4TH INTERNATIONAL SWAT CONFERENCE

BOOK OF ABSTRACTS

UNESCO-IHE
Institute for Water Education
Delft, The Netherlands

July 4-6, 2007

Table of contents

Wednesday, July 4th 2007

Session 1: Agricultural management (1A)
Convener: Daniel Moriasi

14:00 – 14:20	**Isabelle Baudin** SWAT: A tool for BMP implementation
14:20 – 14:40	**Jos van Orshoven** Possibilities and limitations of AVSWAT2000 for the assessment of the environmental impacts of farming practices
14:40 – 15:00	**Vinay Pandey** Development of effective management plan for a small watershed using AVSWAT
15:00 – 15:20	**Manoj Jha** Optimal placement of conservation practices in Iowa watersheds using Genetic Algorithm with SWAT

SWAT: A tool for BMP implementation

Isabelle Beaudin, Julie Deslandes and Aubert Michaud

E-mail : isabelle.beaudin@mail2.irda.qc.ca
Institut de recherche et de développement en agroenvironnement. 2700, rue Einstein, Québec, Québec, Canada, G1P 3W8.

ABSTRACT

An agreement between the governments of the province of Québec (Canada) and the state of Vermont (USA) calls for a 41% decrease in phosphorus (P) loads reaching Missisquoi Bay, the northern portion of Lake Champlain. The agreement particularly targets the agricultural sector, since 80 % of non-point source P inputs to the bay are associated with cultivated lands. In order to identify sustainable cropping practices likely to help meet the target P loads, the SWAT (Soil and Water Assessment Tool) model was employed to assess hydrological processes, erosion and P mobility on the bay's principal Québec P contributing area, the 630 km^2 Pike River watershed. Strong in-watershed spatial clustering of vulnerability to non-point source exports highlights the need for targeted implementation of sustainable agricultural practices and soil conservation works, to derive the greatest environmental benefits. Planting cover crops over the 10 % most vulnerable lands would result in a 21 % drop in overall P exports at the watershed outlet, whereas the same 10 % randomly distributed over the watershed would only contribute to a 6 % drop in P exports. The study of different field-scale management scenarios indicated that achieving the targeted 41 % reduction in P exports, would require the widespread (half the land devoted to annual crops) implementation of sustainable cropping practices, and the conversion of a specific 10 % of the territory to either cover crops or permanent prairie-land. Meeting the P target-loads would require additional investments in the protection of flood-plains and riparian strips, the targeted construction of runoff-control structures, and the rapid soil incorporation of manures on lands dedicated to annual crops.

POSSIBILITIES and Limitations of AVSWAT2000 for the Assessment of Environmental Impacts of Farming Practices

J. Van Orshoven[1], J. Coppens[2] and J.-M. Terres[3]

[1] Professor, Department of Land management and economics, Katholieke Universiteit Leuven, Celestijnenlaan 200E, BE-3001 Leuven-Heverlee, Belgium
[2] Master student Land and Forest Management, Katholieke Universiteit Leuven, Belgium
[3] Action leader, Institute for Environment and Sustainability, Joint Research Centre of the European Commission, Via E. Fermi, IT-21020 Ispra (VA), Italy
E-mail from Van Orshoven: jos.vanorshoven@sadl.kuleuven.ac.be.

Abstract

Farming practices (FP) affect the transport and fate of water, carbon, nitrogen, phosphorus, pesticide and other bio-geo-chemical substances in agricultural watersheds. We used the AVSWAT2000-modelling framework to assess environmental impacts of an array of FP and evaluated its possibilities and limitations for this purpose. We mainly considered FP which are important in the context of the EU's Common Agricultural Policy: diversification of crop rotations, introduction of cover crops, shift to zero-tillage, shift to organic fertilization, afforestation. We calibrated SWAT for total discharge in a medium-sized, almost flat, semi-rural watershed taking into account current FP. Next we simulated 11 land use and land management scenarios involving the selected FP. We finally compared the scenarios in terms of the modeled discharge at the outlet and the soil organic carbon stocks of HRU. Although the relative simulation results are largely according to expectation, we found that the plant growth and management modules of AVSWAT2000 are not fully operational to efficiently and realistically parameterize and evaluate the impacts of FP. We identified the simulation of biomass development over time, the computation of a true carbon balance, the handling of crop rotations and the definition of the till-operation to be among the major points of attention for improving AVSWAT2000's capabilities in dealing with FP and their environmental effects.

Development of effective management plan for a small watershed using AVSWAT

V. K. Pandey,[1*] S. N. Panda[2], N. S. Raghuwanshi[3] and S. Sudhakar[4]

E-mail: vkp12@yahoo.co.in

[1] Department of Soil and Water Engineering, Faculty of Agricultural Engineering
Indira Gandhi Agricultural University, Raipur-492006 (C.G.) India.
[2 & 3] Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur-721302 (W.B.) India

[4] National Remote Sensing Agency, Indian Space Research Organization
Government of India, Hyderabad-500037 (A.P.) India

Abstract

In the present investigation on effort has been made to identify the critical sub watersheds for development of best management plan for a small watershed of Eastern India using a hydrological model namely AVSWAT2000. Total 180 combinations of various management treatments including crops (Rice, maize ground nut and soybean); tillage (zero, conservation, field cultivator, mould board plough and conventional practices) and fertilizer levels (existing, half of recommended and recommended) have been evaluated. The investigation reveled that rice can not be replaced by other crops like groundnut, maize, mungbean, sorghum and soybean since comparatively these crops resulted in higher sediment yield. The tillage practices with disk plough has been found to have more impact on sediment yield and nutrient losses than conventional tillage practices for the existing level of fertilizer. Sediment yield decreased in case of zero tillage, conservation tillage, field cultivator, moldboard plough, conservation tillage as compare to conventional tillage. Lowest NO_3-N loss was observed in zero tillage in all the fertilizer treatments, where as field cultivator, moldboard plough and disk plough resulted increased in NO_3-N loss. As compare to conventional tillage the losses of soluble phosphorus were increased in moldboard plough. The losses of organic nitrogen were also increased as fertilizer dose increased. After zero tillage the conservation tillage preformed better in all the fertilizer treatments as per loss of organic nitrogen and organic phosphorus is concerned. It can be concluded that the sediment yield was found to be the highest in case of disk plough followed by moldboard plough, field cultivator, conventional tillage, field cultivator and least in zero tillage practices, where as the nutrias losses were found to he in different order with tillage practices, resulted highest nutrient losses in disk plough tillage practices. In view of sediment yield and nutrient losses, the conservation tillage practice was found to he the best as the sediment yield is less than the average soil loss where as nutrient loss is within the permissible limit.

Optimal placement of conservation practices in Iowa watersheds using Genetic Algorithm with SWAT

Manoj Jha*, Sergey Rabotyagov, Philip W. Gassman, Hongli Feng, and Todd Campbell

Email: manoj@iastate.edu
* Center for Agricultural and Rural Development, 560 Heady Hall, Iowa State University, Ames, IA 50011.; phone: 515-294-7695; Fax: 515-294-6336.

ABSTRACT

Due to the unique nature of the biophysical relationship between conservation practices and resulting water quality levels, the effectiveness of a given conservation practice on a given field depends on the placement of conservation practices and cropping systems in the watershed. Additionally, multiple conservation practices exist for each field in the sense that there are a potentially large number of conservation practices that could be implemented on each field. This means that solving for the optimal solution requires comparing a very large number of possible land use scenarios. Specifically, if there are "N" conservation practices possible for adoption on each field and there are "F" fields, this implies a total of N^F possible configurations to compare. In a watershed with hundreds of fields and more than a couple of conservation practices, this comparison quickly becomes unwieldy. Fortunately, the recent development of genetic algorithms provides a solution strategy for just this sort of problem. Genetic algorithms mimic the process of evolution, which, in effect, is a method of searching for solutions among an enormous amount of possibilities.

In this application, we use the water quality model SWAT in conjunction with detailed information on conservation practices, and calibrate the model for flow, sediment, and nutrients for a watershed in Iowa. The genetic algorithm is then applied to the SWAT model to find an optimal allocation of conservation practices that minimizes the water quality pollution level at the watershed outlet. The set of practices include contour farming, field buffers, contour buffers, terraces, reduced tillage, and land retirement.

Wednesday, July 4th 2007

Session 2: Sediment modelling (1B)
Convener: Sue White

14:00 – 14:20	**Jari Koskiaho** Assessment of Hydrology and Sediment Transport and Prospects of Simulating Agri-Environmental Measures with SWAT
14:20 – 14:40	**Yiannis Panagopoulos** LAND Use Change Effects on River Sediment Yields in Western Greece
14:40 – 15:00	**P.M. Ndomba** Sediment Yield Modelling using SWAT model at Larger and Complex Catchment: Issues and Approaches. A Case of Pangani River Catchment, Tanzania
15:00 – 15:20	**Peter Allen** Rapid Geomorphic Assessment of Watershed Sediment Budgets for Water Supply Reservoirs Using SWAT and Sub-Bottom Acoustical Profiling

Assessment of Hydrology and Sediment Transport and Prospects of Simulating Agri-Environmental Measures with SWAT

Jari Koskiaho[1], Sirkka Tattari[2] & Ilona Bärlund[3]

[1]Research Engineer, Finnish Environment Institute, PO Box 140, FIN-00251 Helsinki, Finland.
E-mail: jari.koskiaho@ymparisto.fi.
[2]Hydrologist, Finnish Environment Institute, PO Box 140, FIN-00251 Helsinki, Finland
[3]Research Manager, University of Kassel, Kurt-Wolters-Str. 3, D-34109 Kassel, Germany.

Abstract

Tools are needed to assess loading from agricultural sources to water bodies as well as the effect of alternative management options in varying environmental conditions. For this, mathematical models like SWAT offer an attractive option. In addition to loading estimates, SWAT also offers a possibility to include various agricultural management practices like fertilization, tillage practices, choice of cultivated plants, buffer strips, sedimentation ponds and constructed wetlands (CWs) in the modeling set-up. In this study, the parameterization of SWAT has been developed particularly in terms of discharge dynamics and sediment fluxes and a sensitivity analysis was made. Moreover, modeling strategies with dominant land uses and soil types vs. land uses and soil types exceeding certain thresholds within subcatchments were compared. In the thresholds-exploiting SWAT project agricultural land was divided into 5 classes whereas the "competing" project only had 2 classes. These SWAT modeling exercises were performed for a 2nd order catchment (Yläneenjoki, 233 km^2) of the Eurajoki river basin in southwestern Finland. The Yläneenjoki catchment has been intensively monitored during more than 10 years. Hence, there is abundant background information available for both parameter setup and calibration. Moreover, information on local agricultural practices and the implemented an planned protective measures are readily available thanks to aware farmers and active authorities. In future, our aim is to exploit this knowledge by modeling different management scenarios and assessing their effects on loading with SWAT.

Keywords: SWAT, agriculture, hydrology, sediment loading, management actions.

LAND Use Change Effects on River Sediment Yields in Western Greece

Y. Panagopoulos[1], E. Polyzoi[2] and M. Mimikou[3]

Laboratory of Hydrology and Water Resources Management, Department of Water Resources and Environment, National Technical University of Athens (NTUA), 5, Iroon Politechniou street, 15780, Zografou, Athens, Greece.
Contact Information
[1] tel: +302107722886, fax: +302107722879, e-mail: ypanag@chi.civil.ntua.gr
[2] tel: +302107722886, fax: +302107722879, e-mail: efi_polyzoi@yahoo.gr
[3] tel: +302107722878, fax: +302107722879, e-mail: mimikou@chi.civil.ntua.gr

Abstract

The purpose of this paper is to implement the "Soil and Water Assessment Tool" model in order to examine the effects that land use change scenarios have on river sediment yields of the Arachtos catchment in Western Greece. Prior to the scenarios, the particular hydrological and erosion regime of the catchment, representative of the Mediterranean climate, was fully demonstrated. The main anthropogenic intervention in the Arachtos river is a dam construction a few kilometres above the watershed outlet that traps sediment material causing the rapid decrease of the reservoir dead storage capacity and the dramatic reduction of sedimentation rates at the estuary.
SWAT successfully predicted soil losses from different HRUs that caused significant river sediment yields. Facing the problem of reservoir inadequacy in the near future, the study attempted to assess the impact of pre-specified land use change scenarios, in terms of quantifying the results from the application of crop rotations and special cultivation techniques on parts of the agricultural land that was the most susceptible landcover type to erosion. All scenarios resulted in a decrease in soil losses and sediment yields comparing to the current state, with winter wheat cultivation under strip-cropping system causing the highest annual reduction of sedimentation rates in the reservoir.
The model predicted explicitly the consequences of non-structural mitigation measures against erosion sustaining that the understanding of land use changes in relation to its driving factors provides essential information for land use planning and sustainable management of soil resources, under the special Mediterranean conditions of Greece.

Keywords: SWAT, agricultural land, erosion, soil losses, sedimentation rates, sediment yields, land use change scenarios, reservoir.

Sediment Yield Modelling Using SWAT model at Larger and Complex Catchment: Issues and Approaches. A Case of Pangani River Catchment, Tanzania

P.M. Ndomba[1*], F.W. Mtalo[1], and A. Killingtveit[2]

[1]University of Dar es Salaam, Tanzania and [2]Norwegian University of Science and Technology, Norway
Email*: pmndomba@ucc.ac.tz or pmndomba2002@yahoo.co.uk

Abstract

A semi-distributed, physics based watershed model, Soil and Water Assessment Tool (SWAT) was used to model sediment yield in a larger and complex catchment where the dominant erosion process is sheet erosion. Based on adequate data of subdaily and daily sediment flow and streamflow at the study area an excellent suspended sediment-rating curve has been established and verified. Since, the ongoing study intends to predict long-term sedimentation rate and the remaining economic life of the reservoir downstream, the lumping nature and assumptions of stationarity and linearity of the rating relationship are not desired. Therefore, a more process based and distributed tool was required. The runoff component of the SWAT model was calibrated from six years of streamflow data, whereas the sediment component of the model was calibrated using daily sediment flow data from one hydrological year. A long-term period over 37 years simulation results of the SWAT model was validated to downstream Nyumba ya Mungu reservoir sediment accumulation information.

The SWAT model captured 56 percent of the variance of the observed daily sediment loads during calibration period. In the latter period the model underestimated the observed sediment load by 0.9 percent. Also, the model has identified erosion sources spatially and has replicated some erosion processes as determined from indirect methods, fingerprinting techniques and field observations. The predicted and measured long-term sediment yields are comparable with a relative error of 2.6 percent. This result suggests that for catchments where sheet erosion is dominant SWAT model is a better substitute of the sediment-rating curve and long-term prediction of sedimentation rate can be done with reasonable accuracy. It should be noted that the calibration was done during the normal wet year when most of hydrometeorological data required for SWAT model is available.

Keywords: Sediment Yield Modelling, Sediment rating curve, SWAT, Pangani River Catchment, Tanzania.

Rapid Geomorphic Assessment of Watershed Sediment Budgets for Water Supply Reservoirs Using SWAT and Sub-Bottom Acoustical Profiling

P. M. Allen[1/], B. Narasimhan[2/], J. Dunbar[1/], S. Capello[1/] and R. Srinivasan[2]

[1] Department of Geology, Baylor University, Waco, TX – 76798
[2] Spatial Sciences Laboratory, Texas A&M University, College Station, TX – 77843.

Abstract

Reservoirs in North Texas supply over 99 percent of the water to the Dallas Fort Worth Metroplex or to over 5.8 million people. The rate of sedimentation to these reservoirs has been estimated to be in the range of 2 cm a year. This is equivalent to an annual loss of future water supply for up to 3000 people per reservoir (lost storage capacity). The costs of new reservoirs as well as the cost of dredging makes options other than watershed management (BMP's) unrealistic. In order to best manage sedimentation into the reservoir, the source of sediment into the reservoir must be quantified. This study represents the approach used by the Tarrant Regional Water District to study reservoir sedimentation. It consists of three integrated steps: (1) rapid geomorphic assessment by sub-watershed and physiographic province to ascertain the magnitude of active processes; sheet/rill; gully; stream erosion supplemented with historic air photographic inventory (2) profiling the reservoir with differential GPS and a 5 transducer sub-bottom acoustical system which gives sediment thickness within the reservoir which is verified with vibracore and Cesium 137 analysis, and (3) modeling the watershed with the SWAT model calibrated to the total volume of sediment as detailed in the survey, watershed erosion processes, any gaged data, climate and land use. Failure to follow each step is shown to produce large errors in the model and potential effectiveness of BMP's.

Wednesday, July 4th 2007

Session 3: Climate change (1A)
Convener: Valentina Krysanova

15:50 – 16:10	**Claudia Hiepe** Modelling soil erosion in a sub-humid tropical environment at the regional scale considering land use and climate change
16:10 – 16:30	**Faith W. Githui** Assessment of impacts of climate change on runoff: River Nzoia catchment, Kenya
16:30 – 16:50	**Mike Winchell** Modeling the Impacts of Municipal Consumption Rates, Outflow Regulation, and Climate Change on a Small Water Supply in North-Central Vermont

Modelling soil erosion in a sub-humid tropical environment at the regional scale considering land use and climate change

C. Hiepe[1], B. Diekkrüger[2]

[1]PhD student, Institute of Geography, University of Bonn, Bonn, Germany
[2]Professor, Institute of Geography, University of Bonn, Bonn, Germany
E-mail: claudia.hiepe@giub.uni-bonn.de.

Abstract

Soil degradation is a severe problem in Africa. The resulting decline of crop yields threatens food security and forces poverty, migration and land use conflicts. In this study, which is part of the German integrated water resource management project IMPETUS, the SWAT2005 model was applied to the Upper Ouémé catchment, Benin (~14500 km^2) in order to quantify water and sediment yield. Future climate and land use change were considered. Prior intervention areas for soil conservation measures should be identified.

The model was successfully calibrated and validated for the years 1998 to 2005 using daily measurements of discharge and suspended sediment concentration at various outlets in the catchment. Subsequently, the model was applied for different scenarios of climate and land use change until 2025 and 2050. Therefore, spatially distributed results from the regional climate model REMO (IPCC SRES scenarios A1B and B1) and the land use/land cover change model CLUE-S, produced by other IMPETUS members, have been processed. CLUE-S results were disaggregated from a 250 m to a 25 m grid for a better representation of agricultural land. Daily REMO output in a 0.5° grid resolution was attributed to the rain gauge sites considering the rainfall distributions of the rain gauges to obtain a correct frequency distribution of site-specific events.

The results of the scenario analysis for the period 2000-2025 indicate opposed impacts of land use change and climate change on water and sediment yield in the same order of magnitude. Land use change led to a strong increase in sediment yields in several subbasins, whereas climate change, in particular lower precipitation, reduced water and sediment yield in most parts of the catchment. Regions with actual and future high erosion risk were identified.

Keywords: SWAT, soil erosion, climate change, land use change, Africa, Benin, tropics

Assessment of impacts of climate change on runoff: River Nzoia catchment, Kenya

Githui F. W*[+], W. Bauwens[+] and F. Mutua*

[+]Vrije Universiteit Department of Hydrology and Hydraulic Engineering, Brussels, 1050 Brussels *University of Nairobi, Department of Meteorology, P O Box 30197, Nairobi.
E-mail: fgithui@vub.ac.be.

Abstract

The SWAT model has been used to investigate the impact of climatic change on runoff of Nzoia river catchment in Kenya. River Nzoia is one of the several streams that drain into Lake Victoria. It has a catchment area of 12,709 km^2 and a length of about 334 km. The required model parameters were obtained from various sources while some were estimated from existing data. The model was calibrated against measured discharge data for the period 1980-1985. The model results showed relatively good fits between measured and modelled discharge with the Nash Sutcliffe efficiency and R^2 >0.7. Percentage changes in rainfall and temperature obtained from GCMs were imposed on the calibrated model. The results showed significant changes in the simulated hydrologic catchment response at the 0.05 significance level. The A2 2020 scenario GCM predicts increases in rainfall of 42% and a temperature change of about 0.8^oC yielding an increase in surface runoff of 190%. The B2 2020 predicts rainfall increase of 12% and a temperature change similar to that of A2 2020 but increasing surface runoff by 108%. In the 2050s, A2 yields changes in rainfall, temperature and surface runoff of about 12%, 1.7^oC and 72% respectively while B2 yields 11%, 1.4^oC and 77%. Results show that the 2020s are likely to experience more flooding events as a result of increased rainfall than in the 2050s. For the same amount of increase in rainfall (12%), a temperature difference of about 0.32^oC did not show any significant change in the amount of water yields while that of about 0.84^oC did show significant change.

Modeling the Impacts of Municipal Consumption Rates, Outflow Regulation, and Climate Change on a Small Water Supply in North-Central Vermont

Michael Winchell[1], Dave Braun[1], and Raghavan Srinivasan[2]

Email: r-srinivasan@tamu.edu
1. Stone Environmental, 535 Stone Cutters Way, Montpelier, VT 05602, 2. Texas A&M University, College Station, Texas

Abstract

The SWAT model was used to investigate the impacts of increased municipal consumption rates, alternative downstream minimum flow requirements, and future climate change on water levels for a water supply reservoir in Montpelier, Vermont. Montpelier is a small city of approximately 8,000 residents located in North-Central Vermont. The city's water supply is the 103 hectare Berlin Pond which drains approximately 26.8 square km. The watershed is composed of primarily deciduous forest and experiences cold wet winters and warm humid summers with average annual precipitation of approximately 1000 mm, 25% of which falls as snow. The city of Montpelier wished to evaluate the impact of increased water withdrawals on water level drawdown in the environmentally sensitive pond. The SWAT model's reservoir management operations were customized to incorporate a pond level-outflow rating curve along with outflow management alternatives from the uncontrolled outlet of the pond. Projected temperature and precipitation time series for the year 2050 were generated by modifying observed time series by an adjustment factor based on output from the Hadley general circulation model 1% annual carbon increase simulation. SWAT simulations representing 25 combinations of municipal usage, downstream flow requirements, and climate regime were run using 30 years of weather data to determine pond-level exceedance probabilities under the various scenarios. The city of Montpelier is now considering the results of this analysis to guide their municipal water supply planning.

Wednesday, July 4th 2007

Session 4: Agricultural management (1B)
Convener: Ali Saleh

15:50 – 16:10	**Nina Omani** Modeling of a River Basin Using SWAT Model and GIS
16:10 – 16:30	**Hiroaki Somura** Application of the SWAT Model to the Hii River Basin, Shimane Prefecture, Japan
16:30 – 16:50	**M.P. Tripathi** Management scenario for the critical sub-watersheds of Chhokranala watershed in Chhattisgarh

Modeling of a River Basin Using SWAT Model and SUFI-2

N. Omani[1], M. Tajrishy[2], A. Abrishamchi[3]

[1]Assistant Researcher, Environment and Water Research Center (EWRC), Sharif University of Technology, Tehran, Iran E-mail: ninaomani@yahoo.com
[2] Associate Professor, Environment and Water Research Center (EWRC), Sharif University of Technology, Tehran, Iran
[3]Professor, Environment and Water Research Center (EWRC), Sharif University of Technology, Tehran, Iran

Abstract

This paper presents the hydrologic modeling for the development of management scenario and the simulation of the effect of management practices on water and sediment yielding in Gharasu watershed (5793 km^2) using the Soil and Water Assessment Tool (SWAT2000) model. The SWAT2000 interfaced with Arc View GIS data layers including Digital Elevation Model (DEM), land cover and soil map by AVSWAT2000 software. The model was calibrated from 1991 to 1996 and validated from 1997 to 2000. Then the model was calibrated again using SUFI-2. The results showed there is no considerable difference between the value of parameters that were obtained by SWAT and SUFI-2, but the duration of calibration was reduced from four months to one week. The calibrated model for hydrological conditions was used to assess suspended sediment load. Eventually, the model was used to predict the effect of changing land use and conservation practices on sediment yield within the basin.

Keywords: Karkheh River Basin, sediment yield, simulation, SWAT, SUFI-2

Application of the SWAT Model to the Hii River Basin, Shimane Prefecture, Japan

H. Somura[1], D. Hoffman[2], J. Arnold[3], I. Takeda[1], Y. Mori[1]

[1]Faculty of Life and Environmental Science, Shimane University
[2]Blackland Research and Extension Center
[3]Grassland Soil and Water Research Laboratory
E-mail: som-hiroaki@life.shimane-u.ac.jp.

Abstract

We tried to apply the SWAT model to the Hii River basin from 1986 to 2005 by daily time step. As a first step of application of the SWAT model to the basin, we paid attention to discharge of the River. The Hii River basin is in the eastern part of Shimane Prefecture, Japan. It covers an area of about 900 km^2 and the length of the river from the source to Ootsu river discharge observation station, where is outlet of whole basin, is about 150 km. About 80% of the land use in the basin is forest and 10% is paddy fields. The parameters were calibrated from 1993 to 1996 and validated from 1986 to 1992 and from 1997 to 2005. The calibrated parameters automatically, which were CANMX, ALPHA_BF, SOL_AWC, SOL_Z, CH_K2, SMFMX, GWQMN, CN2, ESCO and SLOPE, were selected by ranking of sensitivity analysis. The both results of calibration and validation were represented fluctuations of discharge relatively well, though some peaks were overestimated. During the calibration period, R^2 varied from 0.65 to 0.77 and *NSI* did from 0.64 to 0.76. During the validation period from 1986 to 1992, R^2 varied from 0.58 to 0.74 and *NSI* did from 0.53 to 0.74. As well, from 1997 to 2005, R^2 varied from 0.51 to 0.71 and *NSI* did from 0.38 to 0.68. Due to advance a next step, it will be necessary to improve density of climatic gages and accuracy of soil and land use information.

Keywords: Runoff analysis, watershed management, GIS

Management scenario for the critical sub-watersheds of Chhokranala watershed in Chhattisgarh

M. P. Tripathi[1], P. K. Shrivastava[2] and S. K. Dwivedi[3]

1. Asso. Prof., AICRP on GWU 2. Research Associate 3. Asst. Professor
Indira Gandhi Agricultural University, Raipur- 492 006 India. E-mail: drmpt64@hotmail.com

ABSTRACT

A distributed parameter model, the Soil and Water Assessment Tool (SWAT) was tested on monthly and seasonal basis and used for developing management scenarios for the critical sub-watersheds of a small agricultural watershed of Chhattisgarh (Chhokranala). The watershed and sub-watershed boundaries, drainage networks, slope and soil texture maps were generated using GIS. Supervised classification method was adopted for land use/cover classification from satellite imagery using ERDAS Imagine. Manning's 'n' for overland and channel flow, and Fraction of Field Capacity (FFC) were calibrated for monsoon season of the years 2002 to 2003. The model was validated for the years 2004 to 2005. Results revealed that the model was predicting the monthly and seasonal surface runoff and sediment yield satisfactorily. Simulation results of nutrients including organic N and P in sediment and NO_3-N and soluble P in runoff were also compared with observed data for several events and found satisfactory. The critical sub-watersheds were identified on the basis of average annual sediment yield and nutrient losses during the study period. Out of seven sub-watersheds, SW5, SW6 and SW7 were found to be critical. Several combinations of treatment options were considered which included four crops, five tillage and three levels of fertilizer. The existing management practice was considered as the base for evaluating other management practices for rice. The results showed other crops couldn't replace rice since these crops resulted in higher sediment yield as compared to rice. Considering both sediment and nutrient losses together the zero tillage, conservation tillage and field cultivator with half dose of fertilizer (40:30 of N:P kg/ha) were found to be better than the other treatments considered for evaluating their impact on sediment yield and nutrient losses for sub-watershed (SW5).

Thursday, July 5th 2007

Session 5: Integrated modelling (1A)
Convener: Roland Price

08:30 – 8:50	**Chris George** MWSWAT: free GIS support for SWAT
08:50 – 09:10	**Pierluigi Cau** The WEB BASHYT DSS: A Web Based Decision Support System For Water Resources Management
09:10 – 09:30	**Ali Saleh** Application of environmental models SWAT and APEX and Farm Economic Model using SWAPP program to evaluate BMBs at the field and watershed levels.
09:30 – 09:50	**Jan Cools** Modelling the impact of emission reduction measures with SWAT: a tool to set up river basin restoration plans

MWSWAT: free GIS support for SWAT

Chris George
United Nations University International
Institute for Software Technology, Macao. E-mail: Chris George cwg@iist.unu.edu

Luis Leon
University of Waterloo, Department of Biology, Waterloo,
ON, Canada

Abstract

Integrated Water Resources Management (IWRM) is a critical necessity almost everywhere in the world. SWAT can play an important role in IWRM, but it currently needs expensive GIS support software.
WaterBase is a project of the United Nations University aiming to support IWRM in developing countries. Its first output is a free, open source interface MWSWAT that generates the inputs for SWAT from the also free and open source GIS system MapWindow. MWSWAT is also designed to exploit GIS data that is available on the internet.

THE BASHYT DSS: A WEB BASED DECISION SUPPORT SYSTEM FOR WATER RESOURCES MANAGEMENT

B. Cau[1], G. Meloni[1], S. Manca[2] and P. Cau[2]

1) ERA Progetti (http://era.hoptp.org), Via Monti, 09100 Cagliari, Italy (tel.+39 0783772078) – brunocau@libero.it – albedo.ambro@tiscali.it
2) CRS4 (www.crs4.it), Parco Scientifico e Tecnologico, POLARIS, 09010 Pula, Italy. pierluigi.cau@gmail.com – simone.manca@gmail.com

Abstract

Prediction, prevention, or minimization of point and diffuse pollution is an important topic for scientific research. Environmental sciences are evolving from a simple, local-scale approach toward complex multilayered, spatially explicit regional ones. The advances in computer simulation and high performance computing in recent years have highly extended the possibilities in this field, and have changed the ways in which land management systems operate. The Basin Scale HYdrological Tool – BASHYT - is a Collaborative Working Environment (CWE) on the web that relies on hydrological models and web-GIS technologies to support decision makers, through a user-friendly Web interface, in the field of sustainable water resources management. The portal, for the general user, exposes hydrological applications based on the SWAT [*Neitsch et al, 2005*] and QUAL 2K [*Brown, L.C. and Barnwell, 1987*] models to quantify the impact of point/non point pollution. Within the experimental CWE environment, modules have been developed to run real-time applications based on numerical solvers, run pre- and post-processing codes, query and map results through the web browser.
Free software and in-house technologies are combined to transparently and automatically deploy the applications on the portal. Our objective is to build a development platform, made of a set of loosely coupled services, that promotes joint initiatives and encourages cooperation among interdisciplinary teams operating in the environmental sciences. To illustrate the potentiality of our decision support system (DSS), we present its application to a Sardinian case history where a complex watershed is threatened by point pollution and intensive agriculture.

Application of environmental models SWAT and APEX and Farm Economic Model using SWAPP program to evaluate BMBs at the field and watershed levels.

Ali Saleh [1], Edward Osei, and Oscar Gallego
[1)]Texas Institute for Applied Environmental Research (TIAER), Tarleton State University, Stephenville, USA. E-mail: saleh@tiaer.tarleton.edu

ABSTRACT

Environmental models are used to assess and evaluate various best management practices (BMPs) at field (e.g., Agricultural Policy/Environmental eXtender, APEX) and watershed (e.g., Soil and Water Assessment Tool, SWAT) levels. However, models such as SWAT and APEX are only capable of simulating mechanistically a limited number of BMP scenarios individually. Furthermore, most computer model applications do not include economic assessment of BMPs, which are critical for optimal practice implementation. Therefore, the SWAPP program was developed to: 1) convert SWAT files to-and-from APEX format and simulate SWAT and APEX simultaneously to take advantage of the strengths of both models; and 2) evaluate the economic impact of BMPs at the field and watershed levels through integration of APEX and SWAT with a farm economic model. In this presentation the SWAPP program and its nested models including APEX, SWAT and the FEM will be presented.

MODELLING THE IMPACT OF EMISSION REDUCTION MEASURES WITH SWAT: A TOOL TO SET UP RIVER BASIN RESTORATION PLANS

Jan Cools[1,2], Marc Huygens[1] & Willy Bauwens[2]

[1] Soresma/Haecon NV, Poortakkerstraat 41, B-9051 Ghent, jan.cools@soresma.be

[2] Department of Hydrology, Faculty of Engineering Sciences,

Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium

Abstract

In order to reach the biological and chemical quality objectives, as set by the EU Water Framework Directive, emission reduction measures need to be taken for most water bodies in Flanders. The physical complexity of a river basin on one side and the many interacting water-related interests on the other side raises the need for an integrated plan of reduction measures. An essential element in the setting up of a plan of measures is the determination of the impact of measures on the water quality of the receiving river. Based on the impact assessment, the optimal set of measures needs to be selected. The optimal set of measures is that combination of measures that allows to achieve the quality objectives at the lowest cost.

To support water managers in setting up river basin restoration plans, a tool is presented that is easy-to-use and hydrologically validated and that has a short calculation time.. For the selection of the most cost-effective set of measures, an economic optimization algorithm is developed in MATLAB and loosely coupled to SWAT. The optimisation algorithm comprises a mixed integer linear programming (MILP) framework with cost-minimization as the objective function and the quality objectives as target. The impact of a measure, or a combination of measures, is modeled in SWAT by considering a stepwise reduction of point and diffuse sources. Consequently, the non-linear modeling results of SWAT are linearized into an impact coefficient which serves as an input for the linear optimization algorithm.

The methodology is applied and validated for the Kleine Nete river basin in Belgium and focuses on the abatement of nitrogen pollution.

Thursday, July 5th 2007

Session 6: Soil water (1B)
Convener: Ashvani Gosain

8:30 – 8:50	**Shaeban Ali Gholami** An Estimate on soil moisture in different soil horizons of plants root zones by the SWAT model (A case study on L ATIAN Emameh Watershed)
08:50 – 09:10	**Daniel Moriasi** Incorporation of Hooghoudt's and Kirkham Tile Equations into SWAT2005
09:10 – 09:30	**Jane Frankenberger** Estimation of Nitrate Leaching from A Tile Drained Watershed Using SWAT
09:30 – 09:50	**B. Sohrabi** The effect of the operation time of sprinkler irrigation system on the cotton yield

An Estimate on soil moisture in different soil horizons of plants root zones by the SWAT model (A case study on LATIAN Emameh Watershed)

Shaeban Ali Gholami

Contact mail: ali_gholami@hotmail.com
Assistant Professor of Watershed and Soil Conservation Research Center of Iran.
P.O. Box:13445-1136 -Tehran- Iran, cel.phone: 09123194894

ABSTRACT

As one of the main elements in human life, soil is the basis source of food protection. Soil moisture is important in three aspects:

1- the quality and quantity of animal husbandry and agricultural products
2- watershed management
3- Less expenditure in measuring soil moisture.

Having enough information on soil moisture in different parts of a farm or different spots of the soil during plant growth is of great efficiency. Yet, measuring soil moisture by means of technical apparatus is time consuming and expensive.

This survey has been carried out in Latian Dam watershed area, a sub unit of Emameh, which is located from 35˚, 37΄10˝ to 35˚, 49΄5˝ northern latitude and 51˚, 31΄, 30˝ to 51˚,38΄, 40˝ eastern length. About 70%of the area is rangeland and forestland and 20% is agriculture & orchard and 10% is used as urban areas and total area is about 40 km2. In this study the SWAT Model has been used as a conceptual, distributional one that can be dramatized. Moreover, it can measure soil moisture in different places and times for planning for agricultural and natural resources proposes .this model includes a range of 56 sub models , on of which is about measuring soil moisture in different spots and aspects of soil, written by FORTRAN 90.

One of the main features of this model is calibrating, evaluating and comparing the measured units, arranged and organized in Mgt. file, with dramatized data. To do so, topographical maps of Amameh Watershed, soil map, typology of soil and preparing and analyzing soil profile has been done. Determining soil layer and soil depth, all the measures gained from different soil parameters has been classified in input Data table along with information and Data on rainfalls and analyzing statistics rainfall.

Then features such as physical characteristics of the land, climatic situation, soil characteristic and canopy cover (rangeland & agricultural& farm plants, Lai Andex and Bio-Mass) were classified in Mgt. File . All these huge mass of information was given to SWAT and satisfactory results were achieved...

There was a logical relationship between soil depth and soil water storage capacity (R^2=0.99) CN and FFC (R^2= 0.98), Soil Depth CN (R^2= 0.88) and Basic water co efficiency (α) and SW (R^2= 14%). is due to negative effect of parameters. It has been proved that based on the achieved results, there was a direct relation between FFC and SW (soil moisture co efficiency), soil depth and WP (plants welting point), but a diverse relation between FFC and CN. As mentioned before, the relation between and soil moisture isn't that much considerable which is due to many slopes and mountainous areas in the watershed. Also, the level in lime in which water flow is too low. As a result, it needs more survey and analysis.

INCORPORATION of Hooghoudt and Kirkham Tile Drain Equations into SWAT2005

D.N. Moriasi[1], J.G. Arnold[2], C.H. Green[3]

[1]Hydrologist, USDA-ARS Grazinglands Research Laboratory, El Reno, OK, USA.
E-mail: dmoriasi@spa.ars.usda.gov.
[2]Supervisory Agricultural Engineer, USDA-ARS Grassland Soil and Water Research Laboratory, Temple, TX, USA
[3]Soil Scientist, USDA-ARS Grassland Soil and Water Research Laboratory, Temple, TX, USA

Abstract

Agricultural tile drainage is a common water management practice in agricultural regions with seasonal high water tables such as the Midwest U.S. The goal of this study was to modify SWAT2005 to enable it to perform multiple scenario simulations to determine cost-effective water management systems at the watershed scale. This was accomplished by incorporating the Hooghoudt steady-state and Kirkham tile drain equations. The Hooghoudt steady-state and Kirkham equations have been successfully used in DRAINMOD, a computer simulation model that has been tested and widely used to simulate the performance of drainage and water table control systems on a continuous basis at field-scale. These equations depend on maximum depressional storage (Sd). Sd, which is assumed constant in DRAINMOD, is allowed to change, in the modified SWAT2005 model, as a function of dynamic soil random roughness. The dynamic random roughness is a function of tillage type and intensity and amount of rainfall. The drainage flux is calculated using a three-step approach. 1) Hooghoudt steady-state equation is used when the water table is below the surface or Sd; 2) Kirkham equation is used to compute the ponded surface drainage flux when the water table rises to completely fill the surface; and 3) when the drainage flux predicted by the appropriate equation is greater than the design drainage capacity (also known as drain coefficient (DC)), then the flux is set equal to DC. These algorithms were successfully incorporated into SWAT2005 and the enhanced SWAT2005 is currently undergoing validation. The modified SWAT2005 shows great potential for use in some of the conservation effects assessment project (CEAP) benchmark watersheds such as South Fork Watershed in north central Iowa and in other regions of the world with tile drainage.

Keywords: SWAT, DRAINMOD, tile drainage, depressional storage

Estimation of Nitrate Leaching from A Tile Drained Watershed Using SWAT

Jane Frankenberger and Yinghui Sui

Contact mail: frankenb@purdue.edu
Agricultural and Biological Engineering, Purdue University, 225 S. University St., West Lafayette IN 47907, Ph: 765-494-1194; Fax: 765-496-1356

ABSTRACT

Nitrate loss from agricultural fields to surface waters contributes to hypoxia in coastal areas such as the Gulf of Mexico. Although it is widely accepted that subsurface tile drains are an important contributor to nitrate loss in poorly-drained agricultural areas in the Midwestern U.S., the amount of nitrate flowing from these drains at the watershed scale is not known. The objective of this study was to simulate the effect of tile drainage on nitrate in the Sugar Creek watershed, a poorly-drained agricultural watershed within the White River basin in central Indiana . SWAT was used to predict the dynamic ground water table and tile flow by setting a restrictive soil layer at the bottom of the soil profile. A sensitivity analysis identified the parameters that have the most influence on nitrate load in this tile-drained watershed, and daily flow and monthly nitrate load have been calibrated by manual and automatic calibration methods. The calibrated model will be used in long-term simulations to estimate nitrate contribution from the tile drains, and the likely water quality impact of innovative drainage management strategies being proposed to reduce nitrate loads in this region.

The effect of the operation time of sprinkler irrigation system on the cotton yield

Sohrabi[1] B., S M Kashefipour[2], S Broomand Nasab[3], A SItani[4]

Email: kashefipour@excite.com
corresponding author: S M Kashefipour, Water Sciences Engineering Faculty
Shahid Chamran University of Ahwaz, Ahwaz, Iran
Tel: 0098 611 3364055 , Fax: 0098 611 3365670

ABSTRACT

For good quality field management, sprinkler irrigation systems generally increase the application water efficiency. Some specialists believe that using these systems may reduce the efficiency due to flower drop for some kinds of agricultural plants such as cotton. However, it seems that using a suitable time of operating system may remove all negative effects on flower drop and as a result on cotton yield. The main aim of this research work was to find the best time of operating of sprinkler irrigation system to minimize flower drop and optimize the net profit. The research was carried out in Cotton Research Center, Golestan province, North of Iran with four irrigation treatments of the operation time at three replications for two consecutive years (2004 and 2005). The treatments were based on the operating time with the same durations and included: irrigation between the hours of 6.00 to 9.00 (T1), 9.00 to 13.00 (T2), 14.00 to 20.00 (T3) and 20.00 to 5.00 (T4). Comparison of the measured yield and statistical analysis for all treatments showed that the best time for operating sprinkler system is irrigation during early morning and between the hours 6.00 to 9.00 (T1). It was found that the cotton yield was reduced by %11, %14 and %0.6 for T2, T3 and T4 respectively. So it is recommended to operate the sprinkler irrigation system for cotton at the early morning and night.

1. PhD Student, Shahid Chamran University of Ahwaz
2. Assistant Professor, Shahid Chamran University of Ahwaz
3. Professor, Shahid Chamran University of Ahwaz
4. Associated Professor, Gorgan University

Thursday, July 5th 2007

Session 7: Hydrological processes (1A)
Convener: Stefan Uhlenbrook

10:20 – 10:40	**Stefan Julich** Distributed model structures in catchment scale modeling
10:40 – 11:00	**Claire Baffaut** SWAT in Karst or how SWAT behaves in a river basin characterized by karst hydrology
11:00 – 11:20	**Brett Watson** Modification of SWAT to simulate saturation excess runoff
11:20 – 11:40	**Peter Vanrolleghem** Toward an Improvement of the Hydrological Performance of the SWAT Model Under Snow Cover and During Snowmelt
11:40 – 12:00	**Cancelled**

Distributed model structures in catchment scale modeling

S. Julich*[1], L. Breuer[1], K. B. Vaché[1] and H.-G. Frede[1]

Institute of Landscape Ecology and Resources Management, Justus-Liebig-University, Heinrich-Buff-Ring 26, 35392 Giessen, Germany. Email: stefan.julich@agrar.uni-giessen.de

Abstract

A prerequisite in the application of eco-hydrological models in the investigation of landuse and climate change is that controlling features in the catchment under study are well captured by the models. If the original model structure is not able to represent the dominant processes either the structure needs to be changed or a different model selected. We applied three different model structures of SWAT (original SWAT, SWAT-G and a new distributed version of SWAT-G) to the mesoscale catchment of the Wetter, Germany. SWAT-G was recently developed to improve model predictions for catchments that are mainly characterized by lateral flow components. The distributed version of SWAT-G now takes into account the various characteristics of sub-catchments, as it distinguishes between sub-catchments with either a dominance in lateral or base flow. All models were applied under a Monte Carlo framework to also investigate their parameter uncertainty. The analysis showed that the distributed version of SWAT-G provided the best results of all three structures compared to measured discharge, thereby reflecting the dominating hydrological processes and the expert's understanding of the catchment.

Keywords: lateral flow, Monte Carlo framework, parameter uncertainty

SWAT in Karst or how SWAT behaves in a river basin characterized by karst hydrology

Claire Baffaut and Verel Benson

Food and Agricultural Policy Research Institute, 101 Park DeVille Drive,
Suite E, Columbia, MO 65203, USA, E-mail: baffautc@missouri.edu

ABSTRACT

The James River Basin, in southwest Missouri, is dominated by karst hydrology, which is characterized by multiple springs, sinkholes, and losing streams that result from acidic water percolating through limestone. These features provide direct connections between surface water and groundwater and generally increase the risk of groundwater contamination. Anthropogenic activities in the watershed (agriculture, tourism, urban areas, and residential areas) accentuate the contamination potentials. Nutrient and indicator bacteria concentration measurements in this watershed and in a nearby, undeveloped watershed indicate that the water quality has been degraded by these multiple activities. The SWAT2005 model was developed and calibrated for this large watershed (3,600 km2) as a tool to test and evaluate different management practices. This paper will discuss the assumptions that were required to represent karst features and it will present the calibration results for flow, nutrient, and bacteria. Understanding the assumptions and the limitations is necessary to determine the future development needs of the SWAT model in this domain and to interpret the results obtained with the current version. The model was then utilized to estimate the magnitude of the contributions from each source of pollution. Those are the preliminary steps necessary to develop a management plan that addresses contamination and its different pathways and propose solutions to maintain and improve the water quality in the river and in the downstream lake.

Modification of SWAT to Simulate Saturation Excess Runoff

B.M. Watson[1*], S. Selvalingam[2] and M. Ghafouri[2]

1. Department of Civil and Geological Engineering, University of Saskatchewan, Canada.
Email: bmw009@mail.usask.ca
2. School of Engineering and Technology, Deakin University, Geelong, Victoria, Australia.

ABSTRACT

The variable source area concept of surface runoff generation is applicable in many catchments in southern Australia, where the widespread presence of duplex soils leads to the development of an ephemeral, perched water table. The intersection of the perched water table with the ground surface leads to saturation excess runoff being produced. The Soil and Water Assessment Tool (SWAT) computes surface runoff using the SCS curve number method which does not account for saturation excess runoff generated from variable source areas. To overcome this limitation, the kinematic storage model, which is embedded in SWAT to simulate subsurface flow, was extended to also simulate saturation excess runoff. This paper describes the extension of the kinematic storage model in SWAT to simulate saturation excess runoff. Results from the application of the modified model, referred to as SWAT-KSM, to a catchment in southern Australia are reported.

Toward an Improvement of the Hydrological Performance of the SWAT Model Under Snow Cover and During Snowmelt

É. Lévesque[1] N. Beauchamp[1] A. van Griensven[2] P.A. Vanrolleghem[1]and F. Anctil[1]

[1]gEAU, Département de génie civil, Pavillon Adrien-Pouliot, Université Laval, Québec, QC, G1K 7P4, Canada

[2] Department of Hydroinformatics and Knowledge Management, UNESCO-IHE, P.O. Box, 3015, 2601 DA DELFT, The Netherlands

Contact mail: etienne.levesque.1@ulaval.ca

ABSTRACT

The use of a two steps composite method has shown a promising avenue to calibrate the hydrological routines of the SWAT model in Eastern Canadian conditions. These hydro-climatic conditions are characterised by average annual precipitation of 980-1230 *mm* composed of one fifth to one quarter falling as snowfall and the presence of a seasonal snowpack of significant duration. The herein method stems in the first phase to find an optimal set of parameters based on a calibration using only summer streamflows, these optimal parameters are then fixed and in the second phase the snowmelt model parameters are adjusted using winter streamflows. This method respects the hydrological processes in the sense that snowmelt events are routed the exact same way as rainfall events, extra components are added in hydrological model to accounted for snow accumulation and melting. Also, it permits to obtain a satisfactory tradeoff between good summer and winter performances as well as isolating the behaviour of the snowmelt model.

The complete methodology of calibration is exposed based on a case study made on two small agricultural catchments (21 and 49 km^2). The satisfactory snowmelt predictions obtained at those sites are questioned in the view of knowing if we are getting the right answers for the right reasons, given how the main snow accumulation and melt processes are simplified in the SWAT model. The required refinement level of the algorithm is addressed in order to enhance water quality predictions during snowmelt events.

Thursday, July 5th 2007

Session 8: Ecological and water quality processes (1B)
Convener: Nicola Fohrer

10:20 – 10:40	**Ann van Griensven** Modelling mitigation measures for pesticide pollution control using SWAT
10:40 – 11:00	**Veronique Vandenberghe** Use of Catchment Models for Pesticide Risk Assessment: Application of SWAT in the Nil Catchment.
11:00 – 11:20	**Ian Holman** Using SWAT to support the Habitats Directive in the UK- a case study from the east of England
11:20 – 11:40	**Philip Gassman** An Alternative Approach for Analyzing Wetlands in SWAT for the Boone River Watershed in North Central Iowa
11:40 – 12:00	**Anthony Lehmann** Building a spatial framework for the analysis of benthic fauna along the river network of Switzerland

Modelling mitigation measures for pesticide pollution control using SWAT

Veerle Gevaert[1], Katrijn Holvoet[1,2], Ann van Griensven[1,3], Piet Seuntjens[2] and Peter A. Vanrolleghem[1,4]

[1] BIOMATH, Department of Applied Mathematics, Biometrics and Process Control, Ghent University, Coupure Links 653, B-9000 Ghent, Belgium
(author for correspondence: e-mail: Veerle.Gevaert@biomath.ugent.be)
[2] Flemish Institute for Technological Research (VITO), Land and Water Management, Boeretang 200, B-2400 Mol, Belgium
[3] UNESCO-IHE Institute for Water Education, Department of Hydroinformatics and Knowledge Management, P.O Box 3015, 2601 DA Delft, The Netherlands
[4] modelEAU, Département de Génie Civil, Université Laval, Pavillon Pouliot, G1K 7P4, Québec, Canada

Abstract

Pesticides are useful for agriculture because of their ability to protect crops against damaging organisms. At the same time, excessive loading of pesticides in streams and water bodies can produce toxic conditions that harm sensitive aquatic species, and render the water unfit for human consumption. Therefore measures need to be designed, evaluated and undertaken in order to reduce the pesticide pollution. In this study we focus on the Nil catchment, a small basin situated in the centre of Belgium. For this catchment, a SWAT model was available to predict the impact of several reduction measures. In agricultural areas, pesticides can enter surface water as point losses or by diffuse pollution. For point source pollution, adaptations needed to be done with regard to the efficiency of applying pesticides directly on the field and the pesticide transport in rivers. This source of pollution is easily controllable by taking precautions, and the effect of reduced point losses was simulated by increasing the value of the application efficiency parameter (apef). For diffuse source pollution, five management scenarios, namely sowing of cover crops, contour farming, strip-cropping, conservation tillage and construction of grassed buffer strips; were simulated and compared to the initial situation. In order to simulate the first three practices, the model parameters Moisture Condition II Curve Number (CN2) and/or USLE support practice factor (USLE-P) were adapted. The functioning of a buffer zone along the river was predicted by adding a part in the source code describing sedimentation in the grassed strip, and by extending the processes in the infiltration module. For user-friendly application of the infiltration processes, some modifications are required with regard to the representation of the landscape in the model. In order to simulate in-stream measures, a recommendation of several adaptations is given for the pesticide routing module.

Keywords: Management, pesticides, point losses, diffuse losses, river water quality, modelling, SWAT

Use of Catchment Models for Pesticide Risk Assessment: Application of SWAT in the Nil Catchment.

Vandenberghe V.[1], Holvoet K.[1,2], van Griensven A.[3], Seuntjens P.[2] and Vanrollghem P.A.
Görlitz G. [5], Schaefer, D. [5] and Röpke, B. [5]

[1] BIOMATH, Department of Applied Mathematics, Biometrics and Process Control, Ghent University, Coupure Links 653, B-9000 Ghent, Belgium
(E-mail: veronique.vandenberghe@biomath.ugent.be)
[2] VITO, Flemish Institute for Technological Research, Land and Water Management, Boeretang 200, 2400 MOL
[3] UNESCO-IHE Institute for Water Education, Department of Environmental Hydroinformatics and Knowledge Management, Delft, Netherlands.
[4] ModelEAU, Département de Génie Civil, Pavillon Pouliot,, Université Laval, Québec, Qc, G1K 7P4, Canada
[5]Bayer CropScience, Germany

Abstract

This paper describes the modelling of isoproturon in the Nil catchment that drains 32 km^2 in Belgium. The model for the Nil catchment was built in SWAT using data on isoproturon (IPU) concentrations in the river, climate, landscape, and landuse of the catchment from 1998 till 2002. Also the year 2004 was modelled but since input data about pesticide use for that year were missing, information of previous years input data on IPU were use to create the pesticide inputs.
We were able to reproduce the measured concentration pattern with the exception of some peak concentration that were contributed to the point sources of IPU that are not modeled by the SWAT model. The effect of information campaigns towards the prevention of direct losses of IPU towards the river are also evaluated.
Since model parameters were calibrated specifically for isoproturon in the Nil, the model cannot be extrapolated to evaluate other pesticides without calibration.
The work done was a cooperation between BIOMATH (Ugent), VITO and Bayer CropScience. Bayer CropScience wants to evaluate its FOCUS SW scenarios using the Belgian IPU dataset on one hand and wants to perform benchmark SWAT calculations for IPU on the other hand.

KEYWORDS: catchment modelling, pesticide modelling, river water, SWAT

Using SWAT to support the Habitats Directive in the UK- a case study from the east of England

Holman, I.P. [1], Whitehead, J. [1,2] and Deeks, L[1]
[1] Department of Natural Resources, Cranfield University, Cranfield, Bedford, UK
[2] Now at ADAS UK Ltd, Gleadthorpe, Meden Vale, Mansfield, UK
E-mail: i.holman@cranfield.ac.uk.

Abstract

The Thurne catchment within the Broads National Park contains internationally important wetland sites, which are designated as Special Areas of Conservation (SAC's) under the EC Habitats Directive. As part of the national regulator's review of discharge consents in the catchment, the SWAT model is being used to assess the relative contributions of point and diffuse sources of phosphorous to the principle water bodies, and the likely impacts of phosphate removal at individual sewage treatment work discharges and land management change. This paper describes the use of the SWAT model within this policy context. It also considers the difficulties associated with applying the model in this flat coastal aquifer, in which much of the land is below sea level and drained by pumps which lift water from the artificial drainage networks into the river and lake system.

Keywords: SWAT, drainage, lakes, Habitats Directive, SAC, Broads National Park.

An Alternative Approach for Analyzing Wetlands in SWAT for the Boone River Watershed in North Central Iowa

Philip W. Gassman, Silvia Secchi, and Manoj Jha [1]

E-mail: pwgassma@iastate.edu
[1]Center for Agricultural and Rural Development, 560A Heady Hall,
Dept. of Economics, Iowa State Univ., Ames, IA, 50011-1070;
phone: 515-294-6313

Abstract

The Boone River Watershed (BRW) covers over 237,000 ha in north central Iowa. The watershed is dominated by corn and soybean production, which together account for almost 84% of the land use. Fertilizer and livestock manure applications to cropland are key sources of nutrient loads to the watershed stream system. Nitrate losses are of particular concern, much of which escapes the cropland via subsurface tiles that drain the predominantly flat landscapes throughout the watershed. A modeling framework using the Soil and Water Assessment Tool (SWAT) model (version 2005) to support analyses of alternative management practice and/or cropping system scenarios that could potentially result in reduced nonpoint source pollution in the watershed. Two SWAT configurations have been constructed for the Boone River watershed consisting of either 30 or 405 subwatersheds. The 30 subwatershed configuration is a typical SWAT approach that facilitates a variety of land use and management scenarios, but does not support detailed constructed wetland scenarios which are potentially a key nutrient loss mitigation strategy for the BRW and other watersheds in the region. However, the second configuration (405 subwatersheds) does provide the potential for a more realistic assessment of wetland impacts by providing the ability to spatially site wetlands in a more realistic manner within the watershed. The general framework for both approaches is discussed here, including differences between the two different subwatershed configurations. Alternative HRU configurations are also presented including the option to overlay common land units (field tracts) in the watershed, which results in over 20,000 HRUs.

Keywords: SWAT, wetlands, tile drainage, nutrient applications, nitrate

Building a Spatial Framework for the Analysis of Benthic Fauna Along the River Network of Switzerland

A. Lehmann[1*], P. Stucki[2], Y. Gonseth[3]
[1] Senior Lecturer, Climatic Change and Climate Impacts, University of Geneva, Switzerland
[2] Director, Private consultancy, Neuchâtel, Switzerland
[3] Director, Swiss Centre for Mapping Fauna, Neuchâtel, Switzerland

[*] Climatic Change and Climate Impacts, University of Geneva, Battelle D, 7 Route de Drize, 1227 Carouge, Switzerland. Ph. (+ 41 22) 379 00 21 / Fax. (+41 22) 379 07 44 / anthony.lehmann@unige.ch

Abstract

The study of large scale distribution of aquatic fauna along river habitats is relatively poorly developed when compared to its terrestrial counterpart. The main reason is that we are often lacking a proper spatial framework to analyze the observed distribution of aquatic fauna (macroinvertebrates and fishes). In terrestrial ecology, it has become very common and useful to derive species potential distributions from point observations of species occurrences combined to GIS raster layers representing habitat characteristics along climatic, geological and topographical gradients . In river ecology, examples of such an approach are still rare, certainly because of the difficulty to describe continuously linear habitats within a GIS and the difficulties to integrate upstream influences on these habitats. We explore here the potential contribution of SWAT to define a spatial framework to analyze, model and predict aquatic species distribution along the river network of Switzerland. This exploration is made by extending the results form a previous simpler GIS analysis of river watersheds. We used Generalized Regression Analysis and Spatial Predictions (GRASP) to correlate species distribution with river environmental variables. We built predictive models for 326 species of invertebrates and showed that watershed predictors were often significantly explaining species distribution. Our conclusions are that SWAT can greatly improve the quality of the environment variables and therefore the obtained models and predictions. However, the spatial resolution of watershed delineation defined by their minimum size is crucial to be able work on small

KEYWORDS: SWAT, GRASP, invertebrates, potential distribution, rivers, Switzerland
.

Thursday, July 5th 2007

Session 9: Nutrient modelling (1A)
Convener: Martin Volk

14:00 – 14:20	**Ashvani Kumar Gosain** Reaction kinetics for modeling non-point source pollution of nitrate with SWAT
14:20 – 14:40	**Valentina Krysanova** Identification of point and diffuse sources contribution and role of retention processes in large river basins: comparison of three approaches
14:40 – 15:00	**Matjaz Glavan** Using SWAT to assess nutrient reduction measures in the Axe catchment, UK

Reaction Kinetics for Modeling Non-Point Source Pollution of Nitrate with SWAT Model

K. K. Narula[1], A.K. Gosain[2]

[1] Associate Director, Water Resources Program, TERI, Lodi Road, New Delhi, India.
[2] Professor, Department of Civil Engineering, I.I.T Delhi, Hauz Khas, New Delhi, India.

Abstract

Excessive use of nitrogenous fertilizer vis-à-vis phosphatic and potassium fertilizers in India has resulted in a shift of NPK ratio from an optimal value of 4:2:1 to a distorted 7.9:2.9:1. Nitrogenous fertilizers such as urea have high hydrolysing property and are not retained by the soil. They get leached into groundwater due to rainfall and irrigation water inputs and are thus distributed by the land phase of the hydrological cycle which requires knowledge of precipitation distribution, runoff generation, distribution, and fertilizer application rate in addition to residence time of water in each of the phases. Residence time is important as nitrates get transformed into gaseous and other stable forms in time and space. The reaction kinetics of the nitrogen transformation processes governs the overall movement of nitrates in each of the phases of the hydrological cycle.

SWAT ArcView GIS Version model has been used to simulate non-point source pollution of nitrate in a mountainous sub-catchment in India. The performance of the model in simulating daily discharge for the validation period was found to be good, measured both in terms of R^2 and Nash and Sutcliffe efficiency criteria. The model performance for estimating nitrates in surface runoff suggests a need for an improvement in the nitrogen transformation processes.

Further, this paper makes an analysis of the internal nitrogen fluxes simulated within SWAT and tries to conceptualize nitrification and denitrification kinetics in the unsaturated zone by making use of Michaelis-Menten mixed order kinetics. The comparison of the existing SWAT nitrate transformation first-order kinetics with the Michaelis-Menten mixed order kinetics show that Michaelis-Menten mixed order kinetics can be used to represent the nitrate transformation processes better.

Keywords: SWAT, Hydrology, Nitrate, Non Point, Pollution, Reaction Kinetics

[1] Dr. Kapil K Narula, Associate Director, The Energy and Resources Institute (TERI), India Habitat Centre, Lodi Road, New Delhi 110 003, India. Fax: 91-11-2468 2145. Email: kapiln@teri.res.in

[2] Prof. A. K Gosain, Professor, Department of Civil Engineering, Indian Institute of Technology (I.I.T) Delhi, Hauz Khas, New Delhi 110 016, India. Email: gosain@civil.iitd.ernet.in

Identification of point and diffuse sources contribution and role of retention processes in large river basins: comparison of three approaches

Cornelia Hesse, Valentina Krysanova* and Fred Hattermann
Contact mail: krysanova@pik-potsdam.de

Potsdam Institute for Climate Impact Research, P.O. Box 601203, Telegrafenberg, 14412 Potsdam, Germany.

ABSTRACT

The robust tools enabling assessment of water quality, contribution of point and diffuse sources and role of retention processes in large river basins are urgently needed for water managers and decision makers in view of Integrated Water Resources Management and Adaptive Management at the basin scale. However such an assessment is still a problem for the modelling community, though there are publications in scientific literature in this direction providing methods and promising results, though mostly for small and mesoscale watersheds.

The objective of this paper is to compare three different approaches to water quality modelling in large river basins. The study is performed using the ecohydrological semi-distributed model SWIM (Soil and Water Integrated Model), and comparing three different modifications of the model. SWIM was developed specifically for climate and land use change impact assessment based on SWAT-93 and MATSALU. The model uses disaggregation of a basin into subbasins and hydrotope classes (HRUs) or hydrotope units and integrates hydrological processes, vegetation/crop growth, erosion and nutrient dynamics at the river basin and regional scale. Previously, SWIM was successfully applied for water quality modelling in mesoscale basins (Habeck et al., 2005; Hattermann et al., 2006).

Three approaches are compared in this study: 1) describing retention in a landscape separately for surface, subsurface and groundwater by a linear differential equation (Hattermann, 2005), and specifying it as a function of a mean retention time T and decomposition rate λ, with constant T and λ for the basin; 2) the same as in the first approach, but differentiating T and λ for the hydrotope units depending on soil properties; and 3) coupling SWIM with the model WASP to additionally describe retention processes in the river network in combination with approaches 1 or 2. The aim is to provide validation of the model not only for the total basin, but also for major intermediate gauges. The first method was already applied for mesoscale basins (drainage area about 500 and 1.800 km^2). The comparison of three methods is done in application to the Saale basin (about 24.000 km^2), a large subbasin of the Elbe river basin. The results demonstrating comparison of methods, their advantages and problems, will be presented at the conference.

Using SWAT to assess nutrient reduction measures in the Axe catchment, UK

Matjaz Glavan[1,2] and Sue White[1]

E-mail: sue.white@cranfield.ac.uk
1. Cranfield University, UK.
2. University of Ljubljana, Slovenia

ABSTRACT

A number of catchments in the UK have been identified as priority sites for the catchment sensitive farming (CSF) initiative, run by the Department for Environment, Food and Rural Affairs (Defra). The CSF catchments have been identified because of a range of issues which make them at risk of failing the European Commission Water Framework Directive (WFD) targets for good ecological status of water bodies. CSF aims to introduce a number of mitigation methods into farming practice to reduce contamination of rivers and water bodies. In the west of England intensive dairy farming and cultivation of maize (corn) as a fodder crop, cause problems with enhanced nitrate and phosphate levels in rivers. The Axe catchment is one of these priority sites in wetern England which causes particular concern due to its high phosphate concentrations in rivers which have high environmental value. This project aims to evaluate both SWAT's ability to represent the proposed mitigation methods and the effectiveness of these measure in reducing nutrient concentrations in the Axe catchment.

Thursday, July 5th 2007

Session 10: Semi-Arid regions/Water resources (1B)
Convener: Willy Bauwens

14:00 – 14:20	**Monireh Faramarzi** Application of SWAT to Quantify Internal Renewable Water Resources in Iran
14:20 – 14:40	**S. Boroomand Nasab** Irrigation main alternative for solving of global water crisis
14:40 – 15:00	**Amardeep Singh** Water Allocations using GIS based Hydrological Modelling

Application of SWAT to Quantify Internal Renewable Water Resources in Iran

Monireh. Faramarzi[1*], K.C. Abbaspour[1], H. Yang[1], R. Schulin[2]

[1]EAWAG Swiss Federal Institute for Aquatic Science and Technology, P.O. Box 611, monireh.faramarzi@eawag.ch8600 Dübendorf, Switzerland. Email:
[2]ETHZ Institute of Terrestrial Ecology, Universitätstr. 16, 8092 Zürich, Switzerland

Abstract

Increasing water scarcity and growing demand for food give rise to the need to improve water use efficiency, or water productivity. This has been one of the important objectives in water resources management. A way of achieving this objective is through virtual water trade strategy. “Virtual water” is the amount of water used in producing agricultural products. The “virtual water trade strategy” in a region calls for producing crops of high water productivity and importing crops of low water productivity taking into account comparative advantage from physical, social, and economic points of view. The objective of this project is to provide a systematic assessment of the feasibility of promoting intra-country virtual water trade as a policy option to improve water productivity in Iran. We used the distributed hydrological model, Soil and Water Assessment Tool (SWAT), to quantify the provincial water resource availability. The model is under calibration/validation with SUFI-2 (Sequential Uncertainty Fitting, ver. 2) procedure using measured daily discharge data from 81 discharge stations across the country. The provincial-based water resources availability and crop water productivity as well as socio-economic conditions will be used in scenario analyses to improve the regional cropping structure. In this paper we only discuss the calibration of the hydrologic model for Iran.

Keywords: water scarcity, virtual water trade strategy, hydrologic modelling, provincial water resource availability, prediction uncertainty, Iran

Irrigation main alternative for solving of global water crisis.

S. Boroomand Nasab

Professor, Faculty of Irrigation and Drainage, Shahid Chamran University of Ahwaz. Iran.
E-mail: boroomandsaeed@yahoo.com
and A. Naserin

ABSTRACT

World population is projected to grow to about 9.3 billion in 2050. This increased population, combined with standards of living in the developing countries, will pose enormous strains on land, water, energy and environment. Need to production of food cope with upcoming increasing of population caused to pay more attention to agricultural water management.

There are evident that water-scare countries are not able to meet their food requirements using conventional methods. It warn necessity of review on methods of production, management and application of agricultural water. Hence, research and innovation and also transfer technologies, will be required in those regions.

Supply management can use wastewater, saline water and on the whole all of low quality water to increase existing water resources. In addition, it alleviate environmental pollution due to remove of those in environment which is great problem of this century. Certainly in all stages should follow guidelines to control negative impacts on human health and environment.

With respect to recent improvement in irrigation Methods and rising of various efficiencies, demand management has key role on solving of the water crisis. It can expand irrigable lands through limiting of water Application, for example with using of deficit or supplementary irrigation. Utilization of genetic science and technologies and agricultural methods for adoption with water scarcity, can. Cause a revolution in farming in the arid region.

In addition to these cases, trading of agricultural and livestock industry as "virtual water" should be considered, because all of affairs which are related to agricultural water management are influenced by it. In all of alternatives socioeconomic considerations should be seen as special issue. More studies indicate that establish of farmers union, their participation and training of villagers can cause to improvement their financial condition and water use efficiencies in the farms.

In this paper we are going to discuss on represented alternatives and suggest solutions to correct of agricultural water management to contribute in global water crisis solution.

Water Allocations using GIS based Hydrological Modelling

A. Singh.[1] and A.K. Gosain.[2]

E Mail: asingh249@gmail.com

[1] Research Officer, Central Soil and Materials Research Station, New Delhi- 110016, India.
[2] Professor Department of Civil Engineering Indian Institute of Technology Delhi
New Delhi- 110016, India.

ABSTRACT

The increasing levels of population as well as industrialisation have led to a rise in the conflicting claims between the various uses as well as the users of water, worldwide. Over 85 percent of the Indian territory lies within its interstate rivers. The problem of allocating water among various riparian states has been plaguing the country for long. The aim of the present study is to utilise simulation modelling for allocating waters among the riparian states by taking case study of a multi-jurisdictional river basin in India. GIS based hydrological modelling has been utilised for estimating the total water yield in the selected river basin. The hydrological model used for the present study is SWAT (Soil and Water Assessment Tool) on a GIS (Arc View) platform. Futuristic scenarios have been generated for various land use changes. The water allocation formulae have been utilised in conjunction with the total water availability scenarios (as obtained from hydrological modelling) so as to determine the total volume of water to be allocated to each of the riparian states for the existing set of land use conditions as well as for each of the proposed land use changes. All these calculations have been performed for all the prevalent legal doctrines so as to compare the water share of each riparian state under each of the legal doctrines.

Keywords: water allocations, SWAT, hydrological modelling, scenario generation.

Friday, July 6th 2007

Session 11: Water quality modelling (1A)
Convener: Peter Vanrolleghem

8:30 – 8:50	**Karim Abbaspour** Application of SWAT to Modelling Hydrology and Water Quality in the prealpine/alpine Thur Watershed in Switzerland
08:50 – 09:10	**Nicola Fohrer** Modelling German lowland catchments with SWAT – experiences and challenges
09:10 – 09:30	**Valentina Krysanova** Water Quality Modelling in a Highly Regulated Lowland Catchment
09:30 – 09:50	**Stefan Liersch** How Realistic is the Implementation of the European Water Framework Directive in River Basins Dominated by Agriculture? The Example of the Upper Ems River Basin (Germany)

Application of SWAT to Modelling Hydrology and Water Quality in the prealpine/alpine Thur Watershed in Switzerland

Karim C. Abbaspour

Swiss Federal Institute of Aquatic Science and Technology (Eawag), Ueberlandstrasse 133, CH-8600 Duebendorf, Switzerland. abbaspour@eawag.ch

Abstract

In a national effort, since 1972, the Swiss Government started the "National Long-term Monitoring of Swiss Rivers" (NADUF) program aimed at evaluating the chemical and physical states of major rivers leaving Swiss political boundaries. In this study we aim to model one of the program's catchments – Thur River basin (area 1,700 km2), which is located in the north-east of Switzerland and is a direct tributary to the Rhine. The program SWAT was used to simulate all related processes affecting water quantity, sediment, and nutrient loads in the catchment. The main objectives were to test the performance of SWAT and the feasibility of using this model as a simulator of flow and transport processes at a watershed scale as well as to study the calibration process of watershed models. Model calibration and uncertainty analysis were performed with SUFI-2 (Sequential Uncertainty FItting Ver. 2). Initial calibration based on variables discharge, sediment, nitrate, and phosphorus at the watershed outlet produced excellent results.

However, a subsequent examination of sediment, nitrate, and phosphorus loads from various landuses produced quite inaccurate results according to local experts. Including a range of these loads (provided by the experts) in the calibration process again produced good calibration results as the watershed outlet, while this time also producing reasonable loads from various landuses. A further application of the newly calibrated model to simulate discharges at local outlets within the watershed produced acceptable results for some outlets while quite poor results for other outlets. We conclude that: 1) in watersheds similar to Thur - with good data quality and availability and relatively small model uncertainty - it is feasible to use SWAT as a flow and transport simulator, and 2) there are different degrees of model calibration, each having specific uses. Hence, care must be taken in applying a "calibrated" model for different purposes.

Modelling German lowland catchments with SWAT – experiences and challenges

Fohrer, N. and B. Schmalz

Contact mail: nfohrer@hydrology.uni-kiel.de
Department of Hydrology and Water Resources Management, Ecology Centre, Christian-Albrechts-University Kiel, Fachabteilung Hydrologie und Wasserwirtschaft des ÖZK
Olshausenstr. 40, 24098 Kiel, Tel: 0431/880-4030, Tel.: 0431/880-1276,
Fax.: 0431/880-4607

ABSTRACT

Lowland catchments in the north of Germany are characterized by a low hydraulic gradient and intensive interactions between groundwater and surface water. River beds are heavily modified and large parts of the landscape are drained by ditches and tile drains. Wetlands control the temporal dynamics of the catchment response to rainfall. The dominating land use is agriculture. Forests and settlements cover less than 10% of the area respectively.

The major problem in river water and groundwater quality is caused by non-point source pollution through agricultural land use and several point sources like waste water treatment plants. Additionally to a continuous sampling at the basin outlets we carried our intensive sampling campaigns along the river to identify the significance of different entry pathways. Significant loads of nitrate and ammonia as well as phosphate and sulphate have been measured.

We applied the SWAT model to the Treene and the Stör river basins and several of their sub catchments in a nested way in order to analyse the model behaviour under lowland conditions. The catchment size varied from 517 to 32 km². To improve the model performance we developed a spatially distributed approach to assess the potential tile drain density and changed the soil input information to SWAT accordingly.

We achieved model efficiencies (Nash Sutcliffe Index) from 0, 86 to 0, 59 and a correlation coefficient between 0, 94 and 0, 68 for the calibration periods. The model performance improved with increasing catchment size. The explicit modelling of the drainage tiles improved the temporal dynamics of the simulations but the effect of the wetland on runoff formation is still not well presented.

Water Quality Modelling in a Highly Regulated Lowland Catchment

Cornelia Hesse, Valentina Krysanova, Fred F. Hattermann

Contact mail: cohesse@pik-potsdam.de
Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, 14412 Potsdam, Germany

Abstract

Water quality modelling in the Rhin catchment was done to answer some river basin specific questions dealing with identification of point and diffuse sources in the catchment, simulating the influences of an expected climate and land use change on water quantity and quality and suggestions of possible measures to be done in order to achieve a “good ecological status” of the river and its lakes as required by the Water Framework Directive (WFD).

The Rhin river catchment is a typical lowland river basin, which is highly regulated. These regulations complicate water quantity and quality modelling in the catchment. The research was done by using the ecohydrological model SWIM (Soil and Water Integrated Model), which simulates water and nutrient fluxes in soil and vegetation, as well as transport of water and nutrients in the river network. The modelling period was from 1981 until 2005. After calibrating and validating the hydrological processes at different gauges within the basin with satisfactory results, water quality (nitrogen) modelling was started taking into account the emissions of different point sources (e.g. sewage treatment plants) and identifying the amount of diffuse pollution caused especially by agriculture.

For suggesting some feasible measures to improve water quality and to reduce diffuse pollution considering possible climate and land use changes different reasonable scenarios will be applied in consultation with the Federal Environmental Agency of Brandenburg (LUA).

Keywords: water quality modelling, nitrogen, lowland river system, SWIM, WFD

How Realistic is the Implementation of the European Water Framework Directive in River Basins Dominated by Agriculture? The Example of the Upper Ems River Basin (Germany)

Stefan Liersch, Martin Volk

UFZ Helmholtz Centre for Environmental Research, Department of Computational Landscape Ecology, Permoserstr. 15, D-04318 Leipzig, Germany. Email: Stefan.liersch@ufz.de

Abstract

The main objective of the European Water Framework Directive (WFD) is the achievement of a good ecological and chemical status of the water environment (water bodies). The objective of our study was to find a land use and land management scenario that would reduce the total nitrogen concentration in the rivers of the Upper Ems River Basin (North-Western Germany) to the WFD water quality class II (3 mg/l). The rivers in the agricultural used basin show total nitrogen concentrations of partly over 9 mg/l. We took policy instruments such as WFD, CAP and landscape development programs into account and developed consecutive land use scenarios. Results of the SWAT scenario calculations showed that the needed measures to achieve the water quality target in the basin would be unrealistic from a socio-economic point of view (reduction of arable land from 77% to 46% [13% organic farming], increase of pasture from 4% to 15%, afforestation from 10% to 21%, increase of protected wetlands from 0% to 9%, etc.). The example shows that the achievement of the environmental targets of the WFD is only possible with a consideration of regional distinctions. A general problem to be addressed is the lack of available water quality data. Strategies on water quality monitoring and water quality data availability must be improved and data access has to be facilitated. Under the current circumstances water quality modelling remains highly uncertain, since model results can not be validated sufficiently and the water quality models can not be proved adequately.

Keywords: Water Framework Directive, land use scenarios, SWAT, water quality.

Friday, July 6th 2007

Session 12: Data and modelling (1B)
Convener: Raghavan Srinivasan

08:50 – 09:10	**Francisco Olivera** Importance of the Spatial Variability of the Hydrologic System and Spatial Resolution of the Data when Modeling Small Watersheds with SWAT
09:10 – 09:30	**Ann van Griensven** Catchment Modelling using Internet based Global Data
09:30 – 09:50	**Jürgen Schuol** Taking the step from a large-scale hydrological model (West-Africa) to a continental model (Africa)
09:50 – 10:10	**Mustafa Gökmen** Evaluation of the SWAT Model Setup Process Through A Case Study in Roxo Catchment, Portugal

Importance of the Spatial Variability of the Hydrologic System and Spatial Resolution of the Data when Modeling Small Watersheds with SWAT

Francisco Olivera* **and Huidae Cho**

Email: folivera@civil.tamu.edu
Texas A&M University, Zachry Department of Civil Engineering
3136 TAMU, College Station, TX 77843-3136, U.S.A.

ABSTRACT

This paper discusses the importance of the spatial variability of the hydrologic system and of the spatial resolution of the data when modeling small watersheds with the Soil and Water Assessment Tool (SWAT). Spatial variability of the hydrologic system refers to the relative location of the different land uses, soil types and precipitation intensities within the watershed. In other words, it accounts for where in the watershed the hydrologic processes take place? Because in SWAT the Hydrologic Response Units (HRUs) are not georeferenced, the spatial variability is captured only by the differences between the sub-basins and not by the heterogeneities within them. Spatial resolution of the data, on the other hand, refers to the level of geographic detail that is captured by the land use, soil and precipitation data. The spatial resolution of the data is related to the cell size of the raster and the scale of the maps used for digitizing the vector datasets.

In the case of modeling small watersheds with times of concentration shorter than one day, however the use of a computational time-step of one day – something very common when using SWAT – tends to average out the spatial variability of the system. That is, the model is not able to capture the difference between a certain land use or soil type in a given location as opposed to another because all the precipitation input leaves the watershed within the same time-step. This situation is even clearer when results are aggregated into monthly values. Spatial resolution, in turn, as long as it yields to watershed delineation that gives accurate area values would not significantly affect the model results. From this evidence, it would follow that, for small watersheds, lumped models would perform as well as distributed models. This statement, however, is only partially true and can be more or less affected by other processes such as groundwater flow.

Catchment Modelling using Internet based Global Data

A. van Griensven (1), M.K., Akhtar (2), D. Haguma (3), R. Sintayehu (1), J. Schuol (4), K. C. Abbaspour (4), S. J. van Andel (1), R. K. Price (1)

[1] UNESCO-IHE Institute for Water Education, Department of Environmental Hydroinformatics and Knowledge Management, Delft, Netherlands. E-mail: A.vanGriensven@unesco-ihe.org
[2] Institute of Water Modelling (IWM), Dhaka, Bangladesh. E-mail: khalediwm@yahoo.com
[3] KIST, Kigali, Rwanda
[4] Eawag, Swiss Federal Institute of Aquatic Science and Technology, Ueberlandstr 133, P.O. Box 611, 8600 Duebendorf , Switzerland

Abstract

The biggest problems in water resources occur often in areas with limited data collection (e.g. infrastructure problems) or with limited accessibility to data (e.g. some international basins). Thorough modelling studies to predict and evaluate water resources management scenarios, are hence not possible. Last decade however, there is an important growth of websites allowing for free of charge downloads of geophysical data such as GIS type data, weather data, etc., often referred to as global data. Such initiatives give new potentials for modelling data-sparce areas.

In this paper, global data is used for hydrological modelling using the Soil and Water Assessment Tool (SWAT), with applications to 3 very different catchments with large water resources problems: the River Kagera in Rwanda, Burundi, Uganda and Tanzania, the River Blue Nile in Ethiopia and the River Ganges in India, Bangladesh and Nepal. The model performance was very different for these catchments. The River Ganges, where the water resources are heavily influenced by human activities and which no data could be found, gave poor modelling results compared to observations, while in more natural areas, such as the Blue Nile, good monthly Nash-Sutcliffe efficiencies could be obtained. The current available global data is mainly originating of remote sensing derived data that provides support to the model inputs with regard to the geophysical characteristics. Rainfall data derived from satellite data could not replace the basic needs of rainfall ground data. For catchments with large human impacts, global data on water use (e.g. dams and reservoirs, irrigation schemes) may still be lacking.

Keywords: SWAT, global data, Ganges, Kagera, Blue Nile

Taking the Step from a Large-Scale Hydrological Model (West-Africa) to a Continental Model (Africa)

Jürgen Schuol[1*], Karim C. Abbaspour[1], Raghavan Srinivasan[2] and Hong Yang[1]

[1]Swiss Federal Institute of Aquatic Science and Technology (Eawag), P.O. Box 611, 8600 Dübendorf, Switzerland. E-mail: juergen.schuol@eawag.ch
[2]Texas A&M University, Texas Agricultural Experimental Station, Spatial Science Lab, College Station, TX 77845 USA

Abstract

The information on the amount of country-based freshwater availability is of critical importance for national strategic water planning and management, particularly concerning water and food security. This information is much more valuable if it accounts for spatial and temporal variations in a country and incorporates the input and modeling uncertainties. Based on globally available data, we implemented and calibrated a SWAT model for water quantity investigations in a 4-million-km^2 area in West-Africa. The model setup was performed using the ArcView interface and the "Sequential Uncertainty Fitting Algorithm" (SUFI-2) program, which was used for calibration and uncertainty prediction concerning input, output and model parameters. The West-African study showed that SWAT and the selected calibration procedure were applicable to very large areas. Considering the scarcity of data in the region, the results were very satisfying and provided notable insight into the freshwater availability and the associated uncertainties in this vulnerable region. All components of the freshwater availability (blue water and green water) were quantified explicitly on a sub-country level and with a monthly interval.

This study is part of a larger project to assess the global freshwater availability. Up to now, the limiting factor for the setup of a continental model was the inability of the ArcView-interface to calculate the geomorphic subbasin-parameters for such large areas with about 1500 subbasins. Using the new ArcSWAT interface this problem was overcome and we succeeded to setup and run a model for the whole continent of Africa. The large variation, e.g. in climate and landuse, major local interferences caused by, amongst others, reservoirs and wetlands, and last but not least the long computation time make the calibration procedure especially challenging. Different ways to handle these continental scale hydrological modelling problems will be shown.

Keywords: hydrological modelling, freshwater availability, blue water, green water, prediction uncertainty, (West) Africa

Evaluation of the SWAT Model Setup Process Through A Case Study in Roxo Catchment, Portugal

M. Gökmen[1], Robert O. Strobl [2], Chris M. Mannaerts[3]

[1] MSc. Environmental Expert, Ministry of Environment and Forests, Turkey.
E-mail: mgokmen1987@yahoo.com.
[2] Postdoctoral Researcher, European Commission, Joint Research Centre, IES, Ispra, Italy
[3] Associate Professor, Water Resources Department, ITC, Enschede- Netherlands

Abstract

Acquisition of input data at a very detailed temporal and spatial scale represents one of the main limiting factors for the successful application of the Soil and Water Assessment Tool (SWAT) model, which is highly physically based and process oriented. Furthermore, model input preparation and setup usually require substantially more time compared to the actual run-time of the model. In this respect, the main focus of this study was the initial stages of model setup, including data gathering, processing, formatting and preparation, catchment discretisation, model parameterisation, etc. The applicability of the GIS coupled SWAT model as an integrated catchment management tool was evaluated through a case study outside the US (Roxo Catchment, Portugal), specifically in terms of data requirements and model input preparation. To perform this task, available spatial and non-spatial data were processed and formatted, a field campaign undertaken, laboratory analyses performed and post-processing of the data carried out. Focusing on “how to get data” rather than “how to model using default values”, it was found that when planned and implemented properly, fieldwork and consequent laboratory analyses combined with other tools, such as mobile global positioning systems (GPS) for fieldwork, freeware, spreadsheets and geographic information systems (GIS), were very effective and rendered it feasible to establish a SWAT input dataset within a reasonable time and budget.

Keywords: SWAT, data acquisitions, model setup, fieldwork, GIS, Roxo Catchment

Friday, July 6th 2007

Session 13: Land use (1A)
Convener: Antonio Loporto

10:40 – 11:00	**Alejandra Stehr** Modelling stream flows under different land use conditions using SWAT: Preliminary results from a Chilean case study
11:00 – 11:20	**Kassa Tadele** Impacts of Land use/cover dynamics on streamflow: The case of Hare watershed, Ethiopia
11:20 – 11:40	**M. Rafee Majid** SWAT in Land Use Planning: Simulating Impacts of Density and Physical Layout of Residential Subdivisions on the Hydrology of an Urbanizing Watershed
11:40 – 12:00	**Jos van Orshoven** Definition of HRU using Area Fraction Images derived from Spectral Unmixing

Modelling Streamflow under Different Land Use Conditions with SWAT: Preliminary Results from a Chilean Case Study

A. Stehr, P. Debels, M. Aguayo, F. Romero, H. Alcayaga

Centre for Environmental Sciences EULA-CHILE, University of Concepción,
P.O. Box 160-C, Concepción, Chile
E-mail: astehr@udec.cl

Abstract

Water resources from the Biobío Basin are of high strategic importance for Chilean economic development. In this context, and under the current scenario of increasing pressures, advances in the general understanding and capacity to describe and predict, in a spatially explicit way, the impact of climate and anthropogenic forcing on the hydrology of the Biobío River Basin are urgently needed. The Soil and Water Assessment Tool (SWAT) was chosen to model the hydrology of the Vergara Basin, a sub-basin of the Biobío. The model was calibrated (2000 -2002) using the PARASOL automated calibration procedure implemented in SWAT2005. Validation took place using monthly output data for the time periods contained between 1994 –1999 and 1977 -1982, which represent current and historic land use conditions, respectively. Validation for the historic time period was done in order to evaluate the capability of the model to accurately describe the basin hydrology under considerably different conditions of land use (the presence of forestry plantations in the basin increased from 0% to 39% between 1979 and 1996).
The results show that model performance can be considered as satisfactory for most part of the basin during calibration and both validation periods. In order to further evaluate the sensitivity of the SWAT model application for Vergara, fictitious “extreme” land use scenarios were generated (e.g. 100% forestry plantations) and modelled. Results were analyzed at the yearly and monthly output level, for both wet and dry season river flows. Results from these analyses are discussed.

Keywords: SWAT, Chile, Vergara Basin, Streamflow, Land use.

Impact Of Land Use/Cover Change on Streamflow: The Case of Hare Watershed, Ethiopia

Kassa Tadele [1] and Gerd Förch[2]

Arba Minch Water Technology Institute, Arba Minch University, kassatad@yahoo.com
2 Research Institute Water and Environment, University of Siegen,
gerd.foerch@uni-siegen.de

Abstract

This study investigates land use/cover dynamics and its consequent impacts on streamflow at Hare River watershed, Southern Rift Valley Lakes Basin, Ethiopia. It further addresses the methods that are needed to better characterize land use/cover dynamics and understand the upstream-downstream linkages with respect to irrigation water use. The understanding how land use/cover change influence watershed hydrology will enable local governments and policy makers to formulate and implement sound policies to minimize the undesirable effects of future land use/cover change or modification.

Spatial databases were developed using black and white aerial photographs of 1967, 1975 and satellite image of 2004 from Landsat ETM that was verified by intensive on field land use mapping in 2005. Three land use/cover maps of 1967, 1975 and 2004 were produced through visual interpretation of the aerial photographs and supervised classification of the satellite image. The rates of land use/cover dynamics were identified for the two periods (1967-1975 and 1975-2004) at watershed and sub-watershed levels. Similarly, streamflow data of 1980-2004 at the outlet of the watershed was utilized to analyze wet and dry season streamflow variability during the second period. SWAT2005 was utilized to compute the water balance of the watershed taking into account changes in land use/cover.

The results of the study indicated that farmlands and settlements class has expanded by 35.5% mostly associated with the decrease in forest class during the whole study period.
The upper watershed and the border zone in between the uplands and lowland were the most affected parts of the watershed. The sensitivity analysis pointed out eight parameters that are most crucial parameters that governs the surface and subsurface hydrological processes and stream routing for the studied watershed. Results of the model performance assessment illustrated that the Nash- Sutcliffe coefficient varies from 0.43-0.62 and 0.45-0.82 for daily and monthly calibrations and validations respectively. Moreover, it was identified that mean monthly discharge for wet seasons had increased by 12.5% while in the dry season it had decreased by 30.0% during the simulation period due to the land use/cover change. As a result, at present Hare River only satisfies 15.75% of downstream irrigation demand even with 100% diversion during the dry season.

SWAT in Land Use Planning: Simulating Impacts of Density and Physical Layout of Residential Subdivisions on the Hydrology of an Urbanizing Watershed

M. Rafee Majid

Lecturer, Dept. of Urban & Regional Planning, Universiti Teknologi Malaysia, Skudai, Malaysia. Email: rafee@utm.my

Abstract

This paper describes the use of SWAT (Soil and Water Assessment Tool) to assess the impact of different residential-development scenarios on watershed behaviour. Calibration of the SWAT simulations is done using the Generalized Likelihood Uncertainty Estimation (GLUE) method. The pre- and post-processing of SWAT's input/outputs are done in ArcView® while impervious surface is estimated from remote sensing images. Using SWAT and ArcView GIS, the study investigates the relationship between stream flow and runoff ratio as a function of percent impervious cover under eleven different residential-development scenarios, varying in density and physical layout. The results indicate that there are differences in the potential runoffs generated by the different scenarios and their subsequent impacts on stream flows. However, at the same design capacity (gross dwelling units/acre) the amount of runoff from high-density compact developments is similar to that from low-density sprawl developments. The study thus confirms a relationship between runoff and pattern of urban development and demonstrates that watershed model can be used to understand the impact of development characteristics on the hydrology of watersheds. The model can generate *what-if* scenarios of a watershed under study, something that is useful to land use planners in making decisions on a variety of land-use options.

Keywords: SWAT, residential density, impervious surface, watershed

DEFINITION of HRU using Area Fraction Images derived from Spectral Unmixing

Y N. Zhu[1], J. Van Orshoven[2] and B. Bossyns[3]

[1] Master student Earth Observation, Katholieke Universiteit Leuven, Belgium
[2] Professor, Department of Land management and economics, Katholieke Universiteit Leuven, Celestijnenlaan 200E, BE-3001 Leuven-Heverlee, Belgium.
E-mail: jos.vanorshoven@sadl.kuleuven.ac.be
[3] PhD-student, Department of Land management and economics, Katholieke Universiteit Leuven and Vlaamse Instelling voor Technologisch Onderzoek (VITO), Belgium

Abstract

Since the rainfall-discharge relationship is modeled by SWAT in a semi-distributed way, there is no need for the land use information to be fully spatially explicit. This feature opens up the possibility of defining HRU by combining a soil map with land use information in the form of area fraction images (AFI). Such AFI are the typical end product of sub-pixel classification of multi-spectral imagery of low to middle spatial resolution. We derived AFI for 5 land use classes from a time series of SPOT-VGT-imagery with a spatial resolution of 1 km^2 by means of linear spectral mixture analysis, with emphasis on the fastly expanding sealed area class. Although the resulting AFI are not accurate enough for operational use, the approach is promising for rapid and low cost assessment of land use and land use changes. Combination with a larger scale soil map for definition of HRU is possible both through downscaling of the soil data and upscaling of the land use data.

Keywords: Spectral unmixing, area fraction image, land use, sealed area, hydrological response unit

Friday, July 6th 2007

Session 14: Sensitivity and uncertainty (1B)
Convener: Veronique Vandenberghe

10:40 – 11:00	**Xianglian Li** Sensitivity Analysis of SWAT and an Application to the Yellow River Basin
11:00 – 11:20	**Michael Rode** Impact of Point Rainfall Data Uncertainties on SWAT Simulations
11:20 – 11:40	**R. Daren Harmel** Consideration of Measurement Uncertainty in the Evaluation of Goodness-of-Fit in Hydrologic and Water Quality Modeling
11:40 – 12:00	**Mazdak Arabi** Sensitivity analysis of sediment processes with SWAT

Sensitivity Analysis of SWAT and an Application to the Yellow River Basin

Xianglian Li and Xiusheng Yang

E-mail: Xianglian.li@uconn.edu
Department of Natural Resources Management and Engineering, University of Connecticut, 1376 Storrs Rd, Storrs, CT 06269-4087, USA. E-mail: :

ABSTRACT

This paper presented an automatic sensitivity analysis procedure for SWAT (Soil and Water Assessment Tool) and its application in the upper and middle parts of the Yellow River Basin, China. Comprehensive literature investigation was performed firstly to screen parameters in sensitivity analysis. Plain random sampling method was used to carry out sensitivity analysis for SWAT. Parameters were firstly generated according to given distribution. Then, the model was called with the different combinations of parameters, and outputs were accumulated and averaged for each run. The loops stopped when the differences of average outputs between two consecutive loops were less than 0.1%. Spearman's rank correlation method was used to evaluate the importance of each parameter. The study identified soil available water content (SOL_WAC) as the most sensitive parameter for simulated streamflow in the study area. The simulated streamflow was also sensitive to parameters of maximum root depth (RDMAX), soil compensate factor (ESCO), and threshold water level in shallow aquifer for base flow (GWQMN).

Impact of Point Rainfall Data Uncertainties on SWAT Simulations

Michael Rode, Gerald Wenk

Department of Hydrological Modelling, Helmholtz Centre for Environmental Research - UFZ, Brückstrasse 3a, D-39114 Magdeburg, michael.rode@ufz.de

Abstract

In this uncertainty analysis study we investigated the impact of systematic and random point rainfall measurement errors on the simulation of discharge and nitrogen yield with the complex spatially distributed nutrient transport model SWAT. The model study was conducted in the Weisse Elster River basin which is located in the middle part of the Elbe watershed, Germany, and covers an area of about 5200 km². We randomly generated 200 rainfall time series for each of the 49 precipitation gauging stations in the Weiße Elster catchment using the Data Uncertainty Engine (DUE). The length of each time series was 12 years. The DUE can handle random errors in the measured data in a statistical framework considering a selected error probability distribution type. Systematic and random precipitation errors were investigated using mean correction values of annual precipitation of different precipitation shelter classes.
Input data uncertainty analysis showed in small catchments with only one precipitation gauge station that the selection of a wrong wind shelter class can lead to large relative discharge errors in the case of low flow conditions. The importance of detailed information on wind shelter classes of precipitation gauge sites compared to the use of mean correction factors will decline with an increase of catchment size and an associated increased number of rainfall gauge stations. Point measurement rainfall errors tend to compensate if a large number of precipitation stations is used. Systematic precipitation errors can significantly be increased by additional random rainfall errors. However the impact of random point measurement errors rapidly decreases with an increase in number of precipitation stations. This suggests that a careful consideration of random point measurement precipitation errors is necessary only if a small number of precipitation stations (< 10) are included in the study.

Keywords: nitrate, modelling, precipitation uncertainties, SWAT

Consideration of Measurement Uncertainty in the Evaluation of Goodness-of-Fit in Hydrologic and Water Quality Modeling

R.D. Harmel[3], P.K. Smith (Haan)[2]

[1] Agricultural Engineer, USDA-ARS, Grassland Soil and Water Research Laboratory, Temple, TX, USA.
[2] Associate Professor, Biological and Agricultural Engineering Department, College Station, TX, USA.

Abstract

As hydrologic and water quality (H/WQ) models are increasingly used to guide water resource policy, management, and regulation, it is no longer appropriate to disregard uncertainty in model calibration, validation, and evaluation. In the present research, the method of calculating the error term in pairwise comparisons of measured and predicted values was modified to consider measurement uncertainty with the goal of facilitating enhanced evaluation of H/WQ models. The basis of this method was the theory that H/WQ models should not be evaluated against the values of measured data, which are uncertain, but against the inherent measurement uncertainty. Specifically, the deviation calculations of several goodness-of-fit indicators were modified based on the uncertainty boundaries (Modification 1) or the probability distribution of measured data (Modification 2). These modifications require estimation of measurement uncertainty with a method such as described in Harmel et al. (2006). The choice between these two modifications is based on absence or presence of distributional information on measurement uncertainty. Modification 1, which is appropriate in the absence of distributional information, minimizes the calculated deviations and thus produced substantial improvements in goodness-of-fit indicators for each example data set. Modification 2, which provides a more realistic uncertainty estimate but requires distributional information on uncertainty, resulted in smaller improvements. Modification 2 produced small goodness-of-fit improvement for measured data with little uncertainty but produced modest improvement when data with substantial uncertainty were compared with both poor and good model predictions. This limited improvement is important because poor model goodness-of-fit, especially due to model structure deficiencies, should not appear satisfactory simply by including measurement uncertainty. A full description of these modifications and results of their application to example data sets appears in Harmel and Smith (2007).

Keywords: Model calibration, validation; Statistics; Nash-Sutcliffe; Index of agreement

[3] Corresponding author: R. Daren Harmel, PhD, USDA-ARS, 808 East Blackland Road, Temple, TX, USA, 76502. Phone - 254-770-6521, Fax 254-770-6561, Email - dharmel@spa.ars.usda.gov.

Sensitivity analysis of sediment processes with SWAT

Mazdak Arabi[1], R.S. Govindaraju[2], B. Engel[1], J. Frankenberger[1], M. Hantush[3]

[1] Department of Agricultural and Biological Engineering, Purdue University, 225 South University Street, West Lafayette, IN 47907
[2] School of Civil Engineering, Purdue University, 550 Stadium Mall Drive, West Lafayette, IN 47907
[3] National Risk Management Research Laboratory, US Environmental Protection Agency, Cincinnati, OH 45268
E-mail from Arabi: marabi@purdue.edu.

Abstract

This paper presents a computational analysis for evaluating critical nonpoint source sediment processes and management actions at the watershed scale. In the analysis, model parameters that bear key uncertainties are presumed to reflect the importance of natural processes and/or management actions that they represent. A hybrid of multivariate sensitivity analysis techniques was integrated with the Soil and Water Assessment Tool (SWAT) to investigate correlation structure in the parameter space. The computational analysis was applied to the Dreisbach watershed in Indiana in the Midwestern portion of the United States. Results showed that incorporation of parameter interactions is essential to obtaining conclusive information about critical system processes and management actions. Interactions between surface runoff volume and within-channel processes were critical to describe transport of sediments in the study watershed. The sensitivity analysis reported herein could be used to derive a list of key nonpoint source best management practices for development of watershed management plans.

Keywords: SWAT, Water quality, nonpoint source pollution, best management practices, uncertainty analysis, modeling.

Friday, July 6th 2007

Session 15: Integrated modelling (1A)
Convener: Karim Abbaspour

14:00 – 14:20	**Il Moon Chung** Integrated Modeling of Surface Water and Groundwater by Using Combined SWAT-MODFLOW Model
14:20 – 14:40	**Jiri Nossent** Comparing SWAT and WETSPA on the river Grote Laak, Belgium
14:40 – 15:00	**Pedro Leitão** Integration of MOHID model and tools with SWAT model
15:00 – 15:30	**Hamed Rouhani** Improved Rainfall-Runoff Modeling Combining a Semi-Distributed Model with Artificial Neural Networks

Integrated Modeling of Surface Water and Groundwater by Using Combined SWAT-MODFLOW

N. W. Kim[1], I. M. Chung[2], Y. S. Won[3], J. G. Arnold[4]

[1]Research Fellow, Water Resources Research Department, Korea Institute of Construction Technology, Ilsan, Gyeonggi-do, South Korea
[2]Senior Researcher, Water Resources Research Department, Korea Institute of Construction Technology, Ilsan, Gyeonggi-do, South Korea
[3]Researcher, River Information Center of Han River Flood Control Office, Seoul, South Korea
[4]Supervisory Agricultural Engineer, USDA-ARS, Temple, Texas, U.S.A.
E-mail: imchung@kict.re.kr.

Abstract

It is essential for the integrated watershed hydrologic model to be able to examine the hydrologic effects and at the same time, allowing hydraulic interaction between surface water and groundwater. To compute the quantity of groundwater recharge and discharge determined by runoff process from the watershed, SWAT model and MODFLOW model were fully combined together. Since the SWAT model has semi distributed features, it is difficult to represent groundwater recharge, head distribution and pumping effect etc. To solve these problems, the method of exchanging the characteristics of the hydrologic response units (HRUs) in SWAT with cells in MODFLOW by fully coupled manner is proposed. The linkage is completed by considering the interaction between the stream network and the aquifer to reflect boundary flow and enhancement of water transfer module in SWAT. This approach is applied to Gyungancheon basin in Korea and it demonstrates the combined model enables interaction between saturated zone and channel reaches, estimation of distributed groundwater recharge and head, which play an essential role in the generation in the Gyungancheon basin. The comprehensive results show that wide applicability of model which represents the various features of surface water and groundwater simultaneously.

Keywords: SWAT, MODFLOW, Groundwater recharge, River-Aquifer Interaction.

Comparing SWAT and WetSpa on the River Grote Laak, Belgium

Nossent J. and W. Bauwens

Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel (Free University Brussels), Belgium[4]

Abstract

SWAT and WetSpa are two hydrologic models that can be used for the simulation of discharges. In order to improve the performance of the models in the future, we compared these two models on the catchment of the low land river Grote Laak. This basin has an area of 56 km² and is situated in Belgium. An automatic calibration (SCE-UA for SWAT and PEST for WetSpa) was performed on a period of four continuous years. Both models provided acceptable results, although SWAT showed slightly better calibration and WetSpa better validation results. Both were not able to simulate an extreme dry event.

Keywords: distributed, modelling, semi-distributed modelling, model comparison, SWAT, WetSpa.

[4] ir. Jiri Nossent, Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel (Free University Brussels), Pleinlaan 2, B-1050 Brussels, Belgium, Phone: +32-2-6293036, Fax: +32-2-6293022, jnossent@vub.ac.be
Prof. Dr. ir. Willy Bauwens, Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel (Free University Brussels), Pleinlaan 2, B-1050 Brussels, Belgium, Phone: +32-2-6293038, Fax: +32-2-6293022, wbauwens@vub.ac.be

Integration of MOHID Model and Tools with SWAT Model

P. Chambel-Leitão[1], F. Braunschweig[1], L. Fernandes[1], R. Neves[1], P. Galvão[2]

[1] Instituto Superior Técnico – Av. Rovisco Pais 1049-001 Lisboa – Portugal Tel: + 351 218419424. chambel.maretec@ist.utl.pt
[2] Hidromod – Av. Manuel da Maia, nº 36, 3º esq. 1000-201 Lisboa – Portugal

Abstract

MOHID Water Modelling System is an integrated state of the art modular system, composed by a series of models that simulate surface water bodies, streams and watersheds. MOHID's code development follows a methodology which improves its robustness related to programming errors. MOHID is written in ANSI FORTRAN 95, profiting from all its new features, including the ability to produce object oriented code, although it is not an object oriented language. It includes object oriented features. This results in a series of object oriented models for simulating the water cycle which integrates several different scales and processes.

SWAT source code was partially modified, namely in the inputs and outputs of the model, using MOHID's code and programming philosophy. These changes maintained the integrity of the original model, thus guarantying that results remain equal to the original version of SWAT. This allowed to output results in MOHID format, thus making it possible to immediately process it with MOHID visualization and data analysis tools.

MOHID River Network is a river model developed in European funded project (TempQSim). A link between SWAT and MOHID River Network was developed. Presently, two modified versions exist, based on the two SWAT releases (SWAT2000 and SWAT2005).

The inclusion of output result files in HDF5 format is currently under development. This allows the visualization of watershed properties (modeled by SWAT) in animated maps using MOHID GIS and animation tools. These tools allow the production of animated files showing the spatial and time evolution of the modeled properties.

The modified version of SWAT described here has been applied to various national and European projects. Results of the application of this modified version of SWAT to estimate diffuse nutrients loads to estuaries and water bodies will be shown.

MOHID source code and its support tools are freely available under the GNU Public License.

Keywords: SWAT-MOHID, Hydrological, Statistics, Mondego

Improved Rainfall-Runoff Modeling Combining a Semi-Distributed Model with Artificial Neural Networks

H. Rouhani[1], **D. Gorissen**[2], **P. Willems**[3], **J. Feyen**[1]

1. Department of Land Management and Economics, K.U.Leuven, 3001 Heverlee, Belgium. E-mail form Rohana: Hamad.Rouhana@biw.kuleuven.be.
2. Department of Mathematics and Computer Science, Antwerp University, 2020 Antwerp, Belgium
3. Department of Civil Engineering, K.U.Leuven, 3001 Heverlee, Belgium

Abstract

The research presented herein explores the simultaneous calibration of river component flows of a watershed using the integrated automatic calibration of the Soil Water Assessment Tool (SWAT) in combination with artificial neural networks, with application to the Grote Nete basin, 383 km^2 in size, located in the sandy plane region of north-eastern Belgium. For model calibration the Shuffled Complex Evolution algorithm (SCEM-UA) was applied using historical data of the period 1994-2002. The simulated daily component flows were further improved applying a multi-layer, feed forward Artificial Neural Network (ANN) trained with a Levenberg-Marquart (LM) backpropagation algorithm. The choice of appropriate ANN topologies for total flow and slow flow, in terms of hidden layers and nodes, was investigated. It was observed that the integration of the SWAT model with ANN improves significantly the model performance.

Keywords: component flows, SWAT, SCE, ANN

Session 16: Model Calibration (1B)
Convener: Mazdak Arabi

14:00 – 14:20	**Willem Vervoort** Uncertainties in calibrating SWAT for a semi-arid catchment in NSW (Australia)
14:20 – 14:40	**Shimelis Gebriye** Calibration and Validation of SWAT2005/ArcSWAT in Anjeni Gauged Watershed, Northern Highlands of Ethiopia
14:40 – 15:00	**Karim Abbaspour** SWAT-CUP, calibration and Uncertainty Programs for SWAT
15:00 – 15:30	**Peter Droogers** Spatial calibration of a distributed hydrological model using Remote Sensing derived evapotranspiration in the Upper Bhima catchment, India

Uncertainties in calibrating SWAT for a semi-arid catchment in NSW (Australia)

R.W. Vervoort[1]

[1]McCaughey Senior Lecturer Hydrology and Catchment Management, Hydrology Research Laboratory, Faculty of Agriculture, Food and Natural Resources, The University of Sydney, NSW, Australia.
E-mail: dmoriasi@spa.ars.usda.gov.

Abstract

Management of catchment scale processes often relies on predictions of large scale hydrological models to study "what-if" scenarios. Large scale models generally need calibration to match parameters to observed values as the models contain a large number of parameters. It is then interesting to study how the underlying conceptual models (determining the choice of calibration parameters) might influence the final calibration. This is particularly an issue in semi-arid catchments as the hydrology is much less understood and calibration is more difficult, even more so if the model outcomes are subsequently used for an economic or social study. SWAT 2000 was calibrated to 10 years of streamflow data from three stations in a 4500 km^2 semi-arid catchment in NSW (Australia). Different conceptual models of the groundwater surface water interaction were calibrated, all with similar calibration results. Overall calibration efficiency was low due to major difficulties in representing the semi-arid system. This was also compared to a much simpler lumped conceptual model again with similar calibration results. The implications of the lack of difference in the calibration results is that this does not allow separation of the conceptual models, all of which would have different consequences for the planned socio-economic modelling of policies to control recharge. This is troublesome as the conceptual parameters in the groundwater module of SWAT are also not easily verified by field measurements. Possibly using a distribution of calibration outcomes would deliver the best input into a socio-economic analysis.

Keywords: Semi-arid hydrology, SWAT, calibration, uncertainty

CALIBRATION and Validation of SWAT2005/ArcSWAT in Anjeni Gauged Watershed, Northern Highlands of Ethiopia

Shimelis Gebriye

Division of Hydraulic Engineering, Department of Land and Water Resources Engineering,
The Royal Institute of Technology (KTH): Teknikringen 76 -3tr, 100 44 Stockholm, Sweden
Tel. +46 8 7909261, Fax. + 46 8 208946, E-mail: shimelis@kth.se

Abstract

Poor land use practices and improper management system had played an important role for causing high soil erosion rates, sediment depositions and loss of agricultural nutrients of the soil in the Ethiopian highlands. Limited measures are taken to combat the surface erosion and sedimentation/pollution problems. To improve the situation decision making tools are needed for the assessment of the hydrology, soil erosion and sedimentation processes. The main study objective was to assess the impacts of land management practices on the surface runoff in Anjeni gauged watershed, Northern highlands of Ethiopia. For this purpose a spatially distributed river basin model, the Soil and Water Assessment Tool (SWAT2005) was used. A 2m by 2m grid DEM, Land use and Soil layers, ten years climatic and stream flow data were used for the delineation and simulation of the hydrology of the watershed. Sensitivity analysis was done to identify the most sensitive flow parameters for the specific landuse and agro-climatic condition of the Anjeni watershed. These sensitive model parameters were adjusted within their allowable ranges during calibration to optimize model prediction. The model was calibrated using eight years hydrometric measurements, from 01 January 1984 to 31 December 1991. Validation of the model was also done with independent measured stream flow data from 01 January 1992 to 31 December 1993. The model performance evaluation statistics such as Nash–Sutcliffe model efficiency (NS>0.91) and coefficient of determination (R^2>0.92) showed that the model can produce reasonable estimates of monthly discharge. The study showed that the SWAT model is a useful modeling tool for analyzing the hydrological processes. It can be used to design appropriate land and water resources conservation strategies.

Keywords : ArcSWAT, Calibration; Hydrology; Modeling; SWAT; Validation,

SWAT-CUP
Calibration and Uncertainty Programs for SWAT

K.C. Abbaspour1, J. Yang1, M. Vejdani2, S. Haghighat2

1Eawag: Swiss Federal Institute of Aquatic Science and Technology, Ueberlandstr 133, P.O. Box 611, 8600 Duebendorf, Switzerland
2 Neprash Gostar Software Development, Tehran, Iran

Abstract

Distributed watershed models are increasingly being used to support decisions about alternative management strategies in the areas of landuse change, climate change, water allocation, and pollution control. For this reason it is important that these models pass through a careful calibration and uncertainty analysis. Furthermore, as calibration model parameters are always conditional in nature, the meaning of a calibrated model, its domain of use, and its uncertainty should be clear to both the analyst and the decision maker.

Large-scale distributed models are particularly difficult to calibrate and to interpret the calibration because of large model uncertainty, input uncertainty, and parameter nonuniqueness.

To perform calibration and uncertainty analysis, in recent years many procedures have become available. As only one technique cannot be applied to all situations and different projects can benefit from different procedures, we have linked, for the time being, three programs to SWAT under the same platform, SWAT-CUP (SWAT Calibration Uncertainty Procedures). These procedures include: Generalized Likelihood Uncertainty Estimation (GLUE), Parameter Solution (ParaSol), and Sequential Uncertainty Fitting (SUFI-2). In this paper we describe SWAT-CUP and the three procedures.

Calibrating SWAT using satellite evapotranspiration in the Upper Bhima catchment, India

W.W. Immerzeel[1], P. Droogers[1]
[1] FutureWater, Costerweg 1G, 6702 AA Wageningen, The Netherlands,
w.immerzeel@futurewater.nl

Abstract

A common issue in hydrological modeling is the lack of reliable data to calibrate the model. Calibration is also constrained by uncertainty in representing the physical features of a river catchment, and the implementation of hydrological processes in a simulation model. With the advent of remote sensing algorithms that enable quantification of actual evapotranspiration (ET_{act}) in time and space calibration of these models can take a novel direction. In this paper, an innovative approach is presented which incorporates Remote Sensing derived evapotranspiration in the calibration of the Soil and Water Assessment Tool (SWAT). SWAT was calibrated using an ET_{act} time series of eight months with high spatial detail in the Upper Bhima catchment in India. In the best performing optimisation, the r^2 between monthly sub-basin simulated and measured ET_{act} was increased from 0.40 to 0.81. ET_{act} was more sensitive to the groundwater and meteorological parameters than the soil and land use parameters. This innovative approach to calibrate on remotely sensed ET_{act} is a promising approach for similar data scarce catchments across the globe.

KEYWORDS: Evapotranspiration, Remote Sensing, Calibration, SWAT

Session 17: Water quality (1A)
Convener: Maria Mimikou

15:50 – 16:10	**James Almendinger** Problems and Solutions in Applying SWAT in the Upper Midwest United States
16:10 – 16:30	**Roberta Salvetti** Application of SWAT Model on Three River Basins within the Venice Lagoon Watershed (Italy): Source Apportionment And Scenario Analysis
16:30 – 16:50	**Cole Green** Evaluation of Phosphorus Transport Methods in the Soil and Water Assessment Tool

Problems and Solutions in Applying SWAT in the Upper Midwest United States

James E. Almendinger[1] and Marylee S. Murphy[2]

St. Croix Watershed Research Station, Science Museum of Minnesota,
Marine on St. Croix, MN, USA,
E-mail: dinger@smm.org

University of Minnesota, Dept. of Geology and Geophysics,
Minneapolis, MN, USA

Abstract

We are applying the Soil and Water Assessment Tool (SWAT2000) to the Willow River watershed in western Wisconsin to assess the effects of land use and management changes. The Willow River drains about 735 km^2, much of which is agricultural land yielding substantial nonpoint-source loads of sediment and nutrients. The upper Midwest USA is a geologically young landscape with many closed drainages, intensive cultivation amid patches of forest, and expanding urban centers. Principal crops include corn, soybeans, and alfalfa typically grown in rotation to support both dairy and cash-crop operations. SWAT had problems with rotations that included alfalfa, wherein alfalfa could not be removed from the landscape once planted. Code changes to the SWAT engine were required to correct this problem. Corn yields were underestimated because of nitrogen stress due to excessive denitrification. Again, code changes allowed parameterization of the nitrification process. About 29% of the landscape drained to closed depressions; the fraction of closed drainage in each subbasin was routed to the Pond routine in SWAT and parameterized to trap all sediment and phosphorus. However, seepage from Ponds was trapped by SWAT in shallow aquifer storage and not included as groundwater recharge, and therefore did not contribute appropriately to stream baseflow. As a surrogate for this missing groundwater discharge, we disallowed Pond seepage and forced slow surficial outflow by increasing the days to reach target storage. Phosphorus loading from subbasins to the channel reaches was complicated by the addition of a subbasin chlorophyll load by SWAT. When the stream water-quality routine was activated, this chlorophyll load was apparently interpreted as algae with significant phosphorus content, and the subsequent release of this phosphorus constituted an additional load unconnected to the land-surface phosphorus budget. To avoid this extraneous phosphorus load, either the stream water-quality routine had to be de-activated, or the phosphorus content of algae had to be reduced to a negligible fraction. Subbasin sediment yields were consistently overpredicted by SWAT with default parameterization. Sediment calibration could be achieved by parameterizing the soil-loss equation to reduce erosion, or by parameterizing the channel to trap excess sediment. Despite these problems encountered during model construction and calibration, the solutions given above have resulted in workable SWAT models for our purposes. We acknowledge other members of the SWAT Midwest America Users Group (SMAUG) in identifying and solving the above problems. Some of these problems have already been addressed in SWAT2005, and we are confident that the code will continue to improve.

Keywords: SWAT, nonpoint source pollution, sediment, nutrients, runoff, agriculture

Application of SWAT Model on Three Watersheds within the Venice Lagoon Watershed (Italy): Source Apportionment and Scenario Analysis

R. Salvetti[1], A. Azzellino[1], D. Gardoni[1], R. Vismara[1], M. Carpani[2], C. Giupponi[2], M. Acutis[2], M. Vale[3], P. Parati[3]

[1] PhD Roberta Salvetti, PhD Arianna Azzellino, Davide Gardoni, prof. Renato Vismara. DIIAR - Environmental Engineering Department, Technical University of Milan, P.za Leonardo da Vinci 32, 20133 Milan, Italy (corresponding author: R. Salvetti. e-mail roberta.salvetti@polimi.it, ph. +39 02 23996431, fax. +39 02 23996499)

[2] Marta Carpani, prof. Carlo Giupponi, prof. Marco Acutis. Department of Crop Science (Di ProVe), University of Milan, Via Celoria 2, 20133 Milan, Italy

[3] PhD Manfredi Vale, Paolo Parati. ARPAV (Regional Agency for Environmental Prevention and Protection in Veneto) - Osservatorio Regionale Acque Interne, P.le Stazione 1, 35131 Padua, Italy

Abstract

Aim of this study was the analysis of the source apportionment of three river basins within the Venice Lagoon Watershed (VLW), in the North-Eastern part of Italy, which on the whole cover about 700 km^2 (i.e. about 35% of the VLW surface area). The three watersheds are characterised by a very intensive agriculture and landfarming systems. Moreover, in this area the groundwater recharge to surface waters significantly contributes to the total load discharged into the Venice Lagoon. SWAT model application allowed to describe the hydrologic and agricultural characteristics of the watersheds and to assess the source apportionment in terms of point and diffuse sources. Furthermore, SWAT model allowed the evaluation of the benefit due to the application of agri-environmental measures through the simulation of a “better-business” agricultural scenario versus the “business-as-usual” scenario. Out of a total annual nutrient load of about 2200 tNy^{-1} and of about 140 tPy^{-1}, the dry weather diffuse sources (i.e. groundwater/spring recharge and tributary/irrigation channels coming from bordering watersheds) resulted to be the most important (65% in case of nitrogen and 35% in case of phosphorus). SWAT outputs indicated a runoff load contribution of about 20% of the total nitrogen load and of about 30% of the total phosphorus load; agricultural runoff resulted to be about 2/3 of this runoff load. The simulation of the Better Business scenario indicated a possible reduction in the agricultural runoff loads of about 50% in case of nitrogen and of about 15% in case of phosphorus, which corresponds to a decrease in the total annual load of about 5-7%.

Keywords: SWAT, Venice Lagoon Watershed (VLW), point and non point sources, source apportionment, scenario analysis

Phosphorus Model Development with the Soil and Water Assessment Tool

C.H. Green[1], J.G. Arnold[1], M.A. Tomer[2], J.R. Williams[3], M. Di Luzio[3]

[1]C.H. Green*, Soil Scientist, and J.G. Arnold, Agricultural Engineer, USDA ARS Grassland Soil and Water Research Laboratory, Temple, TX, USA
[2]M.A.Tomer, Soil Scientist, USDA ARS National Soil Tilth Laboratory, Ames, IA, USA
[3]J.R. Williams, Agricultural Engineer, and M. Di Luzio, Agricultural Engineer, Texas A & M Experimental Station, Temple, Texas, USA
*Corresponding Author: C.H. Green, USDA ARS GSWRL, 808 E. Blackland Rd., Temple, TX 76502; ph: 254-770-6507; fax: 254-770-6501; chgreen@spa.ars.usda.gov.

Abstract

The ability to accurately simulate phosphorus transport at watershed scales is essential to environmental managers for making pollutant reduction decisions. Computer models are inexpensive tools that can quickly identify environmentally sensitive areas. Phosphorus transport is dependent on hydrologic properties inherent to soil and land management. In order to effectively model P transport, an efficient hydrologic model is necessary. The SWAT model simulates P movement in surface runoff and in-stream which includes soluble and sediment attached P. The SWAT model has been updated to include the linking of P surface and subsurface algorithms so that P can travel throughout the entire soil profile. SWAT PBIAS results for the calibration and validation periods for the South Fork watershed in Iowa for lateral flow were -33.3 and -38.9. The tile flow calibration and validation periods PBIAS SWAT results were -2.7 and 35.6. These PBIAS results range from very good to good when considering P water quality data. Overall, the new P algorithms have proved to be a useful since P can now move throughout the soil profile projecting more realistic values.

Keywords: SWAT, phosphorus, subsurface flow, water quality.

Friday, July 6th 2007

Session 18: Forest modelling (1B)
Convener: Fred Hatterman

15:50 – 16:10	**Pedro Leitão** Simulating *Nothofagus* forests in the Chilean Patagonia: a test and analysis of tree growth and nutrient cycling in SWAT
16:10 – 16:30	**Gordon Putz** Evaluating the role of shrub, grass and forb growth after harvest in forested catchment water balance using SWAT coupled with the ALMANAC model
16:30 – 16:50	**Martin Wattenbach** Hydrological impact assessment of afforestation and change in tree-species composition – a regional case study for the federal state of Brandenburg (Germany)

SIMULATING NOTHFAGUS FORESTS IN THE CHILEAN PATAGONIA: A TEST AND ANALYSIS OF TREE GROWTH AND NUTRIENT CYCLING IN SWAT

Matt Yarrow1, Pedro Chambel Leitão2

1Laboratorio de Modelación Ecológica, Facultad de Ciencias, Universidad de Chile, Las Palmeras 3425, Nuñoa, Santiago, Chile.
E-mail: matiasyarrow@yahoo.com.
2IST – MARETEC Secção de Ambiente e Energia Av. Rovisco Pais 1049-001 Lisboa

Abstract

The SWAT model was applied to the Aysén River Basin of Southern Chile as part of ECOManage, an international project aimed at make available modeling and decision-making tools for managers of coastal zones. This heterogeneous basin of 11,456 km2 presents a modeling challenge due to the mountainous terrain, strong precipitation gradient and the importance of non-agricultural land cover types. The low nitrogen deposition and cold climate of Chilean Patagonia place restrictions on the nitrogen cycle in the forests of the region. After presenting the results of the hydrodynamic calibration of SWAT for the Aysén Basin, we analyze the importance of vegetation growth and litter production in the nitrogen cycle of evergreen and deciduous Nothofagus (Southern Beech) forests. We compare SWAT2000 and SWAT2005 in terms of tree growth and the nitrogen cycle. Finally, we present our conclusions as to the most appropriate way to simulate Nothofagus forests while trying to balance model complexity and data requirements with the realism of the simulations.

Keywords: SWAT, nitrogen cycle, forest growth, Patagonia

Evaluating the role of shrub, grass and forb growth after harvest in forested catchment water balance using SWAT coupled with the ALMANAC model

J. Douglas MacDonald[1,5*], Jim Kiniry[3], Stacey Luke[1], Gordon Putz[2], Ellie Prepas.[1]

[1]Department of the Forest Environment, Lakehead University, Thunder Bay, ON, P7B 5E1.
*(macdonalddo@agr.gc.ca, (418)-840-2902).
[2]Department of Civil and Geological Engineering, University of Saskatchewan, Saskatoon, SK.
[3]Grassland, Soil, and Water Research. Laboratory, USDA, Temple TX.
[4]Department of Civil and Environmental Engineering, University of Alberta, Edmonton, AB.
[5]Agriculture and Agrifood Canada, Quebec City, QC, Canada, G1V2J3.

ABSTRACT

To accurately simulate watershed hydrology after forest harvest using SWAT, it is important to understand the factors that potentially make certain sites more sensitive to disturbance. The growth model in SWAT has been modified to provide a more precise description of forest growth dynamics, by integrating a multi-species growth model, $ALMANAC_{BF}$. We collected field data to develop parameters for the multi-species growth model. The biomass, leaf area index and light interception was measured on hummock tops and in depressions of three sites that differed in pre-harvest forest stand composition. Among the sites, the overall light extinction coefficient (k), of sites was observed to be 0.49 ± 0.22 and the estimated radiation use efficiency (RUE) was 4.9 ± 1.7 for annual species and 3.3 ± 2 for shrubs. We observed significant differences in percent cover of vegetation, biomass and leaf area index among sites representing differing pre-harvest forest stands and associated with topography, between hummocks and depressions. LIDAR imagery was used to provide estimates of leaf area and biomass that accounted for variations in vegetation associated with landscape characteristics. Our results demonstrate that on the hummocky terrain of the Boreal Plain, there are important variations in vegetation recovery after disturbance among different ecosites and among landscape positions. Research to identify trends in vegetation reestablishment after harvest requires sampling designs that capture differences in vegetation associated with these factors. LIDAR imagery and targeted sampling of obvious landscape variations was effective in correcting vegetation cover estimates to account for differences in cover observed between depressions and hummocks in a variety of sites.

Hydrological impact assessment of afforestation and change in tree-species composition – a regional case study for the federal state of Brandenburg (Germany)

Martin Wattenbach[1], Marc Zebisch[2], Fred Hattermann[1], Pia Gottschalk[4] Horst Goemann[3] Peter Kreins[3] Franz Badeck[1], Petra Lasch[1], Felicitas Suckow[1], Frank Wechsung[3]

[*] corresponding author:
[1] Potsdam Institute for Climate Impact Research, Dep.: Global Change & Natural Systems, P.O. Box 60 12 03, 14412 Potsdam, Germany, m.wattenbach@abdn.ac.uk, Fred.Hattermann@pik-potsdam.de, Franz.Badeck@pik-potsdam.de, Petra.Lasch@pik-potsdam.de, Felicitas.Suckow@pik-potsdam.de, Frank.Wechsung@pik-potsdam.de

[2] *EURAC research, Institute for Alpine Environment,* Viale Druso 139100 Bolzano, Italy, Marc.Zebisch@eurac.edu

[3] Institute of Rural Studies of the Federal Agricultural Research Centre, Bundesallee 50 38116 Braunschweig, German, horst.goemann@fal.de, peter@fal-kreins.de

[4] Department of Plant and Soil Science, University of Aberdeen, Cruickshank Building, Aberdeen, AB24 3UU, UK, Pia.Gottschalk@abdn.ac.uk

Abstract

Policy changes are often implemented without the assessment of their full environmental impact. We investigate the hydrological effects of changes in forest area triggered by shifts in European agricultural policy and changes in species composition caused by decisions of regional forest authorities. The scenarios were modelled for the federal state of Brandenburg (Germany) on a 50m grid scale using the SWIM (Soil Water Integrated Model) model utilising spatially explicit land use patterns. For the purpose of the study the SWIM model was extended by a module for simulating the hydrological properties of forest stands based on a robust computation of the spatial and temporal LAI (leaf area index) dynamic. The module considers phenology, mortality and simple management practice and their interaction with interception of precipitation and transpiration of forest stands with and without groundwater in the rooting zone.

The results suggest a negative impact of afforestation on abandoned arable land (9.4% total state area) on the regional water balance, causing an increase in mean annual evapotranspiration of 3.7% at 100% afforestation when compared to no afforestation. The relatively small annual change covers a much more pronounced seasonal effect leading to an increase in evapotranspiration by 25.1% in spring with a strong feedback to other hydrological components. In contrast, a change in species composition in existing forest (29.2% total state area) from predominantly Scots Pine to Common Oak decreased the evapotranspiration by 3.4% accompanied by a much weaker but apparent seasonal pattern. The changes show a high spatial heterogeneity that is masked by a linear mean response for the total state area.

Poster Presentations:

Fethi Abdelli
Use of SWAT-WH for assessing the effects of land use changes in the arid Oum Zessar watershed, southeast Tunisia

Ou Yang Wei
Landscape transformations and impacts on regional non point source pollution load by upper Yellow River basin

S. Boroomand Nasab
Variations of Soil Infiltration Rate under Different Tillage Operations

Jiří Kadlec
Simulation of extreme rainfall-runoff events using SWAT 2005

Henning Busche
Modelling hydrological processes in a semi-arid, mountainous environment at the regional scale

Manuel Reyes
SWAT Stream Flow Predictions in the Upper Haw River Watershed of North Carolina

Walter Immerzeel (presentation by: Peter Droogers)
Calibrating SWAT using satellite evapotranspiration in the Upper Bhima catchment, India

A.D. Khan
Gis Based Hydrological Modeling Of Upper Indus Basin

Kittiwet Kuntiyawichai
Application of the SWAT model in the Chi river basin, Thailand, and application of different land use scenarios

Pengtao Yu
Influence of Afforestation on Water Resources in Northern China

A. Jaleh, A. Jalalian , K. C. Abbaspour, and M. Afyouni
Sediment and Runoff Estimation Using SWAT Model in Mountainous Watershed in Iran (a Case Study: Vanak, West Iran)

Armen Kemanian
Evaluation of the incorporation of a simple carbon model into SWAT2005

Samaneh S. Ghasemi
Effect of Climate Change on Streamflow in Zayanderoud in Iran

R. Rostamian (Jalalian)
Application of SWAT Model to Estimate Runoff and Sediment in a Mountainous Watershed (Case Study: Beheshtabad, Central Iran)

Nam Won Kim
On the Characteristics of Flow Duration Curve According to the Operation of Multi-purpose Dams in Han-River Basin

Flora Umuhire
Modelling Tile Drainage for Modelling Nutrient Transport in the Pike River Watershed using SWAT.

Didier Haguma
Development of a hydrologic model of Kagera River basin using remote sensing data

Ali Sadeghi
Comparison of SWAT and AnnAGNPS applications to a sub-watershed within the Chesapeake Bay Watershed in Maryland

Elke Verbeeten
The Impacts Of Climate Change On Hydrological Services Provided By Dry Forest Ecosystems In West Africa

Ian Holman
Application of SWAT in a mountainous arid catchment in United Arab Emirates

K. Schneider
Does it runoff when it rains? - Challenges in model calibration in a semi-arid catchment in northern China

Jim Kiniry
Simulating Bermudagrass, Bahiagrass, and Native Range Species on Diverse Sites in Texas

Use of SWAT-WH for assessing the effects of land use changes in the arid Oum Zessar watershed, southeast Tunisia

Fethi Abdelli[1 *], Adriana Bruggeman[2], Mohamed Ouessar[1]

email: Abdelli1@yahoo.fr

[1] Institut des Régions Arides (IRA), 4119, Médenine, Tunisia.
[2] International Center for Agricultural Research in Dry Areas (ICARDA), Aleppo, Syria.
* Corresponding author: Fax: +21675633006

ABSTRACT

In the arid regions of Tunisia, huge efforts are made for water harvesting and soil conservation. A growing need for the assessment of their effects is felt. Due to the complexity of the processes at the watershed level, recourse to modeling is inevitable. SWAT-WH, which is a modified version of the SWAT model adapted for arid Mediterranean watersheds with water harvesting practices (Ouessar, 2007), was used to evaluate the long-term effects of the land use changes on the water balance in the 350-km^2 watershed of wadi Oum Zessar in southeast Tunisia. Similar to the field observations, the model results indicated that the outflow to the sebkha in the downstream areas was significantly reduced while groundwater recharge and the evapotranspiration of the cropped areas behind the water-harvesting structures had increased. The aquifer recharge will be further investigated based on groundwater monitoring data.

Key words: modeling, watershed, water harvesting, SWAT, arid, Tunisia.

Non point source pollution responses simulation for conversion of cropland to forest in mountains by SWAT in China

Wei Ouyang[1,2] • Fang-Hua Hao[1] • Hong-Guang Cheng[1] • Xue-lei Wang[3]

1. School of Environment, State Key Laboratory of Water Environment Simulation, Beijing Normal University
2. International Institute for Geo-Information Science and Earth Observation (ITC), Netherlands
3. School of Geography, Beijing Normal University

Abstract

Several environmental protection policies have been implemented to prevent the soil erosion and non point source (NPS) pollutions. After severe Yangtze River floods, the conversion of cropland to forest policies (CCFP) was implemented through out China, especially in the middle and upper stream of Yangtze River. The research area was located in Bazhong City Sichuan Province in Yangtze River watershed, where soil erosion and NPS pollution are serious concern. Major NPS pollutants are nitrogen (N) and phosphorus (P). The objective of this study was to evaluate the long-term impact of implementation of CCFP on stream flow, sediment yields and other two NPS pollutants at watershed level by using model. The Soil and Water Assessment Tool (SWAT) was a watershed environmental model and was applied to quantify the impacts of implementation of CCFP. There were four scenarios representing different conversion of cropland to forest conditions. The scenario A represented the original agricultural land and forest area conditions before the implementation of CCFP. Scenario B demonstrated the condition of the agricultural land slope larger than 25° was transferred into forest. In scenario C and D, agricultural land slope larger than 15° and 7.5° was implemented of CCFP. The reductions in NPS pollutions due to CCFP implementation from 1996~2005 was estimated by SWAT. The results are presented as percentage change in water flow, sediment, organic N and organic P at watershed level. The principle between the forest area ratio and ten years' average estimations was regressed in order 2 polynomial trendline. The results revealed that the benefits of the CCFP were obviously due to the increase of forest area in mountain area. The consequence of organic N and organic P were greater (decrease 42.1% and 62.7% respectively) at the watershed level. This study proved that SWAT modeling approach can be used to estimate the NPS pollutants impacts of conversion of cropland to forest policies in large watersheds.

Keywords Non point source pollutions · Conversion of cropland to forest ·SWAT · simulation · China

Variations of Soil Infiltration Rate under Different Tillage Operations

S. Boroomand Nasab

Professor, Faculty of Irrigation and Drainage, Shahid Chamran University of Ahwaz
. E-mail: boroomandsaeed@yahoo.com
A. Bavi

Former M.S. Student of Irrigation and Drainage
O. Sabzikar

Former M.S. Student of Irrigation and Drainage

Abstract

Infiltration is one of the most important parameters in different irrigation methods. Infiltration rate is altered by any agricultural activities such as tillage, planting and transiting machines. In this paper, infiltration variations were studied by applying different tillage conditions in Mollasani Agricultural Region near city of Ahwaz, Iran. The study was performed in a wheat field with an area of 1.5 ha. The tillage treatments included conventional tillage, minimum tillage and no tillage. Also, infiltration variations were closely investigated for the treatments in three phases including before-planting, after-planting [during growing season] and after harvesting. The results showed that the most infiltration rate was of the conventional tillage operation while least infiltration rate was obtained in no tillage treatment. The infiltration variations in three stages insisted that the most intake rate occurred during before-planting phase while least infiltration rate was during growing time. In the present study, Kostiakov infiltration equation was used. The effective infiltration parameters in the treatments and also during three above phases were determined.

Keywords: Infiltration, Kostiakov, Conventional tillage, Minimum tillage, No tillage

Simulation of extreme rainfall-runoff events using SWAT 2005

Jiří Kadlec and Zdenèk Kliment

Department of Physical Geography and Geoecology, Charles University Prague, Czech Republic. E-mail: kadlec2@natur.cuni.cz

ABSTRACT

Excessive soil erosion and sediment transport can have negative impact on surface water quality. Observations from the Blšanka watershed (Czech Republic) show that the largest portion of total sediment load transported out of the watershed originates from a small number of extreme rainfall-runoff events. In combination with other factors, rainfall intensity can have significant effect on soil erosion and sediment transport during the runoff event.
In this paper, the results of SWAT simulation for typical rainfall-runoff events in the Blšanka watershed are presented. The Blšanka watershed (374 km^2) is situated in a dry, hop-growing region dominated by arable land on relatively highly erodible soils. Daily observations of suspended sediment concentration have been conducted at the watershed outlet from 1995 to 2006 and four main types of runoff events with largest measured sediment concentrations were identified.

Simulation of runoff and sediment transport was performed with SWAT 2005 using two options: daily time step and hourly time step. For the hourly routing option, detailed sub-hourly precipitation data is needed. A simple computer program (RADARSWAT) was developed to estimate the sub-daily temporal rainfall distribution from available daily precipitation records and 10-minute meteorological radar reflectivity images.
Using the built-in sensitivity analysis and autocalibration algorithms, important model parameters were identified and automatic calibration was performed. This improved model performance for the long-term period and individual events. Different optimal values of soil and channel routing model parameters were obtained by the automatic calibration procedure for the daily and hourly routing method.

First results show that the selected simulation time step has significant effect on predicted sediment load for the investigated runoff events. This can be explained by different values of calculated overland peak flow and surface runoff volume. These values are used by the MUSLE equation to estimate soil erosion and deposition in the subbasins. In general, sediment loads calculated with hourly time step of simulation are closer to observed values for the majority of examined rainfall-runoff events. However, both routing options tend to overestimate sediment deposition in the main channels. Further research is needed to verify the SWAT channel sediment routing algorithms and their applicability for the Blšanka watershed.

Modelling hydrological processes in a semi-arid, mountainous environment at the regional scale

H. Busche[1], B. Diekkrüger[1]

[1]Geographical Institute, University of Bonn,
Meckenheimer Allee 166, 53115 Bonn, Germany

Abstract

In this study ArcSWAT 2005 is used to quantify the hydrological processes in a 1,216 km^2 semi-arid mountainous catchment (Oued M'Goun, South-Morocco). The Oued M'Goun is a sub-catchment of the macro-scale Drâa-Basin investigated within IMPETUS, an integrated water resource management project. The modelling presented here is the first step of a hierarchical approach, followed by the modelling of the hydrological processes in the Upper-Drâa catchment (~15,000 km²), which drains in the reservoir Mansour Eddahbi and is of high importance for irrigation of the downstream oasis. Therefore the model has been applied with data which are available for the whole Drâa-catchment (SRTM-DEM, LANDSAT-LU/LC classification, official soil map), allowing the future expansion of the research area without changing the database. In the M'Goun watershed discharge is rare, extreme and highly variable, depending on snowmelt and precipitation. Snow sublimation in the elevated areas and high infiltration rates in the wadi beds constitute dominant factors of the water balance. SWAT is able to reproduce annual runoff, as well as evaporation and baseflow ratios, derived from field measurements and geochemical studies.

Keywords: SWAT, semi-arid region, high mountains, climate change

SWAT Stream Flow Predictions in the Upper Haw River Watershed of North Carolina

M. Reyes, R. Srinivasan, and R. Stever

Email: mannyreyes@nc.rr.com

North Carolina A&T State University , Texas A&M, University, and North Carolina A&T State University

ABSTRACT

Jordan Lake is a major regional drinking water supply, a recreational resource, and aquatic habitat for Cary and Raleigh , NC , and has been designated by the Environmental Protection Agency as an impaired water body. Increases in point and nonpoint source nutrient loads will further degrade Jordan lake's water quality and if not managed properly, the population and economic growth that are projected to occur in the watershed over the coming decades will further threaten the ability of the lake to support its designated uses. Jordan Lake has an algae impairment which is caused by nitrogen (N) and phosphorus (P) pollution. To address NP pollution, a nutrient management strategy was developed through the Jordan Lake Stakeholder Project, a consortium funded and supported by several watershed stakeholders.

The Upper Haw River watershed drains to Jordan Lake . This research will evaluate the stream flow predictions of the Soil and Water Assessment Tool (SWAT) model. SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. T he poster will report how SWAT inputs were estimated and results comparing SWAT predictions with measured stream flow.

Calibrating SWAT using satellite evapotranspiration in the Upper Bhima catchment, India

W.W. Immerzeel[1], P. Droogers[1]

[1] FutureWater, Costerweg 1G, 6702 AA Wageningen, The Netherlands,
w.immerzeel@futurewater.nl

Abstract

A common issue in hydrological modeling is the lack of reliable data to calibrate the model. Calibration is also constrained by uncertainty in representing the physical features of a river catchment, and the implementation of hydrological processes in a simulation model. With the advent of remote sensing algorithms that enable quantification of actual evapotranspiration (ET_{act}) in time and space calibration of these models can take a novel direction. In this paper, an innovative approach is presented which incorporates Remote Sensing derived evapotranspiration in the calibration of the Soil and Water Assessment Tool (SWAT). SWAT was calibrated using an ET_{act} time series of eight months with high spatial detail in the Upper Bhima catchment in India. In the best performing optimisation, the r^2 between monthly sub-basin simulated and measured ET_{act} was increased from 0.40 to 0.81. ET_{act} was more sensitive to the groundwater and meteorological parameters than the soil and land use parameters. This innovative approach to calibrate on remotely sensed ET_{act} is a promising approach for similar data scarce catchments across the globe.

Keywords: Evapotranspiration, Remote Sensing, Calibration, SWAT

GIS BASED HYDROLOGICAL MODELING
OF

UPPER INDUS BASIN

A.D. Khan, Jeff G. Arnold and Mauro Di Luzio

E-mail: drkhanad@yahoo.com

Abstract

System modeling in water resources is gaining popularity due to predictive ability of hydrological models. Several computer based mathematical models have been developed and applied for study of complex management and associated environmental problems in water resources sectors. Development of high speed computers and recent integration of Geographical Information Systems (GIS) in hydrological models has increased the resolution of simulation and efficiency in the process of preparation of input data files. A GIS based SWAT model was applied for study of hydrology of the Indus River of Pakistan. SWAT is a semi-distributed hydrological model which simulates eight major components in a watershed; hydrology, weather, erosion/sedimentation, soil temperatures and plant growth, nutrients, pesticide and land management. The model is applied in the Indus Basin and calibrated at Kalabagh on the Indus River and Nowsehera at the Kabul River. Kalabagh is a site proposed for construction of a large dam for generations of hydropower and storage of water to meet increasing water demand of the Worlds Largest Contiguous Indus Irrigation System. The quantitative hydrological parameters of Indus are simulated for assessment of baseline to study several management scenarios i.e addition of a dam and then climate changes impact assessment on water resources of Pakistan. Delineation of the watershed is carried out by Digital Elevation Map (DEM). The land use data in the project has been derived from the website of Global Environment Monitoring Unit of the Institute for Environment and Sustainability at the European Commission's Joint Research Centre. To obtain information on soil cover at a regional scale FAO 1:0.5 million soil vector maps were used and then characteristics of the three soils series identified in the watershed were derived by using USDA MUFF data file. Climatic data of 22 weather stations falling in watersheds in Pakistan, India, China and Afghanistan has been used for simulation period of 11 years. Monthly river discharge data of period; 1994 to 2004 has been used for calibration of various components of water balance in the Upper Indus Basin. This paper describes different aspects of hydrology of the Upper Indus Basin and evaluates the capability of the SWAT model.

Application of the SWAT model in the Chi river basin, Thailand, and application of different land use scenarios

Kittiwet Kuntiyawichai, Bart Schultz, Stefan Uhlenbrook, F.X. Suryadi

UNESCO-IHE Institute for Water Education, Delft, the Netherlands
E-mail: kittiwet_k@hotmail.com

Abstract

In the Chi river basin, Thailand, land resources are retreating from landscape due to employment alternatives in various branches of agriculture, industrialization, urbanization, etc. In this study, the influences of land use changes on hydrology are investigated using a Geographic Information System (GIS) based Soil and Water Assessment Tool (SWAT). The SWAT model integrated with ArcView is used to analyze the impact of land use changes on extreme events. This will be used to simulate the impacts of future scenarios. The overall goal of this research is to formulate land use development options and flood management measures for the Chi river basin. The initial inputs to SWAT are: Digital Elevation Models (DEMs), soil and land use data sets. The output variable is runoff.

Simulations will be made for cases in such a way that the agricultural land, which is the major land use in Chi river basin, may be changed from one cropping pattern to various cropping patterns in order to determine how the specific crop type might affect evapotranspiration and total runoff throughout the year. The changes of growing seasons (type, lengths, number), along with changes in land surface characteristics (e.g. elevation, soil type and soil depth), contribute to changes in the water balance will also be considered.

Additionally, future scenarios will be defined, in the form of possible future land use developments, relative to their impact on surface-water conditions (e.g. surface runoff). These hydrological outputs are estimated for the baseline of current land use patterns and predicted 10, 25 and 50 years in the future for evaluating the spatial impacts of land use change patterns on surface-water hydrology with a focus on the relative magnitude and spatial distribution of the computed changes.

Finally, the SWAT model will be coupled with a hydrodynamic model (SOBEK) by using the discharges at the outlet of the sub-river basin as boundary conditions of the model for flood simulation in the Chi river basin. As a result, sustainable integrated solutions in terms of optimal flood management will be achieved.

Keywords**:** Land use scenarios, Land use changes, Cropping pattern, Water balance, Surface-water conditions

Influence of Afforestation on Water Resources in Northern China

Pengtao Yu[1]*, Valentina Krysanova[2], Yanhui Wang[1], Wei Xiong[1], Lihong Xu[1], Wei Guan[1], Zhongjie Shi[1], Mingchun Guo[1], Fei Mo[1], Jianli Liu[1]

[1]Research Institute of Forest Ecology, Environment and Protection, The Chinese Academy of Forestry, Beijing, 100091, China.
E-mail: "Pengtao YU" <yupengtao@googlemail.com>

[2]Potsdam Institute for Climate Impact Research, P.O.Box 601 203, Telegrafenberg, D-14412 Potsdam, Germany

Abstract

There are many serious environmental problems in the dry regions of northern China, such as severe soil erosion, wide-spread desertification, frequent droughts and occasional flash floods. Increasing vegetation coverage is usually considered as a good method to solve these problems. The policy of encouraging afforestation and vegetation restoration has been implemented in this region by the Chinese government since 1999. However, there is an increasing worry that improper afforestation may reduce water yield from the watersheds so that it may lead to new environmental and social problems. In fact, some adverse impacts, such as soil drying and decreased runoff, have already been observed. A correct prediction of the water-related impacts of afforestation is a key issue to balance the positive and negative effects of afforestation in these regions.

For understanding and predicting the effect of afforestation on water yield, two small catchments in Liupan Mountain, which is located in the eco-tone between the semi-humid and semi-arid zones and represents the main afforestation area of this region, are chosen as the research sites. The ecohydrological model SWIM (Soil and Water Integrated Model) was used to analyse the eco-hydrological processes in afforested small catchments, to simulate and compare the afforestation influences on generated runoff, and to evaluate different afforestation options in this region. The results showed that the runoff generation process and its volume are influenced by many factors besides vegetation, especially the soil depth and soil properties. One of the most important runoff generating processes is, that about 10% of precipitation passes through the soil and enters into rock cracks, which are very abundant in rocky mountain areas, and turns into water yield from small catchments. This means that at least 10% of precipitation will be turned into runoff, not obviously influenced by forest/vegetation on slopes. So the streams in small catchments will not be dried up after afforestation.

Sediment and Runoff Estimation Using SWAT Model in Mountainous Watershed in Iran (a Case Study: Vanak, West Iran)

Jaleh[1] A., A. Jalalian[1], K. C. Abbaspour,[2] and M. Afyuni[1]

[1]Isfahan University of Technology, College of Agriculture, 84156 Isfahan, Iran.
Email: afyuni@cc.iut.ac.ir
[2] Swiss Federal Institute for Environmental Science and Technology, EAWAG, Ueberlandstrasse 133 P. O. Box 611, 8600 Dübendorf, Switzerland.

Abstract

The annual soil loss due to erosion in Iran ranges from 15 to 20 tones ha^{-1} $year^{-1}$. Modeling in recent years has become an attractive tool for management. The objective of this study was to use SWAT (Soil and Water Assessment Tool) to evaluate runoff and sediment yield in Vanak basin (3198 km^2) located in western Iran. SWAT was calibrated and validated based on the discharge and sediment data at the basin outlet and three other outlets in the interior of Vanak basin using SUFI-2 (Sequential Uncertainty Fitting Ver.2) procedure. Data from the period of 1990-2000 was used for calibration, and data from 2001-2004 was used for model validation. The R^2, Nash-Sutcliffe (*NS*) coefficient, *p-factor* and *d-factor* were used to assess the goodness of fit. The *p-factor* is the percentage of data bracketed by the 95% prediction uncertainty calculated at the 2.5% and 97.5% percentiles of the cumulative distribution of the simulated variables, and *d-factor* is the ratio of the average distance between the above percentiles and the standard deviation of the corresponding measured variable. The results showed that *p-factor*, *d-factor*, R^2 and *NS* values for monthly calibration of runoff at the watershed outlet were 0.56, 0.5, 0.81 and 0.68, respectively, and for the validation, these parameters were 0.50, 0.61, 0.73 and 0.52, respectively. The daily values for calibration of sediment at watershed outlet were 0.73, 30, 0.42 and 0.08, respectively. The results of sediment prediction at Vanak watershed were not very satisfactory.

Evaluation of the incorporation of a simple carbon model into SWAT2005

Armen Kemanian, Cole Green, Jeff Arnold, and Jimmy Williams

ABSTRACT

The carbon cycle is biogeochemically of interest due to its reactions with other elements that undergo oxidation and reduction transformations. Natural and anthropogenic factors affect the soil carbon pool transformations. In an effort to model the basic principles of soil carbon dynamics, a simple framework based on an earlier model by Henin and Dupuis (1945) was devised and implemented in SWAT. Only one pool of carbon is considered, as accounting for several carbon pools is tedious and wrought with uncertainty when applied at the watershed scale. Soil carbon decomposition follows first
order kinetics, and inputs of carbon from the vegetation litter are regulated by a humification factor. Both decomposition and humification rates are affected by soil properties and the environment, particularly moisture and temperature. This simple carbon model can compute decomposition rates per soil layer within a soil profile. There is minimal need for calibration with this model and the need to estimate different carbon pool sizes and turnover rates is bypassed. The incorporation of this model into the SWAT2005 model will be presented in relation to multiple scenarios.

Effect of Climate Change on Streamflow in Zayanderoud – Iran

Samaneh S. Ghasemi[1] , Ahmad Abrishamchi[2] ,Masoud Tajrishy[3]

[1]-M.Sc. Student, Civil Engineering Department, Sharif University of Technology,Tehran, Iran
[2]-Professor, Civil Engineering Department, Sharif University of Technology,Tehran, Iran
[3]-Associate Professor, Civil Engineering Department, Sharif University of Technology,Tehran, Iran
E-mail from Ghasemi: samanehghasemi@yahoo.com.

Abstract

Rising concentration of greenhouse gases may have significant consequences on the global climate. Changes in temperature and precipitation have a serious impact on hydrologic processes and water resources. Climate model projections show an increase in the global mean air temperature by 1 to 3.5°C over the next century. One of the most important problems in the management and planning of water resources is forecasting of streamflow. This study focuses on the impact of climate changes on streamflow in the Zayanderoud river basin in Isfahan, Iran. The Soil and Water Assessment Tool (SWAT1) has been used for forecasting streamflow changes due to climate change. SWAT is a daily time step model that allows for detailed simulation of the water balance. SUFI-22 model is used for calibrating SWAT model's parameters. SWAT model is calibrated and validated by utilizing observation data in 1990-1998. Next, downscaling precipitation and temperature due to CGCM2 model are used. These data are derived from two scenarios, A2 and B2 for two periods: 2021-2050 (immediate future) and 2071-2100 (far future).
The SWAT model was run for all cases. The hydrology of the climate change shows winter streamflow increases due to more precipitation and higher air temperature in winter than observed. The results also show that less snowpack and an earlier snowpack melt resulting in an earlier spring runoff that caused shift in peak flow for both periods.

Keywords: *Climate Change, Streamflow, Simulation, SWAT, SUFI-2*

Application of SWAT Model for Estimating Runoff and Sediment in a Mountainous Watershed in Central Iran

Rostamian[1], R., S. F. Mousavi[1], M. Heidarpour[1], M. Afyuni[1] and K. C. Abbaspour[2]
[1]Isfahan University of Technology, College of Agriculture, 84156 Isfahan, Iran. Email: mousavi@cc.iut.ac.ir
[2] Swiss Federal Institute for Aquatic Science and Technology, Eawag, Ueberlandstrasse 133 P. O. Box 611, 8600 Düebendorf, Switzerland

Abstract

Soil erosion is an important economical, social and environmental problem requiring intensive watershed management for its control. Modelling has in recent years become a useful approach for assessing the impact of various erosion-reduction approaches. Because of limited hydrologic data in mountainous watersheds, watershed modeling is, however, subject to large uncertainties. In this study, SWAT2000 was applied to simulate runoff and sediment in Beheshtabad watershed, a sub-basin of Northern Karun catchment in central Iran, with an area of 3860 km^2. Model calibration and uncertainty analysis were performed with SUFI-2, which was interfaced with SWAT. Two measures were used to assess the goodness of calibration: 1) The percentage of data bracketed by the 95% prediction uncertainty (P-factor), and 2) The d-factor, which is the ratio of average distance between the 2.5 and 97.5 percentiles and the standard deviation of the corresponding measured variable. Runoff data (1996-2004) of six hydrometery stations were used for calibration and validation of Beheshtabad watershed. The Results of the monthly calibration P-factor, d-factor, R^2 and Nash-Sutcliffe values for runoff at the watershed outlet were 0.61, 0.48, 0.85 and 0.75, respectively, and for the validation, these statistics were 0.53, 0.38, 0.85 and 0.57, respectively. The values for calibration of sediment at watershed outlet were 0.55, 0.41, 0.55 and 0.52, respectively. SWAT predicted runoff much better than sediment.

On the Characteristics of Flow Duration Curve According to the Operation of Multi-purpose Dams in Han-River Basin

N. W. Kim[1], J. E. Lee[2], B. J. Lee[3], I. M. Chung[4]

[1]Research Fellow, Water Resources Research Department, Korea Institute of Construction Technology, Ilsan, Gyeonggi-do, South Korea, E-mail: nwkim@kict.re.kr
[2, 3]Researcher, Water Resources Research Department, Korea Institute of Construction Technology, Ilsan, Gyeonggi-do, South Korea
[4]Senior Researcher, Water Resources Research Department, Korea Institute of Construction Technology, Ilsan, Gyeonggi-do, South Korea.

Abstract

Many dams were constructed for effective water resources management, especially the multi-purpose dams located in the Han River basin that provide the capital region (Gyeonggi, Gangwon, Seoul etc.) with valuable water source. The purpose of the present study is to evaluate the changes in the characteristics of flow pattern of the Paldang Dam basin due to operations of the Soyang and Chungju multi-purpose dams. A semi-distributed watershed model, SWAT-K, was used in order to generate regulated and unregulated daily flow of water upstream of the Paldang Dam. The reservoir operation module in the SWAT-K was modified from the original module in SWAT for modeling parallel multi-reservoir operations appropriately. Simulated flow regulated by the Soyang, Chungju, and Hwacheon dams was calibrated by comparison with the observed inflow data at the Paldang reservoir. The flow pattern analyses by using this calibrated system show the entire effect of the Soyang and Chungju multi-purpose reservoirs is a storage capacity of 21.6 billion tons/year for 54 days during the flood season. For the Soyang reservoir, the stored quantity is approximately 9.1 billion tons/year, which was stored for 63 days. For the Chungju reservoir, the stored quantity is approximately 12.5 billion tons/year, which was stored for 28 days. This study is the first attempt to evaluate the flow pattern characteristics by using simulated flow according to dam operation. More accurate analysis is expected to reevaluate the operating status of multi-purpose reservoirs in Korea.

Keywords: SWAT-K, Reservoir operation, Flow Duration Curve, Storage Capacity.

Modelling Tile Drainage for Modelling Nutrient Transport in the Pike River Watershed using SWAT.

Umuhire, F.[1], Beaudin, I.[2], van Griensven, A.[1], Deslandes, J.[2], Lévesque, E.[3], Michaud[2], A., Vanrolleghem, P.A.[3]

[1] UNESCO-IHE Institute for Water Education, Department of Environmental Hydroinformatics and Knowledge Management, Delft, Netherlands.
[2] Institut de recherche et de développement en agroenvironnement (IRDA), 2700 rue Einstein, Sainte-Foy, (Québec), G1P 3W8
[3] Département de génie civil, Université Laval, Québec, QC G1K 7P4, Canada.

Abstract

In the Missisquoi Bay of Lake Champlain, water quality is impaired by cyanobacteria blooms. Non point source phosphorus exports from farmlands are identified as a critical factor contributing to the recurrent algae blooms. The Missisquoi Bay catchment is located partly in southern Quebec, Canada, and Vermont, USA, and covers a total rea of 630km^2. The water quality study focuses on the the main river contributing to the bay, the Pike River. The objective was to adapt and calibrate a SWAT (The Soil and Water Assessment Tool) model to the existing conditions in the Pike River watershed.

The SWAT2003 hydrologic model was tested at a small scale using the Walbridge (7 km²) sub-watersheds within the Pike River watershed, which presents contrasting landscape attributes. The ability of the model to simulate the watershed system depended on how watershed processes were represented by the model and how the watershed system was described by the model input parameters. Even after calibration the model failed to predict the water distribution budget on the Walbridge's sub-watersheds, underestimating tile drains flows. The model required modifications of its source codes in order to predict the path of water and nutrient flows towards the river in a correct way. In Quebec, tile drainage can account for up to 79% of the total annual water yield at parcel scale. Consequently, the contribution of tile drainage to the hydrologic cycle must be properly modeled. This study determined the effects of different model improvements with regard to tile drainage on the water distribution in the hydrological network of the area in view of meeting the water budget conditions and nutrients dynamics. Modeled tile flow provided a dominant pathway for N and a significant pathway for P. Overall, modeling results are promising regarding future use of the moditified SWAT codes in predicting the effect of best management practices (BMPs) in the Pike River watershed.

Development of a hydrologic model of Kagera River basin using remote sensing data

Haguma D. (1), A. van Griensven (2), S.J. van Andel (2), E. Lévesque (3), F. Anctil (3), R. Price (2)

1) KIST, Kigali, Rwanda,
2) UNESCO-IHE, Institute for Water Education, Delft, The Netherlands,
3) Université Laval, Québec, Canada
(a.vanGriensven@unesco-ihe.org, hagudi@gmail.com)

Abstract

Model-based decision support tools are important for the management of water resources. Specifically in developing countries, there is a lack of local data (ground collected data) and information to build, calibrate and validate the underlying hydrological models. We should therefore use alternative source of data such as remote sensing data or global data.

There are various archives of global datasets available online that could be used for hydrological modeling. They range from topographical data (SRTM) to soil data (FAO soil maps) and land use (Global land use maps) as well as climatic data. The most interesting are climatic datasets, which include precipitation and temperature. Some data have been collected by different satellites such as TRMM, NCEP/NCAR Reanalysis, others provide statistical data. An example is the CRU monthly datasets for rainfall, temperature and number of wet days per month that can produce daily data in as stochastic manner, using the weather generator DWGA.

In this research, remote sensed data and global data have been evaluated and used to develop a hydrological model for the Kagera River basin, which is located in east-central Africa and it is a sub-catchment of the Nile River basin. The model was developed using Soil and the Water Assessment Tool-SWAT, a continuous time and hydrological model used for river basin scale modeling. Satellite datasets and global datasets were used to generate the inputs for simulating daily/monthly flows for the Kagera basin.

All the precipitation datasets had almost the same temporal and spatial distribution; however the precipitation depths varied from one data set to another. The simulated flows showed clear differences of model response to those precipitation data sets. The SWAT model performance was low, due to precipitation data quality, model resolution and variability in topography, climate and landform of the study area.

Keywords: remote sensing; global data; SWAT; Kagera River.

Assessing the Performance of SWAT and AnnAGNPS Models at Choptank, a Coastal Plain Watershed, in Maryland, U.S.A.

Ali Sadeghi[1], Kwang Yoon[2], Carrie Graff[3], Greg McCarty[1], Laura McConnell[1], Adel Shirmohammadi[4], Dean Hively[1], Kerry A. Sefton[1]

1. Soil Scientist, USDA-ARS, Beltsville, Maryland, U.S.A.
2. Visiting Scientist, South Korea.
3. Scientist, Limno Tech, Washington, DC., U.S.A.
4. Professor, University of Maryland, College Park, Maryland, U.S.A.

Abstract

This study was conducted under the USDA-Conservation Effects Assessment Project (CEAP) on the Choptank watershed which is located within the Chesapeake Bay watershed in the Eastern Shore region of Maryland, U.S.A. The watershed is nearly 400 square mile and is dominated primarily by corn and soybean productions. Poultry manure is being used rather heavily in this watershed and thus, excess nitrogen and phosphorous are being considered as major pollutant loads into the surface waters.
Recent years, significant numbers of USDA incentive programs are being initiated for water quality improvement in this watershed, but environmental benefits from these programs have never been quantified. Two of the most widely used USDA watershedscale models, SWAT (Soil and Water Assessment Tool) and AnnAGNPS (Annualized Agricultural Non-Point Source) are being applied to quantify the environmental benefits, such planting cover crops after crop harvest during fall and winter periods. Five years (1991-1995) of detailed database used to provide a baseline calibration and validation for the two models. Simulation results showed significant differences in base-flow estimations for the two models; that can be considered to be a significant factor in model selection to estimate nutrients and sediment loads in regions of fairly flat landscapes.

The Impacts Of Climate Change On Hydrological Services Provided By Dry Forest Ecosystems In West Africa

Elke Verbeeten and Johnson Nkem

E-mail: e.verbeeten@cgiar.org

Center for International Forestry Research (CIFOR), 06 BP 9478 Ouagadougou 06, Burkina Faso, Tel: +226 76549066;

ABSTRACT

Regulation of the hydrological cycle is one of the services provided by forests. The challenge to predict the quantity and quality of water availability is greater under changing climatic conditions.

Much has been documented in humid tropical forests, but only a little is known concerning the roles of forests in regulating the hydrological cycle in semi-arid environments, especially in West-Africa. In this region a sustainable water supply, especially during the long dry season, is of importance to the population. Water can be available as shallow groundwater and as dry season flow in river systems.

The Soil and Water Assessment Tool (SWAT) has been used to assess the impacts of climate change on the water balance. The model indicates how runoff and infiltration changes affect the water balance quantity and quality at a catchment level. The main data inputs for the model are meteorological data, river discharge, land use and soil physical parameters.
Preliminary results demonstrate that erratic and intensive rainfall leads to higher peaks of discharge in the rainy season, and consequently a decline of water availability during the dry season. Under such climatic conditions the sediment load also increases, affecting the water quality. Input parameters are now being fine-tuned to improve the accuracy of predicted outputs.

Results are useful for dry forest policy and management options. Moreover, this information can be used to generate criteria for vulnerability assessment of dry forest ecosystems and the forest-dependent community.

Application of SWAT in a Mountainous Arid Catchment in United Arab Emirates

Holman, I.P,[1] and Mulla, M. [1,2]
[1] Department of Natural Resources, Cranfield University, Cranfield, Bedford, UK
[2] Now at Ministry of Environment and Water, UAE

Abstract

This paper describes the application of the SWAT model in the mountainous 192 km^2 Wadi Ham catchment in the United Arab Emirates. Average annual rainfall in the catchment is around 150 mm/a, although this varies between around 20-325mm/a, while elevation ranges from 75 -1000 masl. The hydrology of the catchment is dominated by very occasional intense rainfall events which lead to flash floods within the wadi system. Recharge to the shallow alluvial aquifer occurs through transmission losses from the wadi bed during these events and from infiltration through the bed of the downsteam recharge dam. The alluvial aquifer supports the groundwater abstraction required for irrigation of the vegetable, date palm and alfalfa cultivation. A different range of SWAT input parameters were shown to be sensitive under arid conditions compared to those previously reported in temperate climates. The parameters that affect the ephemeral streamflow in Wadi Ham, UAE are mainly related to the soil and channel properties of the catchment. The SWAT model was used to improve the understanding of the hydrological processes operating in the catchment and to support improved water resources management. However, due to data constraints, individual model components were largely validated through plausibility against literature and field observations. The challenges and results of this first application of SWAT in an arid Gulf Region catchment provides insights for other arid zone researchers.

KEYWORDS: SWAT, mountainous, arid, United Arab Emirates, wadi

Does it runoff when it rains? - Challenges in model calibration in a semi-arid catchment in northern China

K. Schneider[1]*, L. Breuer[1], K. Vaché, and H.-G. Frede[1]

Email: katrin.schneider@agrar.uni-giessen.de

1. Institute of Landscape Ecology and Resources Management, Justus-Liebig-University, Heinrich-Buff-Ring 26, 35392 Giessen, Germany.

ABSTRACT

Successful applications of the SWAT model have been developed for watersheds in a range of environments and under differing boundary conditions. Commonly, a change of model parameters leads to an acceptable representation of runoff in a catchment, and the model is considered successfully calibrated. There is however a growing interest in cases where calibration is unsuccessful, leading to directed questions regarding the model structure and process representation.

The application of SWAT in the 3600km2 semi-arid Xilin watershed in northern China proved to be challenging as neither manual nor automated calibration improved the model performance to an acceptable degree. In this paper we provide a step by step analysis of the relevant processes resulting in model failure, and follow with changes to the model structure or application procedures which results in an improved representation of key hydrologic processes. The study area is marked by a continental climate with warm/wet summers and cold/dry winters. Mean annual precipitation in this steppe environment is 350 mm. The model structure is unable to capture (1) the spring snowmelt peak and (2) summer discharge. Modeled spring snowmelt is far too low as compared to observed data, and summer peaks are considerably higher than observed. Two different processes, not well captured within SWAT parameters, resulted in the unsuccessful calibration. The first relates to snow accumulation during the winter months from November to March and the fast depletion of this storage in spring. The model underestimates the snow accumulation, and redistribution of snow is not accounted for which leads to a significant underestimation of vernal discharge. The second relates to the spatial variability of warmer weather precipitation inputs. Only few rain gauges exist so the spatial variability of the mainly convective summer precipitation is not accounted for in the model. Given available data, individual high rainfall events are apportioned throughout the entire catchment, leading to a high simulated discharge.

For both runoff situations in spring and summer the source area for runoff generation proved to be important for model performance. The question relates to the topographically delineated catchment area and whether it is equivalent to the region which contributes high flow runoff in the Xilin river. It is unclear whether remote parts of this large semi-arid catchment with potentially high spatial variability of input are active contributors to runoff generation and, consequently, whether over- and underprediction of runoff is not only linked to model parameters, but also to watershed properties that usually are not considered in model calibration.

Simulating Bermudagrass, Bahiagrass, and Native Range Species on Diverse Sites in Texas

Jim Kiniry

USDA-ARS, Grassland, Soil, and Water Res. Lab., 808 E. Blackland Road, Temple, TX 76502, USA. E-mail: jkiniry@spa.ars.usda.gov

Abstract

A robust simulation model capable of simulating native grasses and improved pasture would be a valuable tool for comparing soil erosion among different management schemes and for addressing water quality questions in such systems. This poster describes plant parameters to simulate native and improved grasses in the southern U.S. Model simulation accuracy is described for some diverse sites in Texas. Biomass was realistically simulated for coastal bermudagrass, bahiagrass, and native grasses for these sites.