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July 18, 2007

Name of Model: TOPKAPI Model

Model Type: Semi-distributed rainfall-runoff model

Model Objective(s): (1) To take advantage of distributed models containing physically meaningful parameters, (2) to overcome the inconsistency of neglecting the transient phase as in the TOPMODEL, (3) to incorporate the possibility of obtaining a lumped version of the same model by integrating the processes over increasing size domains without the need for recalibration, and (4) to allow for the application of the model at increasing spatial scale from hillslope to catchment scale to GCMs.

Agency and Office: Department of Earth and Geo-Environmental Sciences, University of Bologna, Bologna, Italy

Technical Contact and Address: Professor E. Todini

Model Structure or Mathematical Basis: TOPKAPI is the acronym of: TOPographic Kinematic Approximation and Integration. It is based on the idea of combining the kinematic approach with the topography of the basin described by means of a lattice of square cells over which the model equations are integrated. The model is structured around three modules which represent the soil component, the overland flow component and flow through the drainage network. Thus, the model comprises three cascades one for each component. The model is available in lumped form as well as semi-distributed form.

Model Parameters: It has six parameters for each soil class, one parameter for each Strahler order, and other parameters for evapotranspiration, and other processes.

Spatial Scale Employed in the Model: Variable, from a hillslope scale to the catchment scale

Temporal Scale Employed in the Model: Continuous

Input Data Requirements: DEM, rainfall, soils maps, land use maps, and rainfall

Computer Requirements: PC with windows

Model Output: Discharge hydrograph

Parameter Estimation / Model Calibration: Parameter by optimization

Model Testing and Verification: The model has been applied to a number of basins in Italy and other countries and the results have been promising.

Model Sensitivity: Not given

Model Reliability: Not given but the model seems to reproduce good results

Model Application / Case Studies: Reno River, Italian basins

Documentation: Not available in the public domain but it can be obtained from Professor Todini.

Other Comments: The model has good potential for practical application.

References:

Ciarapica, L., and Todini, E., 1998. TOPKAPI-Un modelle afflussi-deflussi applicabile dalla scala di versante alla scala di bacino (in Italian). Procedings, XXVI Convengo di Idraulica e Construzioni Idrauliche, Vol. II, pp. 49-60.

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Name of Model: ARNO Model

Model Type: Continuous time, semi-distributed rainfall-runoff model

Model Objective(s): To develop a model for water master planning, analysis of extreme floods, real-time flood forecasting, and represent the soil component in general circular models.

Agency and Office: Department of Earth and Geo-Environmental Sciences, University of Bologna, Bologna, Italy.

Technical Contact and Address: Professor E. Todini

Model Structure or Mathematical Basis: The model is a suite of modules representing most of the processes which are described at the catchment or sub-catchment scale. The processes include soil moisture balance, drainage, percolation, groundwater, evapotranspiration, snow accumulation and melting, parabolic overland runoff routing, and parabolic in-stream routing.

Model Parameters: 11, 6 of which relate to soil moisture that need calibration; the remaining parameters can be estimated from geomorphologic and soil and land use maps.

Spatial Scale Employed in the Model: Catchment or sub-catchment scale

Temporal Scale Employed in the Model: Continuous time

Input Data Requirements: Hydrometeorological data, rainfall, soils maps, drainage maps, and land use maps.

Computer Requirements: PC with windows

Model Output: Discharge hydrographs

Parameter Estimation / Model Calibration: Some parameters are estimated by model calibration using an optimization routine.

Model Testing and Verification: The model has been extensively tested on Italian basins as well as on basins outside of Italy.

Model Sensitivity: Nor given.

Model Reliability: Not given, but the model accuracy is reported to be within 20 to 30 % accuracy.

Model Application / Case Studies: Tiber River in Italy, Arno River in Italy, and others.

Documentation: Not available in public domain but it can be obtained from Professor E. Todini.

Other Comments: The model is simple and has potential for practical applications at the catchmet scale.

References:

Todini, E., 1996. The ARNO rainfall-runoff model. Journal of Hydrology, Vol. 175, pp. 339-382

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Name of Model: CLS model

Model Type: Multiple input single output linear system model

Model Objective(s): To simulate non-linear rainfall runoff and flood routing processes

Agency and Office: Department of Earth and Geo-Environmental Sciences, University of Bologna, Bologna, Italy

Technical Contact and Address: Professor E. Todini

Model Structure or Mathematical Basis: The model is based on a piecewise approximation of the nonlinear rainfall runoff and routing processes, with impulse responses derived by quadratic programming

Model Parameters: 8 parameters

Spatial Scale Employed in the Model: Catchment or sub-catchment scale

Temporal Scale Employed in the Model: Continuous time

Input Data Requirements: Rainfall, antecedent moisture condition and watershed maps

Computer Requirements: PC with windows

Model Output: Discharge hydrograph

Parameter Estimation / Model Calibration: Estimated by optimization, such as constrained linear least squares method.

Model Testing and Verification: Extensively tested and verified

Model Sensitivity: Notgiven

Model Reliability: Not reported, but the model accuracy is with 20 %

Model Application / Case Studies: Arno River, Nile River, Niger River, and others

Documentation: Not available in public domain but it can be obtained from Professor Todini.

Other Comments: Promising tool for flood forecasting at the catchment scale.

References:

IBM Italy, 1977. Modelle Matematico delle Piene dell'Arno (in Italian). Editrice Adonia, Milano.

Natale, L and Todini, E., 1977. A constrained parameter estimation technique fro linear models in hydrology. In Mathematical Models for Surface Water Hydrology, edited b T. A. Ciriani, U. Maione and J. R. Wallis, pp. 109-147, John Wiley & Sons, London.

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Name of Model: SIRG – Numerical Model of Surface Runoff, Infiltration, River Discharge and Groundwater Flow

Model Type: Physically-based, process-oriented, lumped parameter, distributed model

Model Objective(s): To develop a physically based model of runoff for conjunctive use of surface water and groundwater.

Agency and Office: Department of Civil Engineering, Ajou University, Suwon, South Korea

Technical Contact and Address: Professor Dong Hoon Yoo

Model Structure or Mathematical Basis: It is comprised of four modules representing surface runoff, infiltration, river discharge, and ground water flow. Each module is based on theoretical description of physical processes.

Model Parameters: 11 parameters where 4 are for surface runoff, 4 for infiltration, 2 for river discharge, and 1 for groundwater flow.

Spatial Scale Employed in the Model: Grid size

Temporal Scale Employed in the Model: Continuous, limited by the grid size

Input Data Requirements: Basin area maps, river cross-sections, rainfall hyetographs, and soil characteristics.

Computer Requirements: PC with windows

Model Output: Discharge hydrograph

Parameter Estimation / Model Calibration: Parameters are obtained from physical characteristics and are refined by model calibration.

Model Testing and Verification: Limited testing by comparison with observed discharge values.

Model Sensitivity: Not reported

Model Reliability: Nor reported

Model Application / Case Studies: Yang-yang Namdae-chun watershed in northeast Korea

Documentation: Not available in public domain but it can be obtained from Progessor D. H. Yoo.

Other Comments:

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Name of Model: DHSVM-Distributed Hydrology Soil Vegetation Model

Model Type: Distributed physically-based model

Model Objective(s): To provide a dynamic representation of the spatial representation of evapotranspiration, snow cover, soil moisture, and runoff at the scale of digital elevation data.

Agency and Office: Pacific Northwest National Laboratory, Richland, Washington, U. S. A.

Technical Contact and Address: Dr. Mark S. Wigmosta

Model Structure or Mathematical Basis: The model provides a dynamic representation of watershed processes at the spatial scale described by digital elevation model data. Physical principles are employed in representation of processes.

Model Parameters: 22

Spatial Scale Employed in the Model: 10 – 90 m horizontal resolution

Temporal Scale Employed in the Model: Continuous

Input Data Requirements:

Computer Requirements:

Model Output: Runoff hydrograph

Parameter Estimation / Model Calibration: Most parameters have physical meaning and estimated from physical measurements.

Model Testing and Verification: Hydrometeorological data, rainfall, soils maps, watershed maps, and land use maps.

Model Sensitivity: Nor reported

Model Reliability: Nor detailed but the model accuracy is reported to be high.

Model Application / Case Studies: It has been applied in numerous studies, including evaluation of mass and energy fluxes under snow free conditions, evaluation of canopy snow interception and ground snowpack, impacts of interception by logging roads, interaction between climate and hydrology, potential impact of climate change on water resources, etc.

Documentation: Nor available but it can be obtained from Dr. M. S. Wimosta.

Other Comments: It is a potentially useful model and can be used for a variety of purposes.

References:

Wigmosta, M. S., Vail, L. W., and Lettenmaier, D. P., 1994. A distributed hydrology-vegetation model for complex terrain. Water Resources Research, Vol. 30, No. 6, pp. 1665-1679.

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Name of Model: RSHM -Regional Scale Hydroclimate Model

Model Type: Physically based distributed regional hydroclimate nested model

Model Objective(s): To study the climate change impacts

Agency and Office: Department of Civil and Environmental Engineering, University of California, Davis, California, U. S. A.

Technical Contact and Address: Professor M. L. Kavvas

Model Structure or Mathematical Basis: It is a nested model in that it connects two different scales by embedding a smaller scale model in a larger scale model. It takes into account interactions between atmosphere and land surface processes.

Model Parameters: 9

Spatial Scale Employed in the Model: 20 km

Temporal Scale Employed in the Model: From a day to a year

Input Data Requirements: Atmospheric and land surface data

Computer Requirements: Large computer

Model Output: Precipitation, evapotranspiration, and temperature

Parameter Estimation / Model Calibration: Parameters are estimated form physical measurements.

Model Testing and Verification: Limited amount of verification has been undertaken on Japan islands

Model Sensitivity: Not reported

Model Reliability: Nor reported

Model Application / Case Studies: Japan islands

Documentation: Not available in public domain but it can be obtained from Professor M. L. Kavvas

Other Comments: The model represents a promising tool fro large scale water resource assessment.

References:

Kavvas, M. L., Chen, Z.-Q., Tan, L., Soong, S. T., Terakava, A., Yoshitani, J., and Fukami. K., 1998. A regional scale land surface parameterization based on areally-averaged hydrological conservation equation. Hydrological Sciences Journal, Vol. 43, No. 4, pp. 611-631.

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Name of Model: ISBA-MODCOU Coupled Model

Model Type: Physically based distributed model

Model Objective(s): To couple atmospheric and hydrologic processes to simulate the entire continental water cycle

Agency and Office: Ecole des Mines de Paris/CIG, UMR CNRS Sisyphe, Fontainbleau, France

Technical Contact and Address: Dr. E. Ledoux

Model Structure or Mathematical Basis: The MODCOU model is comprised of five distict but interconnected functions for simulation of different components of the water cycle, icluding the production function that separates precipitation into infiltration, runoff, evapotranspiration, and soil moisture storage; surface transfer function, the transfer function through unsaturated zone, groundwater function and river/aquifer exchange function. The ISBA land-surface scheme simulates land surface processes.

Model Parameters: The basin geometry and surface routing network parameters are derived from digital elevation models. Transmissivity and storage parameters are calibrated using piezometric and hydrologic data.Surface parameters are derived from soil texture and vegetation type.

Spatial Scale Employed in the Model: I km

Temporal Scale Employed in the Model: Monthly to yearly

Input Data Requirements: Atmospheric, and land surface data

Computer Requirements: Large computer

Model Output: Discharge hydrograph, surface fluxes, soil moisture, and snow depth or water equivalent

Parameter Estimation / Model Calibration: Some by calibration using an optimization routine

Model Testing and Verification: Tested on French basins

Model Sensitivity: Nor reported

Model Reliability: Nor detailed

Model Application / Case Studies: Adour and Rhone basins in France

Documentation: Not available in public domain but can be obtained from Dr. Ledoux

Other Comments: The model seems to be a promising tool to couple land surface processes and atmospheric processes.

References:

Ledoux, E., Girard< g., de Marsily, G. and Deschenes, J., 1989. Spatially distributed modeling: Conceptual approach, coupling surface water and ground water. In Unsaturated flow Hydrologic Modeling –Theory and Practice, edited by H. J. Morel-Seytoux, NATO -ASI Series, Vol. 27, pp. 435-454, Kluwer Academic Publishers, Boston.

Noilhan, J. and Mahtouf, J.-F., 1996. The ISBA land surface parameterization scheme. Global Planet. Change, Vol. 13, pp. 145-159.

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Name of Model: ARC/EGMO-Hydrologic Modeling System

Model Type: Distributed dynamic model

Model Objective(s): (1) To develop a modeling system and tool box at river basin scales (meso- and macro-scales), (2) to quantify the effect of land use change and climate change on catchment hydrology, (3) to apply different spatial disaggregation schemes, and (4) to assess the spatial and temporal variability of different hydrologic processes.

Agency and Office: Potsdam Institute for Climate Impact Research, Potsdam, Germany

Technical Contact and Address: Dr. A. Becker

Model Structure or Mathematical Basis: The model has a modular structure permitting to activate various component models (modules) which describe the corresponding individual processes. It is coupled to a GIS, such as ArcInfo/ArcView, permitting to use GIS maps in the process of disaggregating a basin into areal units. The model has major modules for horizontal processes, vertical processes, basin disaggregation, land use cover, GIS ArcInfo, routing, and so on. Within each module, there are major component process models.

Model Parameters: Most parameters are determined from physical measurements and the number of parameters depends on the basin disaggregation.

Spatial Scale Employed in the Model: Elementary areal unit or grid size

Temporal Scale Employed in the Model: Daily

Input Data Requirements: Hydrometeorological data, rainfall, land use cover maps, soils maps, and basin maps

Computer Requirements: Large computer but also PC with windows

Model Output: Discharge hydrograph

Parameter Estimation / Model Calibration: Calibration of some parameters by optimization

Model Testing and Verification: Tested on several basins in Germany (5 to 20,000 square kilometers)

Model Sensitivity: Not reported

Model Reliability: Nor reported

Model Application / Case Studies: Saale River basin (24,000 square kilometers) and Stepenitz basin in Germany

Documentation: Not available in public domain but it can be obtained from Dr. A. Becker.

Other Comments: The model is well designed and its architecture is commendable. Ithas the potential to be popular model around the globe.

References:

Becker, A. and Pfutzner, B., 1987. EGMO-Systems approach and subroutines for river basin modelling. Acta Hydrophysica, Berlin, Bd 31, H. ¾.

Becker, A. and Nemec, J., 1987. Macroscale hydrologic models in support of climate research. IAHS Publication No. 168, pp. 431-446.

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Name of Model: HMS-Hydrologic Modeling System

Model Type: Semi-distributed model

Model Objective(s): To predict the influence of human activities on catchment hydrology

Agency and Office: Laboratory of Water Resources, Helsinki University of Technology, Espoo, Finland

Technical Contact and Address: Dr. H. Koivusalo

Model Structure or Mathematical Basis: The model is based on division of a catchment into hydrologically similar units (HSU), with each unit representing possibly non-contiguous areas which share common runoff generation mechanisms. Each HSU is assigned a hillslope-scale water balance scheme called a characteristic profile method (CPM). The total runoff generated from all HSUs is routed through the channel network using a streamflow routing procedure. The modeling system includes submodels for canopy, snow, soil water movement, and channel processes.

Model Parameters: Many parameters depending on the model structure and the number of HSUs.

Spatial Scale Employed in the Model: Small HSU or sub-basin

Temporal Scale Employed in the Model: Continuous

Input Data Requirements: Hydrometorological data, rainfall, soils maps, land use maps, and basins maps.

Computer Requirements: PC with windows

Model Output: Discharge hydrograph

Parameter Estimation / Model Calibration: Calibration by optimization on the basis of submodel for channel processes against observed data.

Model Testing and Verification: Tested on a number of watersheds.

Model Sensitivity: Not reported

Model Reliability: Nor reported but the model has been found to yield satisfactory results.

Model Application / Case Studies: Rudback catchment (small, forested) and Lestijoki catchment (1,290 square kilometers) in Finland

Documentation: Not available but it can be obtained form Dr. H. Koivusalo

Other Comments: The model seems promising for practical applications.

References:

Koivusalo, H., Karvonen, T. and Lepisto, A., 2000. A quasi-three dimensional model for predicting rainfall-runoff processes in a forested caychment in southern Finland. Hydrology and Earth System Sciences, Vol. 4, No. 1, pp. 65-78.

Kakkonen, T., Koivusalo, H., Karvonen, T. and Lepisto, A., 1999. A semi-distributed approach to rainfall-runoff modeling-Aggregating responses from hydrologically similar areas. In MODSIM ’99, edited by L. Oxley and F. Scrimgeour, The Modeling and Simulation Society of Australia and New Zealand, Hamilton, New Zealand, pp. 75-80.

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Name of Model: SHETRAN

Model Type: Physically-based distributed river basin model

Model Objective(s): To simulate transient three-dimensional flow and transport in basins up to about 5,000 square kilometers.

Agency and Office: Water Resource Systems Research Laboratory, University of New Castle, New Castle upon Tyne, U. K.

Technical Contact and Address: Dr. John Ewen

Model Structure or Mathematical Basis: The model represents a basin as a three-dimensional mesh and the storages and movements of water, sediment and solute are represented by finite difference approximations to the governing conservations for flow and transport.

Model Parameters: Varying depending on the processes to be simulated.

Spatial Scale Employed in the Model: Grid size (250 m x 250 m)

Temporal Scale Employed in the Model: Continuous

Input Data Requirements: Hydrometeorologic data, rainfall, soils, basin geomorphology, and land use. Other data depend on particular type of application.

Computer Requirements: PC with windows or a large computer

Model Output: Discharge hydrograph, sediment graph, and solute graph.

Parameter Estimation / Model Calibration: Parameters are obtained from physical measurements.

Model Testing and Verification: Tested on a umber of watersheds in U. K. and other countries.

Model Sensitivity: Not reported

Model Reliability: Discussed in short and the model is reported to very reliable.

Model Application / Case Studies: Agri basin (1700 square kilometers) in Italy; Slapton Wood, Devon, in England; Murg basin (75 square kilometers) in Switzerland; and Ellerton Ings, River Dervent, Yorshire in U. K.

Documentation: Not available in public domain but it can be obtained from Dr. J. Ewen

Other Comments: The model is physically based and can simulate a variety of processes accurately.

References:

Ewen, J. and Parkin, G., 1996. Validating catchment models for predicting land-use and climate change impacts: 1. Methodology. Journal of Hydrology, Vol. 175, pp. 5830594.

Ewen, J., Parkin, G and O' Connell, P. E., 2000. SHETRAN: Distributed river basin flow an dtransport modeling system. Journal of Hydrologic Engineering, ASCE, Vol. 5, pp. 250-258.

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Name of Model: LASCAM-Large Scale Catchment Model

Model Type: Conceptual model

Model Objective(s): To predict the impact of land use and climate changes on the daily trends of streamflow and water quality (salinity, sediment, nutrients, etc.) in large catchments over long periods.

Agency and Office: Centre for Water Research, University of Western Australia, Nedlands, Australia

Technical Contact and Address: Dr. M. Sivalapan

Model Structure or Mathematical Basis: The model is a complex conceptual one, the basic building blocks being subcatchments organized around the river network. All hydrological and water quality processes are modeled at the sub-catchment scale.

Model Parameters: 87 parameters

Spatial Scale Employed in the Model: 100 to 10,000 square meters

Temporal Scale Employed in the Model: Daily

Input Data Requirements: Topographic, hydrometeorological, rainfall, soils, land use, basin geomorphological, and water quality.

Computer Requirements: PC with windows

Model Output: Streamflow and water quality

Parameter Estimation / Model Calibration: Parameters are obtained by fitting an doptimization

Model Testing and Verification: Verified on a number of catchments in Australia and outside

Model Sensitivity: Not reported

Model Reliability: Not reported but excellent model simulations have been obtained.

Model Application / Case Studies: Swan-Avon River basin and Salmon basin in Australia; a tropical catchment in Malaysia

Documentation: Not available in public domain but it can be obtained from Dr. Sivapalan

Other Comments: The model is comprehensive and produces excellent results.

References:

Sivapalan, M., Viney, N. R. and Ruprecht, J. K., 1996. Water and salt balance modeling to predict the effects of land use changes in forested catchments: 1. small catchment water balance model. Hydrological Processes, Vol. 10, pp. 393-411.

Sivapalan, M., Viney, N. R. and Ruprecht, J. K., 1996. Water and salt balance modeling to predict the effects of land use changes in forested catchments:2. Coupled model of water and salt balances. Hydrological processes, Vol. 10, pp. 413-428.

Sivapalan, M., Viney, N. R. and Ruprecht, J. K., 1996. Water and salt balance modeling to predict the effects of land use changes in forested catchments:3. The large catchment model. Hydrological Processes, Vol. 10, pp. 429-446.

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Name of Model:RIOFISH

Model Type: Deterministic, numeric simulation system

Model Objective(s): To simulate habitats for New Mexico sportsfisheries and their supporting biotic communities

Agency and Office: Department of Fishery and Wildlife Sciences, New Mexico State University, Las Cruces, New Mexico, U. S. A.

Technical Contact and Address: Dr. Richard A. Cole

Model Structure or Mathematical Basis: The model is comprised of hydrologic, ecological and socio-economic components. Information outputs from the hydrologic component become inputs for the function of both ecological and the socio-economic components of RIOFISH.

Model Parameters: Many parameters, some obtained from physical measurements and some obtained by calibration.

Spatial Scale Employed in the Model: Catchment or sub-catchment scale

Temporal Scale Employed in the Model: Bimonthly or 13 to 16 days

Input Data Requirements: Hydrologic and socio-economic and ecological

Computer Requirements: PC with windows

Model Output: Diagnostic information for management decisions

Parameter Estimation / Model Calibration: Parameters are obtained from physical measurements and by calibration against observations.

Model Testing and Verification: tested on a number sites in New Mexico

Model Sensitivity: Nor reported

Model Reliability: Nor reported

Model Application / Case Studies: Applied to a number sites.

Documentation: Nor available in public domain but it can be obtained form Dr. R. A. Cole

Other Comments: The model is a potentially useful tool for management decisions.

Refereneces;

Cole, R., Ward, T., Ward, F. and Deitner, 1986. A simulation model for managing fisheries in reservoirs of the Rio Grande of New Mexico. In Reservoir Fisheries Management Strategies for the 80's, edited by G. E. Hall, pp. 18-28, Allen Press, Lawrence, Kansas.

Cole, R. A., Ward, F. A., Ward, T. J. and Wilson, R. M., 1990. Development of an interdisciplinary model fro water and fishery managemnt. Water resources Bulletin, Vol. 26, No. 4, pp. 597-609.

Cole, R. A., Ward, T. J., Ward, F. A., Deitner, R. A.,Rodden, R. W., Bolton, S. M. and Green-Hammond, K. A., 1995. RIOFISH: A statewide comprehensive managemnt system model fro New Mexico sportsfisheries. WRRI Technical Completion Report 291, New Mexico Water Resources Research Institute, New Mexico State University, Las Cruces, 230 pp.