrology and land use changes in the watershed. The SWAT model has been adopted by many agencies and organizations to address complex point and non-point source pollution, and environmental sustainable problems. It is the goal of this study to apply the SWAT model to the Missouri River basin and make it an effective tool for evaluating the watershed management practices and their load reduction for impaired water bodies. The SWAT models was applied and calibrated with 20 years of measured stream flow data collected from 20 U.S. Geological Survey stream flow gage stations in the basin. SWAT model performance ranges from satisfactory to very good for the simulation period. The SWAT model results provide spatial and temporal distribution of sediment, nitrogen and phosphorus loads in the basin. Baseline model results showed that the largest total nitrogen and total phosphorus loads come from the subbasins in the Lower Missouri River watershed because of heavily cultivated crop lands. The smallest loads were from the Upper Missouri and Yellowstone River regional watersheds, where inputs from all sources are modest and attributable to the large pasture and range land in this area. The total load delivered to the Mississippi River from the MORB included approximately 6.1 x 107 tons/yr of total suspended sediment, 4.5 x 108 kg/yr of total nitrogen, and 1.0 x 108 kg/yr of total phosphorus. Of these loads, Lower Missouri River regional watershed contributes 30% of the nitrogen, respectively, and 40% of the phosphorus; however, the nitrogen and phosphorus contributions by the Upper Missouri and Yellowstone River regional watersheds were less than 1%. This study further investigated the relationship between land use change and non-point source loads in the basin. Non-point source load reduction was compared at three scales: subbasin (8-digit hydrologic unit), regional watershed, and the whole basin. This scenario analysis will be useful to quantify changes in average sediment and nutrient loads in response to increased biofuel feedstock production in this region.

Keywords

Missouri River, SWAT, non-point source, water quality, land use change, biofuel production

Effect of slope gradients on nonpoint source pollutant under rainfall-runoff process

Xueting Xu, Wei Ouyang*[1], Fanghua Hao, Xiang Gao

1. Email: wei@bnu.edu.cn (corresponding author)

Abstract

In this paper, Dongjiang was taken River Basin as the study area. The study area was divided into high, medium and low three groups according to the slope classification criteria, which was chosen by Digital Elevation Model (DEM). The results of NPS pollutant loss have been simulated by the hydrological model: Soil and Water Assessment Tool (SWAT), which considering the rainfall-runoff processes under the different slope conditions. The research analyzed the relationship between nutrient loss and slope level with rainfall-runoff process. The results were as follow: 1) The generation of runoff was related to the slope, but it was mainly decided by rainfall; 2) Comparing with the different land use types, the agricultural land, which was the paddy land in the study watershed, was the one that most of NPS loss happened. The years of average TN and TP loss in the farmland reached to 29.9kg_ha and 6.5kg_ha, respectively; 3) With slope increased, soil erosion would aggravate, therefore the erosion-induced NPS increased. According the soil erosion amount, the main erosion slope ranged from 5° to 25°; 4) In the study area, near 20° existed a critical slope. The tendency of NPS pollution was initial ascent and then descent. Thus, this research can provide the useful information for controlling the nonpoint source pollution and conserving the water quality of water source for Dongjiang River Basin.

Keywords

SWAT; nonpoint source pollutant; slope gradient; rainfall-runoff process; soil erosion

Simulation of Vegetation in FAO Ecoflorist Zones

Charles Allan Jones*[1]

1. Senior Research Scientist, Texas A&M University. Email: cajones@tamu.edu (corresponding author)

Abstract

We are developing SWAT plant growth parameters for the 20 global ecofloristic zones described by the United Nations Food and Agriculture Organization. This vegetation classification system represents expert opinion of the characteristcs and locations of 20 selected vegetation types (ecofloristic zones) that would be expected to occur in the absence of human disturbance. The FAO system provides maps, statistical data, and narrative descriptions of the climate, physiography, and "natural" vegetation in each of seven geographic regions of the world. Each of the ecozones of each geographic region is characterized by its temperature regime (tropical, subtropical, temperate, boreal, and polar) and vegetation type (humid forest, dry forest, moist deciduous forest, shrubland, steppe, desert, etc.). By proposing specific SWAT vegetation growth parameters for these ecozones, we hope to help the SWAT user community to simulate the growth and hydrology of "natural" and "near natural" vegetation more effectively.

Keywords

plant growth parameters, ecofloristic zones

Evaluation of watershed responses to multiple natural disturbance and anthropogenic activities in the Chenyulan Watershed, Taiwan

Li-Chi Chiang*[1], Chih-Mei Lu[2], Pin-Chih Shih[3]

1. Assistant Professor, Department of Civil and Disaster Prevention Engineering, National United University, Miaoli, Taiwan. Email: lchiang@nuu.edu.tw (corresponding author)
2. Graduate Student, Department of Civil and Disaster Prevention Engineering, National United University, Miaoli, Taiwan.
3. Graduate Student, Department of Civil and Disaster Prevention Engineering, National United University, Miaoli, Taiwan.

Abstract

Land use and climate change are both important drivers for ecosystem degradation. Human-driven land use changes, such as deforestation and urbanization, reduce ecosystem resilience to disasters. The impacts of climate change include global warming and the increasing frequency of extreme weather events such as storms, flood, and drought. In this study, we aimed to evaluate the combined impacts of land use and climate change on the Chenyulan watershed, Taiwan, which has been suffering typhoons during summer and especially one big earthquake in 1999. The impact of cumulative natural disturbances on watershed was quantified by using a hydrological model, SWAT (Soil and Water Assessment Tool) with the land use (1996-2005) update module. The SWAT model performed well for monthly flow simulation with R^2 (0.66~0.86), NSE (0.65~0.85), PBIAS (-10.7%~5.6%) at 3 gages for calibration period (1992-1995), and with R^2 (0.59), NSE (0.3), PBIAS (-14%) at 1 gage for validation period (1997-2001). Without the land use change model activated, several hydrological parameters (CN, GWQMN, GW_REVAP, ESCO, and SURLAG) could be overfitting. It was found that historical natural disturbances had greater impact on hydrological regime and components, and sediment yields than disaster-induced land cover change and anthropogenic activities did. In near future (2020-2039), the ecosystem function could be degraded more severely. Based on our results, we further developed an integrated plan including ecosystem service management, land use management, and climate change adaptation to increase the resilience of the ecosystem in the Chenyulan watershed.

Keywords

SWAT, natural disturbance, land use update, climate change, land use change

A Composite Method to Generate Meteorological Field Scenarios for SWAT as an Environmental Risk Simulation Tool

Yaobin Meng*[1], Lingfeng Zhou[2], Chao Lu[3]

1. Associate Professor, Beijing Normal University. Email: yaobin-meng@bnu.edu.cn (corresponding author)
2. Ph.D. Candidate.
3. Ph.D. Candidate.

Abstract

The widely appreciated capability of SWAT modeling system, a distributed hydrological model, to model the transport of a variety of materials, affords the potency for environmental risk analysis. In light of the fundamental logic that regional meteorological events drive land surface/subsurface hydrological processes, the capability of SWAT for environmental risk analysis is essentially a manifestation of the variability of meteorological events. Thus, how to prepare meteorological scenarios becomes the pivotal issue, that is, how could certain "highly risky" scenarios, "unprecedented" ones in particular, could be generated while these scenarios are still deemed reasonable rather than unfoundedly fantastic? This presentation puts forward a method which makes use of empirical mode decomposition (EMD), a recently well-recognized method to successfully capture the transient frequency of a sequence by decomposing it into a bundle of Intrinsic Mode Functions (IMF). The overall method includes the Empirical Orthogonal Function decomposition (EOF), EMD, Segmented System Modeling, and Simulation. This method is used to prepare several years-lasting meteorological fields scenarios, each characterized on a clearly recognizable physical basis, for SWAT simulation in Liuyanghe Upstream Basin of China. The simulation results will be reported by a second presentation on the conference. Generally, the method introduced here shows prosperous applicability in SWAT use in the field of environmental risk simulation.

Keywords

Meteorological Fields Scnarios, Environmental Risk, Empirical Mode Decomposition, Simulation

Watershed Scale Management of Onsite Wastewater Treatment Systems Using SWAT model

Sushama Pradhan*[1], Tewodros Assefa[2], Manoj Jha[3], Charles Humphrey[4]

1. Environmental Sr. Specialist. Email: sushama.pradhan@dhhs.nc.gov (corresponding author)
2. Graduate student .
3. Assistant Professor.
4. Assistant Professor.

Abstract

Population growth, development pressures and the high costs of public sewerage systems will result in ever-increasing utilization of on-site wastewater treatment systems (OWTS), commonly called septic systems, as part of the permanent wastewater infrastructure in not only rural communities but also suburban ones. According to the U.S. EPA, one out of every four homes in the U.S. relies on OWTS to treat and dispose of household wastewater. However, the potential environmental impact of OWTSs is relatively unknown, specifically at watershed scale. Soil and Water Assessment Tool (SWAT), a comprehensive watershed model capable of simulating OWTS biozone processes, was applied to the Lick Creek Watershed in North Carolina, U.S. to quantify OWTS-derived nutrient contribution to Falls Lake. In this watershed, about 85 percent of the housing units utilize OWTSs. A modeling setup was constructed using topography, land use, OWTS users, soil and climate datasets. Model calibration and validation was conducted using flow and nutrient field-based data and survey data on existing OWTSs. Cumulative nutrient contributions from OWTSs at current developments and various development densities were modeled using the SWAT model. Information collected during this project will assist local and state governments in decision-making processes regarding sewer extensions and requirements for more advanced (and potentially more costly) types of OWTSs that can substantially reduce nutrient loads. In addition the data may help answer questions and address concerns regarding needs for instituting on-site system management strategies in impacted affected watersheds and counties.

Keywords

Onsite systems, septic system, SWAT model, Biozone process, Nutrient loading, watershed, density

Applying the SWAT model to a Managed Irrigated Watershed in a Semi-Arid Region: Model Construction

Xiaolu Wei*[1], Ryan Bailey, Ali Tasdighi, Mazdak Arabi

1. Email: hhuwxl@gmail.com (corresponding author)

Abstract

Of the existing watershed models, the Soil Water and Assessment Tool (SWAT) is a well-established, distributed, eco-hydrologic model that is often used to assess changes in hydrological processes and nutrient transport under changing management, climate, and land use. An important use of SWAT could be investigating water flow and nutrient loading in semi-arid irrigated systems. However, an accurate application of SWAT to intensive, highly-managed irrigation systems often will require the following four modifications to either the modeling code or to pre-processing of input files: (1) designating each cultivated field as a hydrologic response unit (HRU), so that irrigation can be applied according to water rights; (2) relating the total applied irrigation water to the volume diverted from the river, also according to water rights; (3) accounting for seepage from earthen irrigation canals to the underlying aquifer; and (4) including nitrate concentration in irrigation water as a source of nitrogen to the soil profile. This study presents the methodology for including the first two items to a SWAT model application. The methodology is applied to a 950 km^2 watershed in the Lower Arkansas River Valley (southeastern Colorado), a semi-arid region that has been intensively irrigated for over 100 years and is threatened by shallow water tables due to over-irrigation, lack of artificial drainage, and seepage from earthen canals. Each field is designated as an HRU, with the management files for each HRU modified to include the patterns of irrigation that occur in the watershed, based on canal diversions from the river and associated water rights. The total number of HRUs is 5,330 with 5% land use threshold, with 4275 HRUs designated to represent individual cultivated fields. The model was calibrated and tested for 4 stream gages within the watershed during the 1999 to 2009 period using monthly stream discharge, with automated calibration performed using dynamically dimensioned search algorithms. After the model is tested, it will be suited for identifying best-management practices effects on streamflow and to address pressing needs for credible representation of nutrient processes in intensively irrigated systems under varying climatic conditions.

Keywords

SWAT; managed irrigated watershed; semi-arid region

Analysis of runoff variation of the Qujiang River basin based on SWAT model

Yongjian Qu[1], Hongtao Xie[2], Xiangrong Cheng*[3]

1. Henan Agricultural University&Research Institute of Subtropical Forestry,Chinese Academy of Forestry.
2. Research Institute of Subtropical Forestry,Chinese Academy of Forestry.
3. Research Institute of Subtropical Forestry,Chinese Academy of Forestry. Email: chxr@caf.ac.cn (corresponding author)

Abstract

The Qujiang River basin is a major tributary in the upper reaches of the Qiantang River, which is an important water source to Quzhou, Jinhua and Hangzhou cities. Evaluating the changes of water resources in the basin is important to water resources planning, ecological management and protection. Here, a distributed hydrological model in Qujiang River basin was set up on the basis of ArcSWAT model, the input files for SWAT including DEM, land use, soil and meteorological databases were created. The monthly runoff variation of the Qujiang River basin from 2005 to 2010 was simulated by this model, and the coefficient of determination (R^2) was 0.795, 0.892, 0.926, 0.891 and 0.982, respectively, between the simulated and measured values. This indicated that the SWAT model could be effectively used to evaluate runoff change in Qujiang River basin. From the analysis, it is concluded that the climate variation is the main cause of runoff change in the river basin. Additionally, the change of vegetation structure in the basin also played an important role to runoff. Therefore, improving forest management and optimizing vegetation structure would be beneficial to runoff regulation.

Keywords

SWAT model; runoff; hydrology; Qujiang basin

A modified SWAT model set-up for a complex tropical catchment, Western Zambia

Wilson Phiri [*1], Edwin Nyirenda, Markus Meindhardt, Kawawa Banda, Imasiku Nyambe

1. Email: wilsonphirik@yahoo.com (corresponding author)

Abstract

A modified SWAT is implemented to enhance the skill of the model to simulate streamflow in a complex tropical catchment characterised by wetlands, ponds, canals and braided channels. This landscape placement introduced uncertainties which affected model performance. Consequently, representation of two processes was deemed critical in addressing the problem: i) mimicking channel-wetland flow interaction, and ii) capturing leakages arising from braiding near the catchment outlet. The hydrologic equivalent wetland (HEW) concept is employed to account for the first process. Six parameters defining wetland fluxes in terms of area, volume, and tributary and main channel conveyance factors were calibrated for this purpose. For the second, a novel idea is developed by introducing a pseudo-reserviour in the sub-basin where braiding occurs. This structure is activated to account for water which leaks and bypasses the main outlet via secondary channels. The set-up is calibrated with measured discharge taken over a three-year hydrological cycle using an acoustic doppler current profiler (ADCP). Preliminary results indicate a marked performance improvement in retrieving stream hydrograph from initial auto-calibration attempts which failed to produce acceptable results. This study proves the importance of incorporating major processes into a hydrologic modeling scheme using innovative techniques to reduce uncertainties which are often lamped into parameter uncertainty or a calibration problem.

Keywords

Modified SWAT, pseudo reserviour, HEW, wetlands, braided channels, streamflow

The identification of critical source area of total nitrogen in Chao river basin with SWAT model

Shujiang Pang[1], Xiaoyan Wang*[2], Mingtao Li[3]

1. College of Resource Environment and Tourism, Capital Normal University, Beijing, China;.
2. College of Resource Environment and Tourism, Capital Normal University, Beijing, China;. Email: wangxy@cnu.edu.cn (corresponding author)
3. School of Urban Economics and Tourism Culture, Lanzhou City University, Lanzhou, China.

Abstract

The total nitrogen loss to receiving water bodies is the primary causes of surface water deterioration. The identification of critical source area(CSA) is extremely important and meaningful to prevention of total nitrogen loss in a specific watershed. In this study, the SWAT model was applied to quantify the spatial distributed of total nitrogen loading in the Chao river basin. The results revealed that the CSAs is mainly located in the upstream part of Chao river basin within the year of 1995, 2000, and 2005, respectively. The correlation of total nitrogen load and annual precipitation was slightly lower compared to the phosphorus load. For the CSAs of objective watershed, intensive agricultural activities and anthropogenic pollution were recognized as the principal reasons with the soil erosion and nutrient element loss. The conclusion mentioned in this paper suggests that the more relevant efforts of conservation practices implementation of upstream area should be paid more attention to for controlling the total nitrogen loss in Chao river watershed. Moreover, the optimization of landscape pattern might be the potential path to prevent the nitrogen loss into this drainage system.

Keywords

Total nitrogen; Critical source area, CSAs; SWAT model; Chao river basin

Terrestrial Carbon Cycle Modeling in SWAT

xuesong zhang*[1], Qichun Yang, Roberto Izaurralde, Jeffrey Arnold, Jimmy Williams, Raghavan Srinivasan

1. Email: xuesongzhang2004@gmail.com (corresponding author)

Abstract

The Soil and Water Assessment Tool (SWAT) model has been applied worldwide to support sustainable land and water management. However, the consequences of these practices for carbon cycling are not adequately represented within SWAT. Here, we introduce recent development of SWAT for depicting carbon cycling in both agricultural and forest ecosystems. Our approach incorporates the CENTURY carbon model into SWAT, which is referred to as SWAT-C hereafter, to describe dynamics of soil organic matter (SOM)-residue and simulate land-atmosphere carbon exchange. We test SWAT-C at sixteen eddy covariance (EC) flux tower sites (including six cropland and ten forest sites) for simulating Evapotranspiration, Net Ecosystem Exchange, and Biomass. Overall, SWAT-C demonstrates favorable performance for simulating land-atmosphere carbon exchange across the agricultural and forest sites with diverse soils, climate, and management practices. SWAT-C is expected to serve as a useful tool for including carbon fluxes into sustainable watershed management under a changing climate. We also note that extensive assessment of SWAT-C with field observations is required for further improving the model and understanding potential uncertainties of applying it across large regions with complex landscapes.

Keywords

Carbon, Climate Change, Biomass, Spatial and Temporal Variation, Watershed Modeling

Improving SWAT for simulating N2O emissions from three cropping systems

Qichun Yang*[1]

1. Email: qichun.yang@pnnl.gov (corresponding author)

Abstract

Nitrous oxide (N2O) plays a disproportionately important role in contributing to global warming due to its long lifetime and high global warming potential. Agricultural activities have resulted in significant emission of N2O. In this study, we develop a N2O emission module and incorporate it into the widely used Soil and Water Assessment Tool (SWAT) to enhance the model's capability in assessing environmental impacts of crop cultivation. We evaluate SWAT simulations of N2O emission over three Great Lakes Bioenergy Research Center (GLBRC) scale-up sites (M1, M3, and M4). Compared with observations, SWAT generally simulates well monthly N2O emission. Average N2O emission rate estimated by SWAT during 2009-2014 at the corn (M1) site is 23.41 ± 23.52 g N/ha/day (Mean ± Standard Deviation), which matches the observed average of 35.81±46.66 g N/ha/day closely. At the switchgrass site (M3), the model simulation of average N2O is 5.06 ± 2.64 g N/ha/day, which is comparable with the observation of 6.10 ± 7.52 g N/ha/day. The Modeled N2O emission rate of 1.99 ± 0.97 g N/ha/day is close to the observed average of 1.84 ± 1.46 g N/ha/day at the M4 site. The model successfully reconstructs differences in N2O emission over the three sites with divergent management practices. Though a local sensitivity analyses, we identify key parameters regulating N2O estimates in SWAT. Results of the sensitivity analysis are expected to provide valuable information for future application of the model. Sensitive responses of modeled N2O flux to changes in precipitation and temperature warrant further investigations of N2O emission under a changing climate. Significant impacts of fertilizer use on N2O emission highlight the importance of improving fertilizer application to minimize nitrogen loss through N2O emission.

An auto-calibration platform for the application of watershed models

Lei Chen, Guoyuan Wei[1], Hui Xie, Xiaoshu Hou, Zhenyao Shen[*2]

1. M.S. Beijing Normal University.
2. Email: zyshen@bnu.edu.cn (corresponding author)

Abstract

Model calibration is an important process for the usage of watershed models, but the calibration process is often time-consuming and the result is often not quite satisfying. In this study, a universal calibration platform, which is based on cloud computing technique, is designed. A specific multi-objective genetic algorithm is combined with other good-of-fit indicators as the framework of this platform, while many cloud technique is also used to make full use of multiple computers' and (or) servers' computing abilities. Specific links have been made to common-used watershed models, such as SWAT, SWMM, HSPF. The case studies indicates this platform can be used for model setup in both urban and agricultural areas. In this sense, this new calibration platform would provide powerful tools for the model sciences.

Keywords

auto-calibration, cloud computing, watershed model

Soil Profiling the Rietspruit Sub-Basin, (Vaal Basin) for SWAT Modelling: Application of the pedo transfer function

Bloodless Dzwairo[*1]

1. Dr; Durban University of Technology, Steve Beko Campus, PO Box 1334, 4000, SA. Email: ig445578@gmail.com (corresponding author)

Abstract

Hydrologically, Rietspruit sub-basin is located in the Vaal Basin, an environment that is inevitably highly threatened both in terms of water quantity and quality. Threats are a result of existing high water demanding and naturally polluting domestic, mining and agricultural activities. In order to model these processes, one of the modelling parameters using SWAT is an associated soil map that overlaps the target area.

For this study, soil parameters from the World Reference Base correlation for soil groups, the Food and Agriculture Organisation (FAO) and the South African Department of Agriculture, Forestry and Fisheries (DAF), were assessed against a soil attribute that was a result of translating parameters into SWAT inputs through a Pedo Transfer Function (PTF).

Because the ultimate goal of this on-going research is to model the Vaal Basin and provide future climate scenarios within an Africa interaction collaborative research group called ***Vaal and Nile Basins Collaborative Research for Environmental Modeling and Remote Sensing (VNREM).*** A very detailed understanding of the soil properties is required in order to simulate any of these scenarios in SWAT. Therefore soil-profiling the Rietspruit sub-basin soils was critical in this respect. Future research seeks to profile the Vaal and Nile basins' soil parameters for SWAT inputs and ultimately the whole of Africa.

Keywords

SWAT, Pedo Transfer Function, soil profile, Vaal Basin, Rietspruit sub-basin, Africa

Effects of Conservation Practices on Phosphorus Loss Reduction from an Indiana Agricultural Watershed

Qingyu Feng*[1], Bernard Engel, Chihua Huang, Dennis Flanagan

1. Email: feng37@purdue.edu (corresponding author)

Abstract

Phosphorus losses from agricultural lands have been identified as the primary non-point source pollutant that causes serious eutrophication problems in freshwater systems, particularly in the Lake Erie region of the USA. However, management practices that can effectively reduce total and soluble phosphorus losses from croplands and drainage channels can be difficult to implement and gauging their effects is also hard to evaluate. Evaluations widely conducted within the region using watershed scale models such as the Soil and Water Assessment Tool (SWAT) provided general suggestions of practices to pursue but very limited indication of likely field specific performance. This modeling study was aimed at evaluating the effects of soil and water conservation practices that could reduce phosphorus losses at the field scale. In the study, we utilized the Agricultural Policy Environmental eXtender (APEX) model to evaluate the effectiveness of these practices across four fields with monitored data, and explored the effects of scenarios with different types, extents, and combinations of practices. The USDA-ARS National Soil Erosion Research Laboratory (NSERL) is actively monitoring over a dozen fields and watershed catchments in the St. Joseph River Basin in northeastern Indiana. Field observations and data from these monitoring stations includes effects of existing land management and conservation practices on runoff, sediment losses, pesticide losses, and nutrient (N and P) losses. The NSERL data were critical for achieving a properly calibrated and validated APEX model, and then the calibrated parameters were used in the scenario trials. This study will provide important information for optimal placement of these practices, and also for potentially targeting of hotspot areas for phosphorus loss reductions.

Keywords

APEX, Field scale, phosphorus loss, Best Management Practices (BMP)

An introduction to EPIC+SUFI2 for calibrating EPIC crop model at different scales

Bahareh Kamali*[1], Hong Yang[2], Karim Abbaspour[3]

1. PhD candidate. Eawag, Swiss Federal Institute of Aquatic Science and Technology; ETH university. Email: bahareh.kamali@eawag.ch (corresponding author)
2. Professor, Eawag, Swiss Federal Institute of Aquatic Science and Technology.
3. Senior scientisit, Eawag, Swiss Federal Institute of Aquatic Science and Technology.

Abstract

Crop models integrate our knowledge of complex mechanisms governing crop growth processes. They have become important tools for evaluating the impacts of crop management on improving water use efficiency and food security. The reliability of their application however depends on the choice and correctness of the parameters during calibration process. Until now, the process is imposed by expensive computational cost on large scale. Here, we coupled the Environmental Policy Integrated Climate (EPIC) model with the Sequential Uncertainty Fitting (SUFI2) algorithm (EPIC+SUFI2) for crop yield calibration at different scales. We tested the application of EPIC+SUFI2 on national and regional case studies selected from Iran provinces. Model performance was evaluated based on *Coefficient of determination* (R^2) and *Mean Squared Error* (*MSE*). The ability of model in terms of capturing uncertainty bound was assessed based on *p-factor* and *r-factor* integrated in SUFI2 and parameters of each country/region were identified. The results show that EPIC+SUFI2 is capable of producing temporal variability of yields on different scale. We concluded that the auto-calibration program developed here is a valuable tool for crop yield calibration at different scales and provides a clear guideline for crop modeling under various agronomic and climatic conditions.

Keywords

Crop calibration, large scale, uncertainty

Overview of the SWAT Literature Database: Current Developments and Updated Literature Trends

Philip Gassman*[1], Curtis Balmer[2], Mark Siemers[3], Raghavan Srinivasan[4]

1. Associate Scientist, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, USA. Email: pwgassman@iastate.edu (corresponding author)
2. Systems Analyst, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, USA.
3. Programmer, Center for Agricultural and Rural Development, Iowa State University, Ames, Iowa, USA.
4. Professor, Spatial Sciences Laboratory, Dept. of Ecosystem Sciences and Management, Texas A&M University, College Station, Texas, USA.

Abstract

The SWAT Literature Database for Peer-Reviewed Journal Articles was created to provide a centralized resource for members of the global SWAT user community to access literature describing applications of the standard SWAT model and other pertinent SWAT-related literature. The origin of the database can be traced to a review study that was published in 2007 in Trans. ASABE, which is accessible via a weblink on the SWAT model homepage (http://swat.tamu.edu/). Roughly 250 SWAT-related peer-reviewed journal articles were identified at the time of that study. Dramatic growth in the SWAT-related literature has occurred since that time, with citation information recorded for 1,700 articles in the database at the time of the 2014 International SWAT Conference (described in the on-line conference proceedings) and nearly 2,700 articles at present.

The database 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 majority of papers included in the database are written in English although citation data has also been included for some papers written in other languages, especially Chinese, Korean, Portuguese, Indonesian, Farsi 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), interfaces between one of the predecessor or related models and SWAT, applications of modified SWAT models such as the SWIM, ESWAT and SWAT-G models, various types of review studies that provide a synopsis of certain types of SWAT applications or comparisons of SWAT and multiple other models, and overview studies for journal special issues. Other models used in studies included in the database that are not part of these subcategories (e.g., HSPF or AnnAGNPS) are not specifically mentioned in the database.

Basic citation information (authors, year, article title, journal name volume/issue, page numbers), the DOI or URL weblink to the article (if available), a brief description of the watershed(s) analyzed in the respective study, article abstract, and keywords (if applicable) are included for each article entry in the database. Subjective broad, primary and secondary classifications are also included for most articles. At present, most of the article abstracts are not visible to database users due to publisher copyright restrictions; however, virtually all abstracts can be viewed via the DOI or URL weblinks to the original webpage for each respective article. Search capabilities are provided in the database including searches performed on any word or phrase of interest (article abstracts are included in these searches). Citations for each new article are automatically generated and added to reference lists ordered either alphabetically or by the specific model(s) featured in the paper (as noted above).

This presentation builds on previous documentation of the literature database by providing updated database structure and literature citation trend information, as well as planned future developments. Including the incorporation of citation database information and data for specific journals represented in the database. Also, issues pertaining to so-called “predatory publishers” will be addressed.

Keywords

SWAT model, modified SWAT models, SWAT literature trends, peer-review literature, predatory publishers, citation databases

The impact of non-point source pollution on groundwater nitrate in shallow aquifer with SWAT applications -a review

Mao Feng[1], Zhen Yao Shen[*2]

1. Student, State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University.
2. Professor, State Key Laboratory of Water Environment Simulation, School of Environment, Beijing Normal University. Email: zyshen@bnu.edu.cn (corresponding author)

Abstract

Non-point source (NPS) pollution has been one of the major reasons for the deterioration of surface water quality throughout the world in terms of soil erosion and nutrients leaching caused by surface or subsurface flow, the Soil and Water Assessment Tool (SWAT) is an integrated model that is widely applied in NPS research. Meanwhile, growing numbers of groundwater pollution caused by agricultural activities occurred in many developing countries, groundwater will become nonpoint source in a river during base flow conditions. In recent years,groundwater degradation by NPS pollutants and NPS pollution caused by shallow aquifer has become one of the most important limiting factors for further control and treatment of NPS pollution. This article reviews the primary nitrate sources, the main factors affecting its transportation, and SWAT model applications in estimating nitrate migration from surface to shallow aquifer. By the analysis of the existing works some recommendations on future research work are proposed regarding:(1) improvement of coupling model including SWAT and groundwater nitrate transport models, which could simulate nitrate transportation in vadose zone effectively and accurately (2) improvement of the estimation accuracy and reliability of the shallow aquifer and its nutrient load, especially during the storm flow period.

Keywords

Non-point source ; SWAT ; Groundwater nitrate ; Groudwater quality

Application of SWAT99.2 in the Sensitivity Analysis of Water Balance Components in the Unique Plots in Hilly Region

Junfeng Dai*[1], Jiazhou Chen[2], Guoan Lv[3], Larry C. Brown[4], Lei Gan[5]

1. Doctor, Professor, Guilin University of Technology. Email: whudjf@163.com (corresponding author)
2. Doctor, Professor, Huazhong Agricultural University.
3. Doctor, Professor, Huazhong Agricultural University.
4. Doctor, Professor, Ohio State University.
5. Doctor, Guilin University of Technology.

Abstract

Although sensitivity analysis for the Soil and Water Assessment Tool (SWAT) in the complex watershed has been widely conducted, little attention has been paid to the model's potential for application to the unique plot scale. In addition, sensitivity analysis of percolation and evapotranspiration with SWAT has only seldom been undertaken. In the present research, SWAT99.2 was manually calibrated to simulate the hydrologic budget components for unique plots of about 0.003 km2 in a hill region with red soil in Southern China from 2000 to 2001. Then, the sensitivity analysis was carried out through OAT sampling to provide insight into which factors contribute most to variance in water balance output. According to the results, the most sensitive parameters for the surface runoff, percolation, and evapotranspiration in the natural grass experimental plot were SCS runoff curve number (CN2), meteorological factors, and permanent wilting point of the soil layer (SOL_PWP). Also, the most sensitive parameters for the output of water balance in the broad-leaf forest plot were SCS runoff curve number (CN2), meteorological factors, max stomatal conductance (GSI), and maximum potential leaf area index (BLAI). Compared to the natural grass, the water balance in broad-leafed forest plots demonstrated more sensitivity to vegetation parameters.

Keywords

forest and grass plots; water balance; sensitivity analysis; SWAT; OAT

Environmental Flow Assessment by Linking Hydrological Characteristics in a Basin Scale

Cheng Feng*[1], Xu Zhao, He Chen

1. Email: fengchengfc@mail.bnu.edu.cn (corresponding author)

Abstract

Environmental flows are required tosustain healthy river ecosystems and to reduce the impact of human activities.Most available assessment methods study theflow regimes in one or several sections of rivers separately. Linkages of upstream and downstream hydrological processes are seldom considered. In this study, we introduced a linkage formula to calculate the environmental flows of main and tributary rivers in a river basin when using the Instream Flow Incremental Methodology (IFIM). Such linkage formula considers the interactions between upstream and downstream through monthly mean runoff and catchment area of each sectionin main and tributary rivers. We choose Ili river basin as study area,
and *Diptychusmaculatus* and *Gymnodiptychusdybowskii* fishes as indicator species. The original results derived from IFIM are adjusted with the linkage formula. Compared to the original results, the adjusted results are more reasonable from the river basin perspective. Our analysis shows that it is important to consider the linking of hydrological characteristicsin a river basin scale.

Keywords

Environmentalflows; Instream Flow Incremental Methodology; Hydrological linkages; Coupling

Impacts of land use change on hydrology using SWAT model in the Huangshui River Basin, China

Xiaohui He*[1], Hengliang Guo[2], Jiaguo Gong[3], Zirui Zheng[4]

1. zhengzhou university. Email: hexh@zzu.edu.cn (corresponding author)
2. Zhengzhou University.
3. China Institute of Water Resources and Hydropower Research.
4. Zhengzhou University.

Abstract

The transition zone of Qinghai-Tibet Plateau and Loess Plateau in Qinghai Province, northwest of China is ecologically fragile area, and undergoing rapid economic development. The Upper Huangshui River basin is the most developed area of the transition zone and land use changed sharply in recent years. As Huanshui River is the principal surface water resource in Qinghai Province, the assessment of land use changes on hydrology is essential for the development of sustainable water resource management and environment protection. This paper present monthly hydrology (surface runoff and evapotranspiration) simulations under land use map in three time periods (1990, 2000, 2010) and four extremely land use scenarios in the Upper Huangshui River using SWAT model. Changes in hydrological components of 1990-2000 and 2000-2010 simulations were related to changes of land use in spatial distribution, and the urbanization has strongest contribution to the increase of surface runoff and decrease of evapotranspiration from 1990 to 2010. The further analyses of the four scenarios simulations indicate cropland also increase the runoff. Increased runoff and decreased evapotranspiration have negative impact on the water resources and environment in the Upper Huangshui River basin. Therefore, the speed of urbanization and area of cropland should be restricted strictly.

Keywords

land use change; hydrological effect; Loess Plateau; Qinghai-Tibet Plateau ; SWAT

Applicability evaluation of CFSR climate data for hydrologic simulation：A case study in the Bahe River Basin

Sheng Hu*[1], Mingming Cao, Haijun Qiu

1. Email: husheng198800@126.com (corresponding author)

Abstract

In recent years, global reanalysis weather data has been used more often during the hydrology modeling around the world, but the results of simulation vary greatly. To discuss the applicability of CFSR reanalysis data in the hydrologic simulation of watersheds, taking the Bahe River Basin as a case, the thesis uses two types of weather data (the conventional weather data and the CFSR weather data) to establish SWAT hydrologic model, and carries out the runoff simulation from 2001 to 2012 of the Bahe river basin based on yearly and monthly dimensions, and makes use of such evaluation methods as repression analysis, Nash-Sutcliffe Efficiency (NSE) and Percent Bias (PBIAS) to compare the simulation effect of both data. At last it puts forward CFSR weather data correction method. The research results show:
(1) To some extent, CFSR climate data has applicability for hydrologic simulation in the Bahe River Basin,the R^2 of the simulated results above 0.50,the Nash-Sutcliffe Efficiency (NSE) is above 0.33, and |Percent Bias (PBIAS)| is below 14.8. Although the quality of the CFSR weather data has some problems, it basically achieves a satisfactory result in the hydrologic simulation of the Bahe River Basin after rainfall data correction. (2) The simulated flow of the CFSR weather data is higher than the observed flow, the reason may be that there are more rainy days and the rainfall intensity is much stronger according to the estimation of day-to-day rainfall data by CFSR, which usually leads to the data will simulate a higher base flow and flood peak discharge in terms of the Water Balance, except for individual years. (3) The relation between the CFSR rainfall data and the observed rainfall data of the Bahe River Basin can be displayed by a power exponent equation: $y=1.4789x^{0.8875}$ ($R^2=0.98$, $P<0.001$); the fitted equation of each CFSR station varies slightly from others. The equation just lays the theoretical basis for correction of the CFSR rainfall data.

Keywords

CFSR; weather data; hydrologic simulation; applicability evaluation; SWAT model ; Bahe River Basin

Hydrological Impacts of Hydropower Development in the Headwater of the Yellow River Basin

Xuan Ji[*1], Jinming Hu[2], Xian Luo[3], Daming He[4], Yungang Li[5]

1. PhD,Asian International Rivers Center of Yunnan University, Kunming 650091, China;Yunnan Key Laboratory of International Rivers and Transboundary Eco-Security, Kunming 650091, China. Email: jixuan@hotmail.com (corresponding author)
2. Prof.
3. PhD.
4. Prof.
5. PhD.

Abstract

The headwater of Yellow River Basin (HYRB) is crucial for the water resources of the whole basin in Northwest and the North China. Nowadays, hydropower dam cascade (14 dams, total installed capacity 4285 MW) development is planned in this region. Concerns have been raised about the consequences of the development for the ecosystems, livelihoods and food security in downstream region. In this paper we assessed the hydrological impacts for Yellow River mainstream caused by the HYRB planned cascade by using a combination of a hydrological model (SWAT) and a reservoir cascade optimization model (CSUDP). The hydrological changes were quantified in detail at the Tangnaihai gauging station, the closest and major gauging station downstream from the dam cascade. On average the HYRB planned cascade increased the December–May discharge by 34–75 % and decreased the July–September discharge by 18–30 % at Tangnaihai. Furthermore, the HYRB planned cascade reduced (increased) the range of hydrological variability during the wet season (dry season) months. The dry season hydrological changes were significant also in downstream gauging stations. On the basis of the understanding gained in this study, it is clear that hydropower development in HYRB will have considerable consequences on the Yellow River's flow regime, but what the consequences are for ecosystems and livelihoods, needs further study.

Keywords

Headwater of Yellow River Basin; SWAT; Hydropower Development; Hydrological Impacts

Spatial Landscape Pattern and Runoff Response of Typical Area in Xiliao River Basin

Kai Wu*[1], Yi Xu[2], Yongxiang Wu[3], Gaoxu Wang[4]

1. Nanjing Hydraulic Research Institute. Email: kwu@nhri.cn (corresponding author)
2. Nanjing Hydraulic Research Institute.
3. Nanjing Hydraulic Research Institute.
4. Nanjing Hydraulic Research Institute.

Abstract

~Xiliao River basin, the upper and middle reaches of Liao River with fragile ecological environment, is a semiarid region in China. Based on the land use pattern images of 1990,2000,2005 and 2010, the spatial-temporal variation of landscape pattern is described by land transfer matrix and landscape index. Regional difference, space difference of land utilization spatial change was performed by overlaying analysis in ArcGIS Platform. Combining the spatial-temporal variation of the hydrological factors such as precipitation and runoff and the region with strong changes, the typical sub-basin was selected. Using the distributed hydrology model Soil and Water Assessment Tool(SWAT), hydrological process was simulated in the typical sub-basin. The reaction of the runoff of the typical sub-basin towards the change of land use was simulated by comparing the change of runoff under the different land use. correlational analyses of Landscape Pattern and Runoff was conducted. The result shows climate changes and human activities has significant influence on hydrological process, which caused oscillation of ecological environment of Xiliao River Basin.

Keywords

Pattern, Runoff; SWAT, landscape index, Xiliao River Basin

Hydrologic Modeling of Fecal Indicator Bacteria in a Tropical Mountain Catchment

Minjeong KIM, Laurie BOITHIAS , Kyung Hwa CHO , Norbert SILVERA , Chanthamousone THAMMAHACKSA , Keooudone LATSACHACK , Emma ROCHELLENEWALL, Oloth SENGTAHEUANGHOUNG , Alain PIERRET , Yakov A. PACHEPSKY , Olivier RIBOLZI *1

1. Email: Olivier.ribolzi@ird.fr (corresponding author)

Abstract

The occurrence of pathogen bacteria in surface waters threatens the world population health. In particular, fecal contamination of surface waters have been issued in developing countries such Lao P.D.R. where surface water is highly contaminated with pathogens of fecal origin due to the lack of adequate sanitation systems. However, the environmental fate and transport of Fecal Indicator Bacteria (FIB) is still poorly known in tropical areas, including LAO P.D.R. In this study, observations on bacterial water quality and flow rates in a 60-ha catchment in Northern Laos were used to explore the watershed-scale fate and transport of FIB Escherichia coli (E.coli) by using the Soil and Water Assessment Tool (SWAT), wherein the influences of the bacterial regrowth, deposition, resuspension, and hyporheic exchange on FIB level were explored. This study applied three different modules to simulate E.coli concentration in stream: 1) original SWAT bacteria module which considers a die-off process only, 2) modified SWAT bacteria module by adding sediment resuspension and deposition, and 3) modified SWAT bacteria module with bacterial regrowth/hyporheic exchange. The results demonstrated that the hyporheic exchange of bacteria across the Sediment-Water Interface (SWI) should be considered to simulate FIB concentration not only during wet weather, but also during the dry season, or base flow period. However, the regrowth process could not simulate FIB concentration throughout the year and can only simulate the wet and dry seasons separately.

Keywords

Fecal indicator organism, Fate and transport, Tropical watershed, Soil and Water Assessment Tool, Laos.

Effects of Land-use and Landscape Pattern on Non-point Source Pollution: A Case Study of the Songhua River Harbin section

Zhe Li, Li Wang[1], Xiaofeng Jiang, Xiongwei Liang, Fang Ma[*2]

1. Professor.
2. Professor. Email: mafang@hit.edu.cn (corresponding author)

Abstract

Agriculture non-point source pollution (NPS pollution) has been one of the most influential factors of eutrophication. Meanwhile, land-use has a significant effect on NPS pollution. Basing on the two-year land use data (2000 and 2008), this paper analyses land-use type and the change of landscape pattern of the Songhua River Harbin section by ArcGIS and Fragstat. Statistical analysis, landscape pattern analysis were used to discuss the relationships between land-use and Non-point source pollution, including Non-point Source-Total Nitrogen (NPS-TN) and Non-point Source-Total Phosphorus (NPS-TP). The results indicated that agricultural land and forestland were the major land-use type of Songhua River Harbin section. They accounted for 57.9% and 25.5% respectively of the study area. The land-use type and landscape pattern had a significant impact on NPS pollution. In the case of land-use type, the export risks of NPS-TN and NPS-TP were ordered by agricultural land, urban land, grassland, forestland. As for the landscape pattern, NPS-TN and NPS-TP were positively related to SHEI and SHDI, while negative correlation with COHESION, AI and LPI. This study draw a conclusion that the more fragmented the landscape patterns were, the more serious the NPS pollution was.

Keywords

SWAT; Fragstat; Non-point Source; Land-use; Landscape Pattern; Songhua River Harbin section

Hydrologic Impacts of Cascade Dams in a Small Headwater Watershed, Southeast China

Jihui Liu, Lei Fang, Jinliang Huang*[1]

1. Email: jlhuang@xmu.edu.cn (corresponding author)

Abstract

Cascade damming is posing a threat to river health and local water security. However, relatively little is known about the hydrologic impacts of cascade dams in small watersheds. The Soil and Water Assessment Tool (SWAT) was used in this study to simulate the hydrologic impacts of cascade dams in a small headwater watershed, Southeast China. Watershed databases including digital elevation model, soil, and land-use data in 2002 (no cascade dams constructed before 2002) were developed in Suxi watershed with an area of 132 km^2. SWAT was calibrated and validated with one-year streamflow data in 2001 and 2002, respectively. Simulated and observed stream flow matched well in calibration period for monthly and daily streamflow (with Nash-Sutcliffe efficiency (NSE) 0.82 and 0.80), as well as in validation period (with NSE 0.78 and 0.75 for monthly and daily streamflow, respectively). We further used the verified SWAT model without reservoir module and with reservoir module to compare the simulated monthly and daily streamflow using streamflow data from 2003 to 2004, there by examining the hydrologic impacts of cascade dam in Suxi watershed. Results showed that the verified SWAT with reservoir module had the higher NSE values than those derived from without reservoir module. When considering the hydrologic impacts of the dam construction by reservoir module, the simulated daily streamflow and peak value during high flow period decreased and the duration of the high pulse became longer. This research provided helpful insight into the hydrologic impacts of cascade dams in small watersheds with extensive cascade damming.

Keywords

Cascade dams· Hydrologic impacts· Streamflow simulation· small watersheds

Fragmentation of Endangered Migratory Fishes by Giant Hydropower Leap in Songhua River Basin

Zifang Liu*[1], He Chen

1. Email: 1531656930@qq.com (corresponding author)

Abstract

Giant hydropower leap has been happening in Songhua river basin in next decades, but its negative effects on riverine ecosystems by blocking rivers and regulating flow have not been quantified. Fishes, especially migratory fishes, act as top trophic species in river ecosystems and are more vulnerable than other species to hydropower development. Hence, we choose 17 migration endanger fishes in IUCN red list as objects of study and calculate the effects of hydropower development on fish migration, a fish migration model that takes into account fish migration activity, dam blocking and flow regulation is used. The fish migration activities are classified into two kinds and the flow regulation is assessed by zero flow days which is quantified by a new water balance model. We find that in our simulations, hydropower is a very important negative factor for fish migration. After complete hydropower development leap in next decades, we demonstrated that blocked river length increases by up to 15% of total river length in 2030, which leads to the decrease of fish passage rate directly and influence the survival rate of migration endanger fishes. We suggest that hydropower development plan should be modified to reduce the negative effects of hydropower. Nature reserves should be founded to protect key migratory fishes.

Keywords

hydropower, migratory fish, model, zero flow days

Simulation of runoff and sediment processes in a semi-arid reservoir catchment using SWAT model

Jiangtao Liu, Zongxue Xu*[1], Gang Zhao, Huan Zhao

1. Key Laboratory of Water and Sediment Sciences, Ministry of Education, College of Water Sciences, Beijing Normal University, Beijing 100875, China. Email: zxxu@bnu.edu.cn (corresponding author)

Abstract

Soil erosion, a potential threat to vegetation maintenance and agricultural sustainability, has become a worldwide environmental problem. Therefore, modeling and quantitative assessment of soil erosion is of vital importance. Soil Water Assessment Tool (SWAT) was employed in the upstream catchment of Panjiakou reservoir to simulate the runoff and sediment generating processes. The model was calibrated and validated against observed runoff and sediment at three outlet stations (Wulongji,Shifo and Sandaohezi station) from 2010 to 2013. Based on the results of sediment simulation, the soil erosion index was also calculated to identify the key areas of soil erosion. The effects of precipitation, hill slope and land use types on the soil erosion were also analyzed. Results showed that: (1) During calibration and validation periods, the R^2 and E_{NS} were around 0.7, which means the performance of the model was quite good in the study area. (2) Runoff from June to October in all the sub-watersheds during the flood period accounted for 74.9% of total annual runoff. (3) Sediment yield from middle of the watershed was larger than those from the eastern and western part while the sediment mainly generated during the period of August to October. (4) There was a positive correlation between precipitation and soil erosion. The risk of soil erosion was higher in the areas with slope more than 8°. Inappropriate ways of land use will lead to a higher risk of soil erosion. Thus, reasonable land use management is recommended to reduce the risk of soil erosion.

Keywords

Panjiakou reservoir, SWAT model, runoff, sediment, soil erosion

Assessment of hydrologic impacts on Yangtze River Watershed of Three Gorges Reservoir (TGR) based on CFSR weather data driven SWAT model

Jianzhong Lu*[1], Xiaolin Cui[2], Xiaoling Chen[3], Sabine Sauvage[4], José-Miguel Sánchez-Pérez[5]

1. Associate Professor, State key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing (LIESMARS), Wuhan University, Wuhan 430079, China. Email: lujzhong@whu.edu.cn (corresponding author)
2. Miss, State key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing (LIESMARS), Wuhan University, Wuhan 430079, China.
3. Professor, State key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing (LIESMARS), Wuhan University, Wuhan 430079, China.
4. Dr., University of Toulouse, CNRS, Ecolab, Avenue de l'Agrobiopole, 31326 Castanet Tolosan, France.
5. Professor, University of Toulouse, CNRS, Ecolab, Avenue de l'Agrobiopole, 31326 Castanet Tolosan, France.

Abstract

Since the Three Gorges Reservoir (TGR) began to impound in 2003, it has increasingly been a hot issue that how the TGR influenced hydrologic regime of the Yangtze River. What's more, it is difficult to collect sufficient data for the model in such a large watershed. In the study, the program SWAT (Soil and Water Assessment Tool) driven by the Climate Forecast System Reanalysis (CFSR) weather data was used to assess the impact on the hydrology change of the Yangtze River and the conjunctional Poyang Lake. Firstly, the CFSR weather data were validated by weather station-observed data. The CFSR temperatures were highly correlated with observed data, with an R^2 larger than 0.9, while the CFSR precipitation were with reasonable accuracy with an R^2 larger than 0.6. The accuracies in calibration and validation period of the SWAT model were assessed with R^2 and E_{NS} that were both greater than 0.8. Particularly, the impacts on outflow of Poyang Lake connected with Yangtze River were also investigated with the model. Then, the calibrated model also kept running without TGR operation extendedly from 2003 to 2011. The simulated results were compared to the observed streamflow that has been affected by TGR operation, in which the TGR begins discharging in April or May and impounding in late September. The results show that streamflow in the middle and lower reaches of the Yangtze River increases from November to next June (especially from May to June) because of the discharge from TGR, while it decreases significantly in October because of the impoundment by TGR. The farther away from TGR in the lower reach, the weaker the impacts on streamflow. The capacity regulation and control by TGR in wet year, for example in July of 2010, played a positive role in flood control for the main stream. TGR impoundment from late September to October leads to water shortage and advances dry season in the Poyang Lake Basin. The study provided more evidences of TGR impacts on lower reach of Yangtze River for the hydrologic engineers and scientists.

Keywords

Three Gorges Reservoir (TGR); Hydrologic impacts; CFSR; SWAT model; Yangtze River Watershed

Research on Application of Hydrological Model -HSPF

Jie Ma*[1], Jing Zhang, Binbin Guo

1. Research on Application of Hydrological Model -HSPF. Email: majie904301@126.com (corresponding author)

Abstract

Water quality simulation is a very important work in the study of hydrology. HSPF (Hydrological Simulation Program-Fortran) model plays a significant role in the simulation of pollutant transport, quantitative research, water quality assessment, rainfall runoff process simulation and climate change, recently. This paper give a brief introduction of the studies on HSPF model around the world, especially in China.

Keywords

HSPF model; Rainfall-runoff; water quality; Climate Change; Microbiological Simulations; Pollutant Transport

Modeling of sediment dynamics using SWAT model: case of Joumine river basin, Tunisia

Slim Mtibaa*[1], Norifumi Hotta[2], Mitsuteru Irie[3]

1. Ph.D Student (Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan). Email: slim.mtibaa@th3pf.com (corresponding author)
2. Associate Professor (Faculty of Life and Environmental Sciences, University of Tsukuba, Japan).
3. Professor (Faculty of Engineering, University of Miyazaki, Japan).

Abstract

Joumine reservoir, located in the north of Tunisia, is one of the most important reservoir that provides water for drinking and agriculture use. However the intense sedimentation caused the loss of about 1% of its storage capacity every year. This problem is directly related to the soil erosion that affect the catchment area (416 km^2). In this study, we focused on the modeling of sediment dynamics in Joumine river basin using SWAT model in order to determine the distribution of the source area of sediment yield. The model was calibrated and validated with observed streamflow data in terms of hydrological run-off analysis until getting good fitting and reasonable water balance. On the other hand, the development of sedimentation in the reservoir was not observed year by year. For the validation of sediment yield estimated by SWAT, the turbidity data observed at the inflow to the reservoir for a limited term was employed. High correlation between flow rate and turbidity was found. The concentration of suspended solids related to the value of turbidity was estimated from flow rate data with this rating curve. Simulated monthly streamflow values matched the observed values with high Nash-Sutcliffe Efficiency (NSE) and Coefficient of determination (R^2) during the calibration step (NSE=0.89; R^2=0.90) and validation step (NSE=0.83; R^2=0.84). The simulated sediment loads show a good agreement with the observed sediment loads with an acceptable values of NSE=0.35 and R^2=0.36. The model results show that the difference of the spatial distribution of the soil erosion rate within Joumine catchment is caused by the differences in land cover type and slope degree. About 40 % of the catchment area were affected by high soil erosion risk and need the application of soil conservation measures to regulate the soil erosion intensity.

Keywords

Joumine river basin, SWAT model, Soil erosion, Sediment dynamics

Improving SWAT Model Prediction Using an Upgraded Denitrification Scheme and Constrained Auto Calibration

A. Sharifi[1], A. Sadeghi[*2], M. Lang[3], G. McCarty[4], S. Lee, H. Yen, J. Jeong

1. Hydrologist, UMD.
2. Soil Physicist, ARS-HRSL. Email: Ali.Sadeghi@ars.usda.gov (corresponding author)
3. Ecologist, UMD.
4. Soil Scientist, ARS-HRSL.

Abstract

The reliability of common calibration practices for process based water quality models has recently been questioned. A so-called "adequately calibrated model" may contain input errors not readily identifiable by model users, or may not realistically represent intra-watershed responses. These shortcomings are partly due to the use of evaluation criteria that are exclusively established using global in-stream model responses without considering intra-watershed responses. In this study, we introduced a modification to the SWAT model's nitrogen (N) cycling relationships and a new calibration tool that collectively decrease the chance of misrepresenting intra-watershed responses. The N cycling relationships in the SWAT model were modified to better represent NO_3 cycling in soils with various degrees of water holding capacity, an approach that demonstrates the capacity to spatially distinguish areas of high denitrification potential. The new calibration tool has the capacity to calibrate paired watersheds simultaneously within a single framework. Results showed that when both proposed methodologies were applied jointly to a system of paired watersheds on the Delmarva Peninsula adjacent to the Chesapeake Bay (i.e., the Greensboro and Tuckahoe watersheds), the performance of the models suffered; however, the intra-watershed responses (mass of nitrate lost to denitrification) in the Greensboro and Tuckahoe models automatically converged on realistic sums. The modified SWAT model demonstrates the capacity to spatially distinguish areas of high denitrification potential (hot spots), an ability that has implications for identifying prominent areas for wetland restoration to minimize nitrogen loss into stream networks.

Keywords

Denitrification, Auto-calibration, N-cycling

Assessing the effectiveness of organic farming practices on stream health in the Upper Houlong River Basin, Taiwan

Li-Chi Chiang*[1], Wei-Che Hsu[2], Chih-Mei Lu[3], Pin-Chih Shih[4]

1. Assistant Professor, Department of Civil and Disaster Prevention Engineering, National United University, Miaoli, Taiwan. Email: lchiang@nuu.edu.tw (corresponding author)
2. Graduate Student, Department of Civil and Disaster Prevention Engineering, National United University, Miaoli, Taiwan.
3. Graduate Student, Department of Civil and Disaster Prevention Engineering, National United University, Miaoli, Taiwan.
4. Graduate Student, Department of Civil and Disaster Prevention Engineering, National United University, Miaoli, Taiwan.

Abstract

Traditional agriculture is regarded as practices using mono-cropping, massive usage of chemical fertilizer, herbicide and pesticide. Although such practices can increase the production, excessive chemical usage can seriously damage the environment in terms of water quality degradation, soil acidification, soil loss, and decrease in soil water content. In recent years, organic agriculture becomes more popular worldwide, which emphasizes on cropping organically by using organic fertilizer and creating an organic environment. However, the benefits of organic farming may be influenced by climate change. This study was conducted in the Upper Houlong River Basin, which contains the 4th large organic farming areas in Taiwan, and is planned to build a transbasin diversion for the Tianhua Lake Reservoir. A total of 14 water quality samples were collected every two weeks since September 2015 for total phosphorus (TP), total Kjeldahl nitrogen (TKN), nitrate and nitrite, and total suspended sediment (TSS), and 13 farm land soil samples were collected in different stages of plan growth for pH, electrical conductivity (EC), organic matter (OM), and available phosphorus (AP). The SWAT model was selected, and calibrated and validated for daily streamflow and TSS (1990-2014) and water quality (2015-2016) using SWAT-CUP. The results showed that SWAT simulated well for the daily streamflow in terms of R^2 Nash-Sutcliffe efficiency (NSE), and Percent bias (PBIAS) (0.77, 0.76, and -8.48%, respectively). The near future (2020-2039) climate scenarios were included for the SWAT mode to assess the effectiveness of different organic farming management on water quality. An appropriate organic farming management is suggested for corresponding government bureaus and institutes in the future.

Keywords

SWAT, nonpoint source, organic farming, climate change

Comprehensive Simulation of Nitrate Transport in Surface-Subsurface Hydrologic Systems using linked SWAT-MODFLOW-RT3D Model

Xiaolu Wei*[1], Ryan Bailey, Rosemary Records, Mazdak Arabi

1. Ph.D Candidate. Email: hhuwxl@gmail.com (corresponding author)

Abstract

Elevated levels of nitrate (NO_3) in surface water and groundwater can degrade water quality and also pose serious threats to human health in drinking water. In this study, the Soil Water and Assessment Tool (SWAT) is linked with the finite difference groundwater flow model MODFLOW and a groundwater solute reactive transport model RT3D (Reactive Transport in 3 Dimensions) to provide a systemic understanding and representation of the complex network of interactions between the land surface, subsurface, and surface water systems. This presentation contains the development of the coupled model as well as its current application to the Sprague River watershed, part of the Upper Klamath River Basin in southern Oregon, with model results tested against measured groundwater NO_3 concentration and in-stream NO_3 loading during the simulation period of 2001 to 2010. According to the results, the annual average NO_3-N concentration (mg/L) in groundwater of the Sprague River watershed ranging from 0 to 0.7 with the highest concentrations occurring along the main Sprague River corridor and in the northwest region of the watershed. As compared to the measured values in the observation wells (average of: 0.33 mg/L), the simulated values are low, likely due to the observation wells being concentrated along the main step of the Sprague River.

Keywords

Nitrate; groundwater; stream-aquifer interaction; solute transport; SWAT; MODFLOW; RT3D

Assessing Irrigation Potential and Land Suitability in Ethiopia

Abeyou Worqlul*[1], Jaehak Jeong[2], Javier Osorio[3], Thomas Gerik[4], Srinivasan Raghavan [5], Neville Clark[6]

1. Texas AgriLife Research, Temple, Texas, USA. Email: aworqlul@brc.tamus.edu (corresponding author)
2. Texas AgriLife Research, Temple, Texas, USA.
3. Texas AgriLife Research, Temple, Texas, USA.
4. Texas AgriLife Research, Temple, Texas, USA.
5. Texas A&M University, College Station, Texas, USA.
6. The Norman Borlaug Institute for International Agriculture, Texas A&M AgriLife Research, College Station, Texas, USA.

Abstract

As part of USAID's Feed the Future (FtF) program, Texas A&M AgriLife Research conducts integrated modeling studies under Innovation Lab for Small Scale Irrigation in three countries in Africa including Ethiopia, Tanzania, and Ghana using SWAT, APEX, and FARMSIM. Although Ethiopia has large land areas that can potentially be developed for surface irrigation, only a fraction of the potential available land has been utilized. This paper presents evaluation of the potential lands in Ethiopia that are suitable for irrigation using groundwater. The suitable land was identified using GIS-based Multi-Criteria Evaluation (MCE) techniques. The factors used were identified from literature and from experts in the region. Factors considered includes physical land features (land use, soil and slope), climate characteristics (rainfall and evapotranspiration), and market access (proximity to roads and access to market). Factors were weighted using a pair-wise comparison matrix, reclassified, and overlaid to identify the suitable areas for groundwater irrigation at 1 km grid. Groundwater data from the British Geological Survey were used to estimate potential groundwater availability and analyze the irrigation potential for dominant crops. Simulated output from SWAT could be used in areas where data is not available. Result indicates that approximately 6.0 million ha of land in Ethiopia is suitable for surface irrigation. A large portion of this suitable land is located in the Abbay, Rift Valley, Omo Ghibe, and Awash River basins, which all also have shallow groundwater access (< 20 m from the surface). The comparison between available groundwater and total crop water requirements indicated that current groundwater resources in the basins are not capable of irrigating all suitable land independently, but groundwater resources are a good option for supplementing current surface water resources in many regions. The study indicated that only 20 % of the suitable land could be irrigated with the groundwater within the grid.

Keywords

borehole yield; groundwater; groundwater depth; multi-criteria

Simulation and regulation of adsorbed nonpoint source pollution processes in a small watershed of the Loess Plateau

Lei Wu*[1], Xiaoyi Ma[2]

1. Associate Professor, College of Water Resources and Architectural Engineering, Northwest A&F University. Email: lwu@nwsuaf.edu.cn (corresponding author)
2. Professor, College of Water Resources and Architectural Engineering, Northwest A&F University.

Abstract

Chinese Loess Plateau is considered as one of the most serious soil erosion regions in the world. Loss of nitrogen and phosphorus in highly erodible areas not only decreases soil fertility, but also causes adverse effects to aquatic environment. In order to explore the process of erosion-type nonpoint source (NPS) pollution in a small watershed of Loess Plateau, an integrated, watershed-based, distributed-dynamic modeling method of adsorbed NPS pollution based on SWAT was established to investigate the distributed coupling effects of processes of hydrology, soil erosion and adsorbed nonpoint source pollution. Results indicate that: 1) the integrated methodology proposed in this study is universal and can be applicable to the hilly and gully region, Loess Plateau; 2) Loss of soil and water especially the sediment is the main reason for the loss of nitrogen and phosphorus in the loess hilly and gully region, the temporal changes of erosion-type NPS total nitrogen (TN) and total phosphorus (TP) load showed an overall decreasing trend, the peak regions of TN and TP loss mainly occurred along the main river banks of the watershed from northwest to southeast; 3) the subtractive effects of the regulation of cropping structure on soil nitrogen and phosphorus loss are comparatively significant. Results may provide theoretical basis and data supporting for multi-scale NPS pollution control of the Loess Plateau.

Keywords

Nonpoint source pollution; adsorbed nitrogen and phosphorus; Cropping structure; Loess Plateau; Soil erosion

Modified SWAT Model for Water-Saving Irrigation in Paddy areas

Yi Xu*[1], Kai Wu[2], Yongxiang Wu[3], Gaoxu Wang[4]

1. Nanjing Hydraulic Research Institute. Email: 564096444@qq.com (corresponding author)
2. Nanjing Hydraulic Research Institute.
3. Nanjing Hydraulic Research Institute.
4. Nanjing Hydraulic Research Institute.

Abstract

Paddy irrigation is always the majoy agriculture water use in southeast China. In recent years, water-saving irrigation is getting more and more attention because of water shortage and waste water pollution(because of overirrigation). This study added one water-saving module to SWAT model in order to simulate the water saving-irrigation and estimate the water-saving potential of the paddy area. This module used some efficiency coefficients to quantize the impact of irrigation scheduling， irrigation projects and management solutions for water-saving ability. These efficiency coefficients were determined by field test and cosidered about the scale effects,a scale coefficient was also tested. This model was applied for some typical irrigation areas in Taihu basin,the resuts show that if appropriate irrigation schedule,project and management solutions are implemented,there is a very considerable amount of water can be saved and also aviod a lot of agricultural non-point source pollution.

Keywords

SWAT model , water-saving irrigation, paddy areas, efficiency coefficient,water-saving potential

Assessments of Impacts of Climate Change and Human Activities on Runoff with SWAT and heuristic segmentation algorithm for the Miyun Reservoir Catchment, China

Tiezhu Yan, Zhenyao Shen*[1], Lei Chen, Yucong Yang

1. Email: zyshen@bnu.edu.cn (corresponding author)

Abstract

The impacts of climate change and human activates on the runoff for Miyun Reservoir Basin, China, have been investigated with the soil and water assessment tool (SWAT), which is calibrated and verified for the baseline period 1969-1979, and then used to reconstruct the natural runoff from 1980 to 2011. The results indicate that both climate change and human activities are responsible for the decrease of observed runoff in the basin and human activities play a more important role. Two change point of the annual runoff was detected using the heuristic segmentation algorithm, thus the time series of 1969~2011 was divided into three periods: 1969~1979 (baseline period), 1980~1998 and 1999~2011. The annual mean runoff for three periods were 10.98, 5.82 and $2.79\times10^8 m^3$, respectively. The climate change resulted in a decrease of runoff depending on decreasing precipitation and increasing temperature. Its impacts on annual runoff are -10.08 and -8.41×10^7 m^3 for 1980-1998 and 1999-2012, respectively, compared with the baseline period 1969-1979. Human activities, on the other hand, generally lead to a decrease of runoff and a relatively larger magnitude than climate change. It has decreased the annual runoff by -25.99 and -51.22×10^7 m^3 for 1980-1998 and 1999-2012, respectively. Human activities contributed more to runoff decrease in wet years due to the storage of the water projects and in dry years for water withdrawal for irrigation. This study provides a quantitative assessment methodology for water resources managers to understand the changing process of the hydrological cycle and attribute its causative factors in the Miyun Reservoir Catchment.

Keywords

Climate change, human activities, SWAT, heuristic segmentation algorithm

A multi-year AquaCrop model simulation and assessment on plastic-film-mulched maize yield response to precipitation and supplemental irrigation in sandy and semi-arid region of Northeast China

Ning Yang[1], Zhanxiang Sun[*2], Lizhen Zhang[3]

1. Liaoning Academy of Agricultural Sciences/ Engineering Research Centre for Dryland and Water-Efficient Farming of Liaoning Province.
2. Liaoning Academy of Agricultural Sciences/ Engineering Research Centre for Dryland and Water-Efficient Farming of Liaoning Province. Email: laasyn@163.com (corresponding author)
3. China Agricultural University.

Abstract

Rain-fed or supplemental irrigation maize (*Zea mays* L.) production in sandy and semi-arid region of Northeast China (42.11°N,121.70°E) is constrained by low temperatures, strong winds and water limitations during the growing season (particularly in seeding stage). Combined plastic-film-mulching (PM) with optimizing supplemental irrigation water (net irrigation requirement,NIR) was an effective strategy to decrease aerodynamic evapotranspiration, increase soil temperature and moisture, furthermore, achieve high and stable maize yield and reduce the yield risk of drought for maize production.FAO's AquaCrop water-driven model, which simulates several yield responses to water conditions, however, there is no easy way to model and evaluate the water productivity of growing plastic-film-mulching on the soil surface and limits the further developments and applications of AquaCrop. Base on combining growing degree-days (GDDs) with compensatory theory of accumulative soil temperature to air temperature of maize, we developed a modified air temperature of PM maize ($T_{air\text{-}PMmaize}$) as AquaCrop input for better calibrate and evaluate PM maize water productivity through $T_{air\text{-}PMmaize}$ and AquaCrop platform, which was parameterized by measuring the number days of growth stage, actual evapotranspiration (ET_a) and grain yield (GY) in 2011a, and validated canopy cover (CC), soil water content (SWC), GY and water use efficiency (WUE) and irrigation water use efficiency (IWUE) with and without plastic-mulching in 2012a and 2013a. The results indicate that the modified $T_{air\text{-}PMmaize}$ were obviously better than the unmodified air temperature from weather station directly. Furthermore, to achieve and evaluate high GY of plastic-mulching maize response to precipitation and supplemental irrigation were investigated using validated AquaCrop by inputting $T_{air\text{-}PMmaize}$ and long term weather data from 1970a to 2013a. The results obtained in these regression analysis are plastic-film-mulched maize GY is maximized range from 13267.6 to 13773.9$kghm^{-2}$ response to precipitation (517.7 mm) and ET_a (460.3mm) in wet and normal climatic scenarios, while IWUE (21.5$kghm^{-2}mm^{-1}$) is highest in optimize supplemental irrigation 281.4mm combine plastic-mulch and supplemental irrigation (furrow, sprinkling and drip micro irrigation,etc.) in dry climatic scenario.The results revealed that supplemental irrigation is necessary for PM maize cultivation because rain is insufficient in dry climatic scenarios in sandy and semi-arid region. Overall, these results suggest the AquaCrop model modified $T_{air\text{-}PMmaize}$ can accurately predict CC, SWC, GY, WUE, IWUE and NIR for PM maize with mult-year meteorological data, thus could be a powerful tool for optimizing plastic-film-mulched maize water management in sandy and semi-arid region of Northeast China.

Comparison of SWAT and DLBRM for hydrological modelling of a mountainous watershed in arid Northwest China

Lanhui Zhang*[1]

1. Email: lhzhang@lzu.edu.cn (corresponding author)

Abstract

A distributed physically-based model, Soil and Water Assessment Tool (SWAT), and a distributed conceptual model, Distributed Large Basin Runoff Model (DLBRM), were selected to compare their applicability and performance in simulating daily runoff in the Heihe River Watershed, the second largest inland river (terminal lake) with a peak elevation of 5584 m.asl in arid Northwest China. Both models have been calibrated against the observed daily runoff at the watershed outlet (Yingluoxia Hydrological Station) for the period of 1995 to 2004 and validated for the period of 2005 to 2009. Results show that both SWAT and DLBRM produced reasonable results in this study, and DLBRM performed better than SWAT. The difference in performance is mainly due to data constraints, different interpolation schemes and spatial representations of landscape variations in the models. Tank storage-output principle used in DLBRM seems more suitable than the SCS-Curve Number (SCS-CN) method used in SWAT to simulate daily flow in arid area. Both models performed worse in simulating low flows mostly occurring in spring and winter, due to lack of detailed representation of the impacts of snow melting processes and frozen soils. Our analysis indicates that consideration of the impacts of snow melting and frozen soils on hydrological process is a key to improve performance of hydrological models in mountainous areas. Because of their simpler operations, lower data requirements, fewer input parameters, and better performances, distributed conceptual models such as DLBRM seem more suitable for hydrological modeling in the data lacking, high elevation, and topographically complex mountainous watersheds in arid region.

Keywords

Model performance; SWAT; DLBRM; the Heihe River Watershed; Mountainous area

SWAT Model Application for Hydrological Study of Artificial Recharge Trough Infiltration Pond in The Water Replenishment at Senjoyo Spring Salatiga Indonesia

Nana Mulyana*[1], David Hemson[2], Sudarsono Soedomo[3]

1. Dr , Bogor Agricultural University (IPB). Email: nmulyana@aksenta.com (corresponding author)
2. Dr, dTs USA.
3. Dr, Bogor Agricultural University (IPB).

Abstract

The climate change has had an impact on rainfall amounts, periodicity and intensity in Indonesia, resulting in declines and increased irregularity in water supplies, and increases in flooding and landslide events. These conditions necessitate interventions to decrease and mitigate the impact of the climate change. The infiltration pond with a dimension 2m x 2m x 2m would always be filled up with water in each rainday. The infiltration ponds are designed to increase spring discharge and reduce run-off by holding run-off, which is then absorbed into the ground. Artificial recharge of ground water is expected to play an increasingly important role in water conservation for mantainance of ground water and springs.

The study site is located at spring of Senjoyo, City of Salatiga Central Java Propince. Four hundred and eight units of infiltration pond are palced at Jetak, Patemon Noborejo, and Butuh Villages. The total area of catchment Senjoyo is 1,867.1ha, and is composed of three land types, residential, 49%, widely spreading in the downstream, mixed gardens and shrub (agroforestry) 39.9%, spread across the catchment, and dry land farming, 10.2%. Run-off simulation was done through pouring 8 cubic meter water into each of the infiltration ponds. The hydrological model, using SWAT (Soil Water Assessment Tools), was developed using historical (existing) data and field data for calibration of the parameters. The relationship between the observed data and data from the SWAT model has a coefficient of determination R^2 = 0.8168 for springs Senjoyo. These indicate that the SWAT represents field conditions accurately. A sensitivity analysis was used as a screening tool for reducing the number of the parameters to be adjusted during calibration.

Regarding Senjoyo springs,based on the results of the sensitivity analysis, it is seen that the hydraulic conductivity factor (SOIL_K), the water level in the shallow aquifer (GW_MIN), and water travel factor (GW_DELAY) will greatly affect the size of the discharge that comes out in the spring Senjoyo. Thus, the fluctuation of soil water is very influential on the fluctuation of discharge springs Senjoyo. In other words, Senjoyo springs discharge were highly dependent on the climate and land cover. Travel time is approximately 77days. Senjoyo springs are classified as large springs, the discharge of springs Senjoyo reach 548 l/s.

The average amount of surface run-off that could be captured by the infiltration ponds was 865.0 m^3/well/year at Senjoyo. As indicated through the SWAT analysis, construction of infiltration ponds can improve the flow of springs, to 3.69 l/s at Spring Senjoyo, that can be used by PDAM Salatiga to increase its service. Construction of 1 unit of the infiltration pond in the catchment areas can increase the number of customers by 7 people at Spring Senjoyo. The decrease in surface run-off in the catchment area of Spring Senjoyo reached 33 %. Placement of infiltration ponds is critical for optimal hydrological performance. Residential areas are better choice for the placement and less costly maintenance.

Keywords

Key word: Climate change, infiltration pond, Senjoyo, SWAT, artificial recharge

Sub-daily hydrological modelling, multi-site calibration, validation and uncertainty studies: a case study in a lowland catchment in the UK

Jie Shi[*1], Roger Falconer[2], Michaela Bray[3]

1. Dr. Email: ShiJ2@cardiff.ac.uk (corresponding author)
2. Professor.
3. Dr.

Abstract

Spatially distributed data makes distributed hydrologic models increasingly useful for simulation of spatially varied hydrologic processes to understand and manage natural and human activities that affect catchment hydrology. Calibration and validation of the model is a key factor in reducing uncertainty and increasing model confidence in its predictive abilities. Information on calibration and validation of multi-site, multivariable SWAT model has been provided to assist gaining a better understanding of the model uncertainty. This study discusses the calibration and validation at three locations along the rivers Frome and Piddle, southern England. The model is built to employ Green and Ampt infiltration method and conducted sub-daily simulations on flow and sediment. The calibration for flow was performed from 2004 through 2005. Sediment calibration was done in 2005. Model validation was performed for 2006. Time series hydrographs and statistics were used for verifying model performance. The daily simulation shows Nash-Sutcliffe Coefficient has a range of 0.70-0.77 for calibration and a range of 0.58-0.62 for validation, R square has a range of 0.76-0.79 for calibration and a range of 0.71-0.80 for validation. This study showed that SWAT is a robust model to predict daily and sub-daily flow and sediment and is suggested to be used for studying impacts of future scenarios such as intensive rainfall events due to climate change as well as catchment agricultural management.

Keywords

Calibration and Validation, Uncertainty, Green and Ampt infiltration, Sub-daily, Spatial and Temporal

Water resource (quantity) balance calculation by using SWAT model Application in Spongicity

Li Wang*[1], Zhe Li, Fang Ma, Xiongwei Liang, Xiaofeng Jiang

1. Email: wli@hit.edu.cn (corresponding author)

Abstract

Harbin municipal district is a priority unit for water pollution control in the Songhua river basin. With the rapid process of urbanization, water resource depletion and unbalanced distribution lead to a series of environmental events and hydrological disasters, which become to the Limit of the local social and economic development. In order to giving a reasonable suggestion for water resources use, we analyzed the variation dynamics and spatial distribution pattern of water resources by the Soil and Water Assessment Tool (SWAT), including precipitation, evapotranspiration and runoff in the Harbin municipal district. Non-parametric tests was used to analyze the trend of water resources dynamic based on the 2-decade years data from 1995-2015 in the study area. Results show that spatial distribution of evapotranspiration is uneven. The left bank of the city inland river in the lower reaches has the largest evapotranspiration. It was also obviously affected by the modes of land use. Runoff in Harbin municipal district increases gradually from upstream along the main river and reaches a maximum in the outlet of unit. Combined with the type of land use, topography, climate conditions and the spatial distribution of water resources, seven functional areas was divided in the study area, and the targeted management suggestions were also represented respectively. The methods and results of this research will be a reference for other similar areas and watershed in the world.

Keywords

SWAT, water resources balance, Distribution pattern, priority control units of Songhua river basin

Charactering effects of landscape factors on water quality in a typical urbanized watershed in Beijing, China

Jin Liu, Zhenyao Shen*[1]

1. professor. Email: z.y.shen@163.com (corresponding author)

Abstract

Understanding the relationship between landscape pattern and water quality in urbanized areas can provide insight into urban water quality management. In this study, self-organizing map (SOM) combined with linear mixed effects model were applied to explore the spatiotemporal patterns of nutrients and their relationship with landscape characteristics in the highly urbanized Beiyun River Watershed based on an investigation of 25 typical river sites during the year 2014-2015. The SOM classified the river sampling sites into nine clusters, from least to most polluted, with differences in land use patterns and seasonal (rainy and dry seasons) distributions. In the upstream of the river and tributaries, located in the urban build-up area, the concentrations of the majority of pollutants (NH4+-N, TN, SRP, TP, COD) are lowest, while the sites in the downstream of the watershed have a higher values for these pollution parameters. Nitrate N (NO3--N), however, exhibited the opposite pattern. The statistical linear mixed effects model results showed that water quality exhibited strong relationships with the proportions of industrial, buildup, road and water land cover types in the urban buildup area and development area, which located in the upstream of the watershed; water quality located in the downstream showed weak relationships with land use, probably due to the influence of upstream nutrient contributions and the point source inputs. The result is valuable for the mechanistic models like SWAT and SWMM to further simulate the nonpoint source pollution procedure in the urban areas.

Keywords

landscape; river continuum; nonpoint source pollution; water quality modeling; urbanization

SWATMOD-Prep: A graphical user interface for preparing coupled SWAT-MODFLOW simulations

Ryan Bailey*[1], Hendrik Rathjens, Katrin Bieger, Seonggyu Park, Xiaolu Wei

1. Email: rtbailey@engr.colostate.edu (corresponding author)

Abstract

This presentation outlines the development and application of SWATMOD-Prep, a new graphical user interface that automates the linkage between a SWAT model and a MODFLOW groundwater flow model. The interface is programmed in Python, with various software packages used for geo-processing operations (e.g. selection, intersection of rasters) and inputting/outputting data. The processes performed by the interface tool are based on a recently published SWAT-MODFLOW modeling code that couples the models through schemes that map groundwater recharge from HRUs (Hydrologic Response Unit) to grid cells belonging to the MODFLOW finite difference grid. The tabs and spatial layout of SWATMOD-Prep guide the user through importing necessary shape files (sub-basins, HRUs, river network) from an existing SWAT model, creating a finite-difference grid for MODFLOW, performing necessary geo-processing operations to link the models, writing out input files for the SWAT-MODFLOW simulation, and running the simulation. The interface can also assist with developing a single-layer MODFLOW model based on the specified finite-difference grid, with the user prompted to provide necessary groundwater input (aquifer thickness, aquifer parameter values). Nitrate transport in the aquifer also can be included by activating the SWAT-MODFLOW version that includes linkage with the three-dimensional groundwater reactive transport model RT3D. The use of SWATMOD-Prep is demonstrated for several study watersheds. A user's manual for SWATMOD-Prep will soon accompany the SWAT-MODFLOW documentation available at http://swat.tamu.edu/software/swat-modflow/.

Keywords

MODFLOW, Graphical User Interface, Model Coupling

Further development of SWATBF to simulate streamflow from forested watersheds in the Central Mixedwood Natural Subregion of Alberta, Canada

Yin Chu[*1], Brett Watson[2], Gordon Putz[3], Toomas Parratt[4]

1. Visiting scholar, Department of Civil and Geological Engineering, 57 Campus Drive, University of Saskatchewan, Saskatoon, Saskatchewan S7N 5A9, Canada. Email: yin.chu@usask.ca (corresponding author)
2. Instructor – Civil Engineering Technologies, Saskatchewan Polytechnic – Moose Jaw Campus, Moose Jaw, Saskatchewan, S6H 4R4, Canada.
3. Professor Emeritus, Department of Civil and Geological Engineering, 57 Campus Drive, University of Saskatchewan, Saskatoon, Saskatchewan S7N 5A9, Canada.
4. Ph.D. Candidate, Department of Civil and Geological Engineering, 57 Campus Drive, University of Saskatchewan, Saskatoon, Saskatchewan S7N 5A9, Canada.

Abstract

The Central Mixedwood Natural Subregion of Alberta lies within the Canadian Boreal Plain ecozone. It consists of extensive tracts of upland forests and wetlands on gently rolling plains. Soils are predominately medium to fine textured Gray Luvisols on upland sites, some Brunisols associated with coarse textured sands, and organic soils underlying wetlands. Vegetation cover is predominantly aspen, mixed-wood and white spruce forests on the uplands, black spruce within treed wetlands, and jack pine on well drained sites on coarser material. The region experiences extreme annual variation in temperature between long severe winters and short mild to warm summers. Peak streamflow is generally produced by either early spring snowmelt or intense storm events during late spring or summer. Wetlands, which are mainly bogs and fens, play an important role in the hydrological processes of Boreal Plain Forest watersheds through evaporation, transpiration, water storage for groundwater recharge and provision of a buffer against both floods and droughts.

Adaptation of SWAT to better represent the hydrological conditions of Boreal Plain Forest watersheds has been a continuing objective of the Forest Watershed and Riparian Disturbance (FORWARD) project. The adapted $SWAT_{BF}$ model (based upon SWAT 2005) included modifications to routines representing solar radiation input, snowmelt, winter baseflow, litter layer water storage, lateral flow and percolation, wetlands and hydrological connectivity between HRUs.

Recent development work on $SWAT_{BF}$ incorporated the previous modifications into SWAT 2012 rev.637 and the wetlands module and HRU connectivity were further revised. Separate upland and lowland wetland representations were defined, and each wetland type was treated as a HRU. The main hydrological processes of upland wetlands were represented by a simple two-layer-bucket model. The lowland wetlands were represented as a modified pothole. For both types of wetlands the evaporation of canopy storage, and the transpiration and evaporation from the water surface are calculated. A portion of the surface flow, lateral flow and shallow ground water flow from upland HRUs can be routed through a lowland wetland in each subbasin.

This paper provides an overview of the previous and current $SWAT_{BF}$ developments, and an example application on a small forested watershed in north central Alberta, Canada.

Keywords

hydrological processes, model development, forested watershed, Boreal Plain, SWATBF model

Development and application of the drainage and irrigation module of polders in plain river network region

Zhengqing Lai*[1], Shuo Li[2], Yang Deng[3], Guonian Lv[4]

1. School of Geography Science, Nanjing Normal University. Email: lzq0129lzq@163.com (corresponding author)
2. School of Geography Science, Nanjing Normal University.
3. Changshu Municipal Bureau of Land and Resources.
4. School of Geography Science, Nanjing Normal University.

Abstract

A polder is a low-lying tract of land enclosed by dikes to prevent flooding that forms an artificial hydrological entity, meaning it has no connection with outside water other than through manually operated sluices or pumping stations. There are about 400 thousand km^2 of polders which has become one of the most common features in plain river network region in southeastern China. However, the conventional hydrological models, including the widely used SWAT, were not able to consider each polder as an independent catchment, nor were they able to model the unique hydrologic processes of polder areas.

In this study, a new module, which is been integrated into the SWAT model, has been developed to simulate the drainage and irrigation processes of polder areas in plain river network region. Based on the analysis of polder structures and regime, this module simulates the drainage processes by calculating the water-storage depth of the streams inside the polder and simulates the irrigation processes by calculating the water requirement of the crop as well as considering the precipitation.

The integrated SWAT is applied to Liyang watershed – an upstream watershed in Taihu Lake basin in China. Each polder in Liyang watershed serves as one subwatershed during the modelling process. Comparisons between the simulated results and observed data demonstrate that the new module is able to model the drainage and irrigation processes of polder areas and the integrated SWAT enhances the simulation accuracy of the streamflow of Liyang watershed. This study will benefit the development of distributed hydrological models in plain river network region for the consideration of the artificial hydrological entity – polder.

Keywords

polder; drainage; irrigation; plain river network region; SWAT model

Watershed Calibration with Incorporation of Soft/Hard Data Using SWAT/IPEAT-SD

Haw Yen*[1], Jeffrey Arnold[2], Michael White[3], James Ascough II[4], Douglas Smith[5], Qingyu Feng[6]

1. Assistant Research Scientist, Texas A&M University, USA. Email: hyen@brc.tamus.edu (corresponding author)
2. Agricultural Engineer, USDA-ARS, USA.
3. Agricultural Engineer, USDA-ARS, USA.
4. Research Hydrologic Engineer, USDA-ARS, USA.
5. Research Soil Scientist, USDA-ARS, USA.
6. Research Associate, Purdue University, USA.

Abstract

The ordinary approach to calibrate a watershed simulation model is to minimize the differences between the simulation outputs against temporal observation data (hard data). However, it has been shown that watershed calibration without considering soft data (non-temporal, summarized output such as denitrification rate) could lead to substantially biased model predictions. In this study, the IPEAT-SD (Integrated Parameter Estimation and Uncertainty Analysis Tool – Soft & hard Data evaluation) was developed by integrating IPEAT and SWAT-Check (post-processing program in examining SWAT outputs) with 59 soft data constraints. By the applications of IPEAT-SD, the quality of models predictions would be maintained by restraining actual watershed behavior during the calibration processes. IPEAT-SD was applied at two watersheds, the Eagle Creek Watershed in Indiana and the Coon Creek Watershed in Wisconsin, USA. Both applications included calibration with and without soft data. In addition, comparisons between two case studies reflected the advantages and necessity of incorporating soft data in the calibration process. The framework of IPEAT-SD is not limited to the SWAT model but can also be implemented to other watershed simulation models with various purposes.

Keywords

Constrained calibration; Soft and hard data; IPEAT; SWAT

Can we trust what we get for free?

Chris George*[1]

1. Email: cgeorge@mcmaster.ca (corresponding author)

Abstract

SWAT is public domain software: it costs nothing to buy. Does this make it worthless? I discuss the characteristics of software that make it valuable, particularly for scientists and engineers. I explain why scientific software should be open source, and the importance of open standards. Drawing on my experience of writing and maintaining MWSWAT, SWATPlot and QSWAT I discuss how to make open source software more reliable.

Keywords

open source software, free software, scientific software, FLOSS

From the Mountains to the Plains: Impact of Climate Change on Water Resources of the Koshi Basin

Luna Bharati[*1], Ustav Bhattarai[2], Ambika Khadka[3], Pabitra Gurung[4]

1. Senior Researcher-Hydrology and Water Resources, International Water Management Institute. Email: L.bharati@cgiar.org (corresponding author)
2. Water Resources Modeler, Water Modeling Solutions Pvt. Ltd..
3. Research Officer-Hydrology, International Water Management Institute.
4. Water and Sanitation Coordinator, DanChurchAid Nepal.

Abstract

This paper assesses the impact of climate change (CC) on spatial and temporal water balances of Koshi basin (China, Nepal and India) using Soil and Water Assessment Tool (SWAT). The model was calibrated and validated using daily flow data at five gauging stations representing five major tributaries of Koshi River within Nepal and they showed good performance. The CC analysis is based on the most recent IPCC AR5 scenarios (RCP4.5 and RCP8.5). Delta change approach was used to generate daily future time series climate data for 2021-2050 from the reference period (1998-2008). The annual average precipitation, actual ET and net water yield for reference period are 1720mm, 520mm and 1124mm for the basin with over 75% of precipitation and flow occurring in monsoon months. The precipitation and net water yield are lowest in the trans-mountain region, highest in the mountain followed by hills, whereas actual ET increases from northern to southern part of the basin. The impact of CC shows increasing trend for precipitation and water yield for most of the basin except for trans-mountain region, which shows decreasing trend for both CC scenarios. The actual ET shows increasing trend for both CC scenarios. Due to CC, the future average and maximum monsoon flows will be higher than past indicating that the impact of CC to be severe during monsoon, whereas future dry season flows are within the past ranges, also suggesting that adaptation strategy might already exist. It is important to identify when and where the future variability is different from the reference period variability to target water resource planning and adaptation strategies. It also signifies that variability in hydrological regime is necessary to understand the uncertainty involved in CC projections. The Koshi basin being an important region with high potential for hydropower and irrigation development to promote economic development, assessment of spatial and temporal water balances and the impacts of CC in their variability is extremely necessary for future basin development plans.

Keywords

Climate change, water balances, SWAT, AR5 scenarios, precipitation, actual ET, net water yield, hydrological regime, CC projections

Impacts of Climate Change on Nitrogen Load and its Control in the Upper Huai River Basin, China

Xiaoying Yang*[1]

1. Ph.D., Fudan University. Email: xiaoying@fudan.edu.cn (corresponding author)

Abstract

The Huai river basin of China is faced with severe water security challenges in terms of both water quantity and water quality, which is characterized with uneven distribution of water resources, complex water pollution sources, and high sensitivity to climate change. Climate change has imposed additional uncertainties on the water security situation in the river basin. In this study, nitrogen loads from all known anthropogenic pollution sources in a river basin upstream of the Huai River were simulated with the process-based SWAT model. The performance of SWAT driven by daily and hourly rainfall inputs was assessed and it was found the one driven by hourly rainfall outperform the one driven by daily rainfall in simulating total nitrogen (TN) loads. Based on sixteen GCMs' outputs under the RCP45 and RCP85 scenarios, the hourly SWAT model was used to assess the impacts of climate change on the TN load of the river basin and the associated uncertainties. In addition, the hourly SWAT model was used to evaluate the effectiveness of three typical watershed pollution control measures for TN load reduction and the potential impacts of climate change on their effectiveness. It is found that climate change is likely to have much impact on the TN load as well as the effectiveness of the watershed pollution control measures in the river basin, which needs to be fully incorporated in the development of local water security programs.

Keywords

SWAT, climate change, nitrogen, uncertainty, Huai River

Evaluation of Paddy Field Algorithm in SWAT Program for Water Yield Prediction of Watershed Containing Paddy Field in Indonesia

Asep Sapei*[1], Yuli Suharnoto[2], Sutoyo -[3], Eri Stiyanto[4]

1. Prof. Dr./Bogor Agricultural University-Indonesia. Email: asep_sapei@yahoo.com (corresponding author)
2. Dr./Bogor Agricultural University-Indonesia.
3. MSc./Bogor Agricultural University-Indonesia.
4. MSc/Bogor Agricultural University-Indonesia.

Abstract

Soil and Water Assessment Tool (SWAT) is a hydrological model developed in the United States. It has been widely used in Asia to assess the impact of land use to discharge and sedimentation where the paddy field cultivation needs flooding.. However,the calculation of the water balance algorithm in SWAT is still the same with other crops. The objective of the research is to evaluate the application of paddy field algorithm developed by Sakaguchi et. al. (2014) in SWAT program. The evaluation was carried out in upper watershed Cisadane, West Java, Indonesia. The research showed that the new algorithm showed better discharge predictions than the original one as it is indicated by the relatively high value of determination (R^2) and the Nash-Sutcliffe efficiency (NSE). The R^2 of the new algorithm were 0.59 for daily discharge and 0.757 for monthly discharge compared to the original one: 0.537 for daily, 0.707 for monthly. The NSE values of the new algorithm were 0.477 for daily discharge and 0.613 for monthly discharge compared to the original one: 0.427 for daily, 0.563 for monthly.

Keywords

Paddy Field Algorithm, SWAT, Watershed, Water Yield

Simulating Evapotranspiration Using the SWAT Model in a Paddy Field Dominated Basin

Di Fang[1], Lu Hao[*2], Hong Qian[3], Mengsheng Qin[4], Lei Sun[5], Tingting Shi[6]

1. Graduate Student,International Center for Ecology, Meteorology, and Environment (IceMe), Jiangsu Key Laboratory of Agricultural Meteorology, Nanjing University of Information Science and Technology, Nanjing, China.
2. Professor, PHD, International Center for Ecology, Meteorology, and Environment (IceMe), Jiangsu Key Laboratory of Agricultural Meteorology, Nanjing University of Information Science and Technology, Nanjing, China, 219 Ningliu Road, Nanjing, 210044,. Email: hl_haolu@163.com (corresponding author)
3. Graduate Student,International Center for Ecology, Meteorology, and Environment (IceMe), Jiangsu Key Laboratory of Agricultural Meteorology, Nanjing University of Information Science and Technology, Nanjing, China.
4. Graduate Student, International Center for Ecology, Meteorology, and Environment (IceMe), Jiangsu Key Laboratory of Agricultural Meteorology, Nanjing University of Information Science and Technology, Nanjing, China.
5. Graduate Student, International Center for Ecology, Meteorology, and Environment (IceMe), Jiangsu Key Laboratory of Agricultural Meteorology, Nanjing University of Information Science and Technology, Nanjing, China.
6. Graduate Student, International Center for Ecology, Meteorology, and Environment (IceMe), Jiangsu Key Laboratory of Agricultural Meteorology, Nanjing University of Information Science and Technology, Nanjing, China.

Abstract

One of the impacts of urbanization on the environment is the variation of land use/cover, which would result in the change of the evapotranspiration (ET) in river watershed and the change of surface runoff, and then affect hydrological process. We conduct our case study in the Qinhuai river basin (QRB) in the highly urbanized Yangtze River Delta region. The overall goal of this study is to understand the key driving processes of ET and its mechanisms underlining the hydrologic impacts of converting rice paddy fields to urban uses. The traditional watershed ecohydrological simulation model (SWAT) was applied for the paddy field-dominated basin. The remote sensing method was applied to estimate the actual ET during 2000-2013 and calibrate and validate the simulation results of the SWAT. The SWAT model simulations matched not very well to measured ET during 2000-2013 (correlation coefficient R = 0.64; Nash-Sutcliffe NS = 0.57). We conclude that during the past decade, the QRB went through dramatic land cover changes characterized by an increase in urban areas and a decrease in paddy fields, accompanied by the decrease of the actual ET of the basin. The water movement in irrigation districts, especially for paddy rice cultivation, is characterized by complicated factors. The SWAT model needs to be improved and adapted for the paddy field-dominated basin.

Acknowledgements
This work was supported by the Natural Science Foundation of China (41571026), The SWAT model was provided by the USDA-ARS, USA.

Keywords

SWAT model; evapotranspiration; urbanization; Land use and land cover; the Qinhuai River basin

swat.tamu.edu/conferences/2016

TEXAS A&M AGRILIFE RESEARCH

USDA ARS Agricultural Research Service