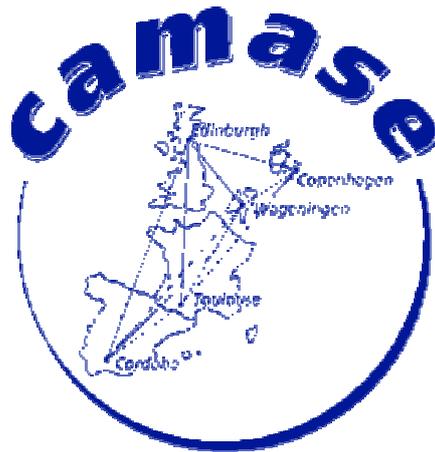


CAMASE

Register of Agro-ecosystems Models



Version June 1996

M.C. Plentinger & F.W.T. Penning de Vries (editors)

CAMASE: a Concerted Action for the development and testing of quantitative Methods for research on Agricultural systems and the Environment

DLO-Research Institute for Agrobiolology and Soil Fertility (AB-DLO)

Preface to this edition

From 1995 until July 1st, 2005, the CAMASE Register of Agro-ecosystems Models was available as a searchable database on the Internet, hosted by Wageningen UR Library.

This electronic-only edition of the Register contains the data present in the Register after the final update in June 1996.

Wageningen, 6 June 2005

Wageningen UR Library

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The CAMASE project

CAMASE: a Concerted Action for the development and testing of quantitative Methods for research on Agricultural Systems and the Environment. CAMASE would not have come into existence without the generous support by the European Commission's RTD programme.

Background of CAMASE

Development and testing of quantitative methods for research on agricultural systems and the environment requires dynamic simulation models of crop, animals and agricultural systems. In the models, current knowledge and insights from different disciplines (including crop physiology, agrometeorology, soil science, agronomy, phytopathology) are integrated in a consistent, quantitative and process-oriented way. These models are used to test alternative hypotheses, analyse current production techniques, and predict the effect of changes in environmental conditions, crop management practices and new design of plant-type. Through associated experimental research, the models continue to be refined and expanded.

Decision support systems aid in strategic and tactical decision-making at the farm level. They allow users to combine technical knowledge contained in assessment and economic analysis of farming enterprises. To determine such optimal strategies and tactics by experimentation would be practically impossible.

Planning land use and rural development requires evaluation of a large number of alternatives for agricultural and non-agricultural land use, with their consequences for the corresponding physical, chemical, biological and socio-economic inputs and outputs. Multiple goal linear programming is such an aid for policy decisions.

Aims of CAMASE

Quantitative methods for research on crop and animal production, agricultural systems and the environment have developed slowly and unevenly in different organisations and different countries over the past to decades. Several models that emerged have now reached a level where they can be applied to some practical problems of agricultural production and environmental problems. Lack of standardisation and documentation is now an important bottle-neck for further application. Currently, many groups in Europe are active in crop modelling. Sharing information among them must be stimulated.

Research on methods and models at the level of agricultural production systems (multiple crops in time, space, arable farming and animal husbandry, involvement of sociological and economic factors at a farm or regional scale) is still at an early stage. Effective linkages with other sciences are to be forged, particularly with economics sciences, and additional techniques are to be employed and/or developed. A concerted action to share more intensively results of ongoing research will accelerate progress for setting research priorities and exploring options for policy decisions.

CAMASE is an EU-supported concerted action of five European groups that are leading in the area of production systems research. The core groups for CAMASE are:

- the *Copenhagen research team* (Denmark): leading drs. Niels Erik Nielsen, Sören Hansen, Henry E. Jensen (The Royal Veterinary and Agricultural University); strength in modelling nitrogen losses and crop growth and production.
- the *Toulouse research team* (France): leading dr. Philippe Debaeke and Mr. Maurice Cabelguenne, Institut National de la Recherche Agronomique; strength in modelling crop production systems.
- the *Cordoba research team* (Spain), leading dr. Francisco Villalobos (Universidad de Cordoba, Dept. Agronomy) and dr. Luciano Mateos (CSIC, Instituto de Agricultura

Sostenible); strength in modelling irrigation systems.

- the *Edinburgh research team* (U.K.): leading prof.dr. Barry Dent and dr. Graham Russell, University of Edinburgh; strength in farm household modelling and expert systems.
- the *Wageningen research teams* (The Netherlands), coordinated by dr. Peter Leffelaar (Wageningen Agricultural University, Dept. of Theoretical Production Ecology), dr. Aad van Wijk (DLO Winand Staring Centre for Integrated Land, Soil and Water Research), prof.dr. Frits Penning de Vries and ing. M.C. Plentinger (DLO Research Institute for Agrobiological and Soil Fertility); strengths in modelling crop and soil processes, dynamics of pests and weeds, crop production systems, methodology, training.

The objectives of CAMASE are to advance quantitative research on agricultural systems and their environment in the EU-countries, by improving systems research in participating institutes through exchange and standardization of concepts, approaches, knowledge, computer programs and data. Specific objectives are:

- to produce a newsletter
- to produce a register of models
- to stimulate research on production systems.

CAMASE started in November 1993, and was funded for three years. Marja Plentinger and Frits Penning de Vries coordinated the project.

CAMASE - Guidelines for modelling

From CAMASE_NEWS (Newsletter of Agro-ecosystems Modelling), extra edition, November 1995.

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Editorial I

CAMASE is a concerted action that would not have come into existence without the generous support by the European Commission's RTD programme. This is greatly appreciated by us and, we are sure, by our readers.

Frits Penning de Vries & Marja Plentinger

Editorial II

Systems analysis and simulation are commonly used tools of researchers. Yet, many of us learned to use them by ourselves, by trial and error. In the process, we tumbled in many pitfalls, sometimes even without realizing it. It was suggested to CAMASE to make an effort to produce guidelines for modelling and distribute widely. We have pooled our limited wisdom in this matter, and propose two short sets of guidelines on these pages. We hope they will make a difference.

No doubt that our guidelines can be improved further! May we have your comments?

Frits Penning de Vries & Marja Plentinger

1 Guidelines

The need for guidelines for modelling has been expressed several times, particularly by those out of the main stream of developments. In [the CAMASE project](#), we have developed a first draft of guidelines for 'validation', 'sensitivity and uncertainty analysis' and 'calibration'. These are presented below, preceded by some relevant definitions. To provide readers with more details and access to examples, we added references to some of the most relevant scientific papers. We welcome very much all responses to further improve the guidelines and the set of most relevant papers. A next step in upgrading the quality of model building and model use should be a manual with more explicit guidelines, procedures, tools and examples. Ongoing projects on software quality aim (see next [CAMASE_NEWS](#)) at developing such manuals.

We acknowledge the input of Dr.Ir. A.K. Bregt, Dr. Ph. Debaeke, Dr.ir. W.A.H. Rossing, Ir. M.J. van der Velden, Ir. G.W.J. van de Ven, and Dr.ir. A.L.M. van Wijk. Frits Penning de Vries, Michiel Jansen, and Klaas Metselaar.

2 Evaluation

2.1 Definitions

Evaluation

The broadest term to describe the action of judging the adequacy of a model. Evaluation includes checking internal consistency and units used in a computer program, comparison of model output with an independent data set of real world observations, uncertainty analysis, and judgement of utility. The term 'test' is sometimes used with the same meaning.

Validation

The term will be used here in its most common utilitarian sense of establishing the usefulness and relevance of a model for a predefined purpose. It is a recurrent activity in a phase of model development. Models have always a limited range of validity, and it is necessary to specify clearly what it is. In case of predictive models, a major part of the validation consists of an assessment of prediction accuracy.

Verification

This technical term designates the inspection of the internal consistency of the model and its software implementation. Some important elements are: analysis of dimensions and units, on-line checks on mass conservation, detection of violation of natural ranges of parameters and variables. Verification also comprises inspection of qualitative behaviour of the model and its implementation, for instance a check whether the response of one model output to changing values of one parameter conforms to theoretical insights.

Calibration and validation data

Sets of data used to calibrate respectively validate a model.

Cross-validation

A procedure for calibrating and validating a model with a limited number of representative data sets. It consists of repeated subdivision of all the data into calibration and validation data, followed by corresponding calibration and validation. The average of the observed prediction errors over the subdivisions provides an estimate of the prediction error in an entirely new situation. There are several variants of cross-validation. In the most popular one, called leave-one-out validation, each independent data set gets the role of validation data exactly once, at which occasion the complementary set gets the role of calibration set.

2.2 Guidelines

- Make explicit for what purpose the model is being validated, and compare whether this is compatible with the objectives for which the model was developed.
- Make explicit in the description of the model which processes or natural resources are limiting the behaviour of the model.
- It is meaningless to simply state that a model is valid. After a successful validation a model is shown to be of practical use for a specific purpose over a specific range. A discussion of acceptable error size, with due regard to the specific purpose, should be included. Large errors might make the model of little practical value as a predictor though it might still have an instructive value. Validation of absolute values of key

variables is best.

- Model evaluation should start with verification of the model and its software implementation.
- In model evaluation every model output should be subject to validation. If the model is to be used in predictions, such as scenario studies, the validation of the model is more efficiently focused on issues of interest, which could be differences between scenarios, or the resulting ranking of alternatives such as e.g. predicting the yield of different varieties.
- The validation data should be representative for the situations in which the model is to be used: Swedish data, for instance, may be unsuitable to validate a model to be used in Spain. The validation set should -if possible- cover the range of situations encountered in predictions.
- Although prediction accuracy will benefit from representative calibration data, representativity of the calibration data is not required for soundness of the validation.
- The calibration data and the validation data should be different. In studies where a large number of validations are executed, there is a chance that calibration set and validation set are identical, when calibration and validation set are arbitrarily taken from the available sets.
- Validation should be repeatable by colleague scientists. This means that all crucial validation data (in a broad sense, comprising input, output, model structure) should be well documented and accessible. Validation data set should be of high quality.
- When dealing with complex models, divide and rule:
 1. If the subject of a model is too large for regular validation (e.g. an entire region), the model is to be subdivided into components that are validated separately. Provide a logical reasoning for which the aggregate model is consistent, and do not miss crucial interactions among the components.
 2. If the subject of the model is takes too long for regular validation (e.g. long term changes in soil structure and organic matter), validation should be undertaken for shorter periods, and indirect evidence (time series from different environments) collected.

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3 Sensitivity and uncertainty analysis

3.1 Definitions

Input

All parameters, initial values, tabulated functions, and driving variables in the model. For some analyses, tabulated functions may have to be parameterized.

Uncertainty

In this context: imperfect knowledge regarding aspects of a model. Uncertainty regarding model variables is usually specified by a probability distribution or by a sample of measured values (an empirical probability distribution); sometimes it is specified by a set of possible values. We adhere to the probabilistic concept of uncertainty, and we use variances as measure of uncertainty.

Sources of uncertainty

Uncertainty exists at the level of inputs and output of the model. Uncertainty at the level of model formulation also exists. In these guidelines, however, we will assume that the model is deterministic, and that uncertainties are solely introduced via the inputs. Input uncertainty is caused by natural variation (e.g. weather, soil or genetic variation) as well as by imperfection of data. Although the causes of uncertainties may differ, their effect is the same, namely uncertainty about the model outputs. It is up to the modeller whether or not to incorporate natural variation in the model; the choice depends also on the spatial or temporal scale at which the model is used. The input uncertainty of different parameters may contain correlations caused by biological or physical mechanisms, e.g. correlation between development rate before and after flowering, or between weather at two consecutive days. Correlation can also be caused by the nature of the data analyzed to estimate parameters, e.g. correlation between estimates of intercept and slope of a regression line.

Sensitivity analysis

Definitions vary. In most studies, sensitivity analysis is the study of model properties through - not necessarily realistically sized - changes in the input variables and the analysis of its effect on model outputs. The questions addressed are for instance:

- whether or not some output is affected at all by some input
- continuity, differentiability, monotonic increase or decrease of the model's response to input variation

Most of the variation of outputs is generally caused by a small number of inputs.

Uncertainty analysis

Definitions vary. In most studies, uncertainty analysis is the study of output uncertainty as a function of a careful inventory of the different sources of uncertainty present in the model. The questions addressed are for instance:

- What is the prediction uncertainty due to all uncertainties in model inputs? (Total

uncertainty, often expressed as variance)

- How do inputs (singly or in groups) contribute to prediction uncertainty?

One-at-a-time sensitivity analysis

An analysis of responses to variation of one input at a time, whereas the other inputs are kept at nominal values. One-at-a-time graphs can be informative and may reveal discontinuities; in these graphs a model response is plotted against the studied input, which latter varies in small steps over some range.

Factorial sensitivity analysis

Analysis where inputs are varied according to a so-called factorial design. In the most common factorial design, called two-level design, each input has two levels: low and high. A full two-level factorial design for n inputs requires 2^n model runs. If this number is prohibitive, one may apply a fractional factorial design, in which only a fraction of the input combinations is realized.

Local sensitivity analysis (or differential sensitivity analysis)

An analysis of responses to very small variations around some setting of the input, e.g. nominal values. Logical sensitivity analysis is the effort to establish by theoretical study of the model, or by inspection of results of sensitivity or uncertainty analysis, whether the model is sensitive at all for changes in an input.

Elicitation

A formal procedure to translate expert knowledge regarding input uncertainty into probability distributions.

3.2 Guidelines

- All parameters should be accessible for uncertainty- and sensitivity analysis. The source code of a model should not contain unexplained numerical values.
- Perform sensitivity analysis for verification of the model and its implementation (cf. Section 2.1). Repeated running of the software over a broad range of circumstances already constitutes a non-trivial test. Then check whether the qualitative behaviour of responses conforms to theoretical expectations.
- A logical sensitivity analysis can help to detect inputs for which an output is entirely insensitive (factor screening). These sleeping inputs might be ignored in subsequent analyses. However, be aware of the fact that the sensitivity of an input may depend on the values of other inputs.
- Apply factorial sensitivity analysis if you are interested in the interaction between inputs. This is important when the response to an input depends on the setting of other inputs.
- Use one-at-a-time sensitivity analysis to detect irregularities, e.g. discontinuities, in the response such as may preclude specific model- calibration techniques.
- For research papers on models and validation studies, an uncertainty analysis is highly recommended.
- The establishment of input uncertainty constitutes the most elaborate and most critical stage of uncertainty analysis. Literature and experiments constitute the most natural source of information. Expert knowledge is another source. Be aware that experts in agro-ecology are not automatically experts in probability; formal elicitation procedures may be helpful.
- Data providing information about input uncertainty pertain often to separate submodels. Information about correlation in uncertain inputs can be quite valuable since such information may greatly reduce output uncertainty.
- Artificially generated weather data are often practical to use. Weather generators are also

models and need to be validated.

- If possible, perform uncertainty analysis for all variables simultaneously. For large models, the analysis may have to be performed for submodels separately.
- Simple random sampling from the input uncertainty distribution is a good starting point, but latin hypercube sampling may be advisable for efficiency. Both methods can incorporate correlations; simple random sampling is conceptually simple and theoretically well developed.
- When comparing alternative scenarios, calculate the relevant contrasts with the same values of the input sample. This provides the most efficient estimates of the scenario effects.
- Uncertainty analysis may be used (and regarded) as partial validation: the total uncertainty about crucial model outputs should be acceptable for the current application. Validation through uncertainty analysis is only partial because structural uncertainty in the model, is hardly ever described as 'input' uncertainty.
- Large uncertainty contributions of individual inputs or groups of inputs to model output indicate that it is worthwhile to know more about these (groups of) inputs, whereas it is pointless to gain new information about other inputs. Thus, uncertainty analysis provides information to support decisions on research priorities.
- By the same token, uncertainty analysis provides support in the selection of calibration parameters.
- Compare estimated model-uncertainty with the current empirical uncertainty. Differences may be due to: structural errors in the model and errors in the presumed input uncertainty distribution, such as, absence of uncertain inputs, absence of correlations between inputs, erroneous specification of distributions etc.

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4 Calibration

4.1 Definitions

Calibration

The adjustment of some parameters such that model behaviour matches a set of real-world data; it is a restricted form of parametrization of models.

Calibration criterium

A function of the parameter values and the calibration data, that provides a measure of the compatibility of the parameter values with the data.

Point calibration

A calibration that results in a single optimal parameter vector.

Many individual parameter vectors are often compatible with the available calibration data, so that the point calibration may be non-robust.

Set calibration

A calibration that results in a set of parameter vectors compatible with the calibration data.

Distribution calibration

A calibration that results in a probability distribution of parameter vectors compatible with the calibration data.

Robust calibration

A calibration leading to results that are rather insensitive to minor changes in the calibration data.

4.2 Guidelines

- Ensure that the calibration method will never result in physically impossible parameter vectors.
- Non-sensitive parameters are a major cause of non-robustness. Sometimes such parameters are given a fixed typical value. Be aware that the calibration results are conditional on the values of these fixed parameters.
- Many calibration methods yield local optima of the criterium: small changes from such an optimum give worse values of the criterium, but further away better values may be realized. It is advised to apply such methods repeatedly with different starting points.
- Set calibration and distribution calibration may be advised in order to circumvent the problems with point calibration. These methods, however, are less well-developed, and are computer intensive.
- Regarding the calibration method to be chosen: Use results from a one-at a time parameter sensitivity analysis to look whether the implicitly defined relations between state variables and parameters are continuous or discontinuous and linear or nonlinear. If the model response is smooth, the model can be linearized, and fast optimization procedures using locally linear approximation are possible. If discontinuous, more robust calibration procedures should be used.
- In the proposed calibration procedures, parameter probability distributions, based on literature reviews or on well-documented expert knowledge, are assumed to be available.
- Parameter choice is best based on a ranking of the model parameters as to their contribution to output uncertainty.
- If the model is not embedded in a parameter estimating procedure, calibration can be executed as follows: Use sensitivity analysis to analyse relations between state variables. Determine independent subsystems, and calibrate the individual subsystems, taking care that once a subsystem is calibrated, that subsystem is not modified in following calibration steps. Calibrate a single parameter from each independent subsystem. This calibration method yields a point estimate.
- If the model is embedded in an optimization procedure, calibration can be executed as follows: Choose parameters on the basis of their contribution to the output uncertainty.
- Use a parameter estimation procedure in which parameter sets are generated according to the distributions and correlations between parameters established in the uncertainty analysis.
- Estimate the parameters simultaneously.
- The uncertainty of the parameters after calibration can be derived under the following conditions: The model is correct and the non-calibrated parameters have a negligible effect on the output uncertainty. To investigate the effect of non-calibrated parameters one should execute an uncertainty analysis.
- If a model for the measurement errors is available, and the calibration criterium is based on it, one may execute a set- or distribution calibration. Both calibrations allow to quantify total uncertainty about crucial model outputs after calibration. This uncertainty should be acceptable for the application.

- If the above methods are not possible, calibration becomes a work of art, which can yield good predictions, but provides no assessment of prediction uncertainty.

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Guidelines reactions

Some comments, reflections and references we received on above guidelines:

Correction sent by *Ph. Debaeke, Centre de Recherches de Toulouse, France*:

- ~~Debaeke, Ph.~~, K. Loague & R.E. Green, 1991. Statistical and graphical methods for valuating solute transport models: overview and application. *J. Contaminant Hydrology* 7: 5173

Sent by *M.B. Beck, University of Georgia, United States*:

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Sent by *D.T. FavisMortlock, University of Oxford, United Kingdom*:

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"What it says. A little old now."
- FavisMortlock, D.T., 1995. The use of synthetic weather for soil erosion modelling. In: McGregor, D.F.M. & D.A. Thompson (Eds.). *Geomorphology and Land Management in a Changing Environment*. Wiley, Chichester, UK. 265282
"This is a validation of the EPIC weather generator WXGEN for its ability to generate low frequency, high magnitude events (it does this badly). I have other, as yet unpublished, stuff on WXGEN's ability to simulate periods of drought."
- FavisMortlock, D.T., J.N. Quinton & W.T. Dickinson (Submitted). The GCTE validation of soil erosion models for global change studies. *Journal of Soil and Water Conservation*.

"This outlines the strategy of the GCTE Focus 3 erosion model validation. It may be particularly relevant to your Guidelines because of the need to 'validate' for unknown future conditions... The results of the validation will be published in: Boardman, J. & D.T. FavisMortlock (Eds.) (Forthcoming). Modelling Soil Erosion by Water. SpringerVerlag NATOASI Global Change series."

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- Wallach, D. & B. Goffinet, 1987. Mean squared error of prediction in models for studying ecological and agronomic systems. *Biometrics* 43: 561573

Sent by *A.L.M. van Wijk, DLO Winand Staring Centre (SCDLO), The Netherlands:*

- Wijk, A.L.M. van, I. Putu Gedjer WidjajaAdhi, C.J. Ritsema & C.J.M. Konsten, 1993. A simulation model for acid sulphate soils. II. Validation and application. In: Dent, D.L. & M.E.F. van Mensvoort (Ed.). *Selected Papers of the Ho Chi Minh City Symposium on Acid Sulphate Soils*. Ho Chi Minh City, Viet Nam, March 1992. ILRI publication 53. 357367

"The Simulation Model for Acid Sulphate Soils (SMASS) was validated by comparing model predictions with measurements obtained during extensive laboratory and field experiments in acid sulphate soils from Southern Kalimantan, Indonesia."

Field definitions for the CAMASE Register of Agro-ecosystems Models

A. General overview

Name and version: The code name of the model, which is often an acronym; add the version number, if there is any. Every registered model must have a name.

Title: The acronym of the title spelled out.

Update: The last date on which the model was updated.

Date last profile: The last date at which this profile was updated.

Program type: Indicate if it is a simulation model or module (part of a model), a simulation tool (e.g. data bases, simulation environment, simulation language, statistical methods), an optimization model (part of a model) or something else (other).

Purpose: There are three categories of uses of models distinguished: for research, for teaching, and for application. For each category, score '1' if very relevant, and '3' for little relevant.

New releases expected: Answer 'yes' if the model is in development, and 'no' if it is completed under this title.

Subject: Indicate the broad subject class in which the model falls: crop science, soil science, crop protection, forestry, farming systems, environmental science, agricultural economics, land use studies, other.

Aggregation level: Indicate the aggregation level in which the model falls: organ, plant/animal, crop/herd population, cropping system/animal husbandry system, farm, regions, supra region or something else.

Description (< 200 WORDS): Describe the model by using relevant keywords in the text (as users of the data base can search for them), mention a typical use of the model, and indicate over what range of conditions the model is valid. Specific but non-standard techniques or (sub-)models mentioned can be entered as separate issues in the database, and will then be labelled with an *.

B. Scientific specifications of simulation models

To indicate the complexity of the model, we ask about:

Rate variables: Give names (of types) of rate variables.

Number of rate variables: Give approximate number of rate variables.

State variables: Give names (of types) of state variables.

Number of state variables: Give approximate number of state variables.

Input data: Give names (of types) of input data.

Number of input data: Give approximate number of input data.

Output data: Give names (of types) of output data.

Number of output data: Give approximate number of output data.

Time interval of simulation: The value or range.

Basic spatial unit: e.g., m², ha, 1000 ha, (watershed), irrigation system, nation.

References general validation: As in journals.

Stand alone model: Yes or no.

Parentage: Indicate in a few words whether the model is derived from or based on other models, if there is/are any. We aim to have all models mentioned in the list included in the data base.

Check internal consistency or material balance present: Yes or no.

Input check in model: Yes or no.

C. Scientific specifications of optimization models

Type of optimization model: Linear Programming or Interactive Multiple Goal Linear Programming

To indicate the complexity of the model we ask about:

Type of variables/activities: Give names (of types) of variables and activities.

Number of variables/activities: Give approximate number of variables and activities.

Type of constraints: Give names (of types) of constraints.

Number of constraints: Give approximate number of constraints.

Type of objective functions: Give names (of types) of objective functions.

Number of objective functions: Give approximate number of objective functions.

Basic spatial unit: The basic spatial unit for which variables/activities have been quantified; e.g., m², ha, 1000 ha, (watershed), irrigation system, nation.

Time horizon: The value or range.

Optimization interval: The value or range.

Stand alone model: Yes or no.

Parentage: Indicate in a few words whether the model is derived from or based on other models, if there is/are any. We aim to have all models mentioned in the list included in the data base.

D. Technical specifications

Hardware: The minimum requirements and recommended configuration.

Programming language: The official name and supplier.

Other software requirements: The official name(s) and supplier(s).

User's guide available: If there is a user guide available, give the full reference.

Technical reference: If there is a technical reference available, give the full reference.

Application reports: Mention important articles of the model.

Source code available: Yes or no.

Executable available: Yes or no.

User contract mandatory: Yes or no.

Costs: Approximate value of purchase in US\$.

Comments: Any comment by the author, up to 200 words.

Contact:

The full name of the contact person.

Address, telephone, telefax, and e-mail: The postal and e-mail address of the contact person.

Co-authors: The names of the co-authors (and their e-mail addresses).

List of all projects in the Register

- ACCESS-I, Agro Climatic Change and European Soil Suitability.
- ACCESS-II, Agro Climatic Change and European Soil Suitability.
- ALES 4.54, Automated Land Evaluation System.
- ALMANAC , Agricultural Land Management Alternatives with Numerical Assessment Criteria
- AMBLE, Atmospheric Model - Boundary Layer Emphasis.
- ANIMO 3.3, Agricultural NITrogen MOdel.
- APSIM, The Agricultural Production Systems SIMulator.
- AQ-AP 3.X, AQuisoft-AP.
- AQ-AS 3.X, AQuisoft-AS
- AQ-AT 3.X, AQuisoft-AT
- ASKAM 1.1, CO2-ASSimilatie KAsgewasModel.
- BACROS, BASic CROp growth Simulator.
- BALANCE, A simple soil water BALANCE model.
- BLAYER, Boundary Layer Model.
- BLIGHT 2, Model for the crop-pathosystem rice - bacterial leaf blight and sheath blight.
- BLOCKPHOT 1.0, Block canopy gross photosynthesis.
- BLOOM II
- BOSMest, A decision support system to optimize the application and processing of manure.
- BRUSPLAN 2.00, Optimum planting plan for brussels sprouts.
- BYM 1.4
- BYMPRAI
- CABO/TPE Weather System
- CAPSEV, A program to calculate steady-state moisture profiles in 1 dimension.
- CAPSEVPC 1.1, A program to calculate steady-state moisture profiles in 1 dimension.
- CARMA, CAse-based Range Management Advisor.
- CARMEN, CAuse effect Relation Model for Environmental policy Negotiations.
- CASE2, CAcao Simulation Engine level 1 & 2.
- Catastrophe Theory Model
- CERCOT
- CERES-Canola 3.0
- CICICP.CSM, Chicory Industrial Crops and Products.
- CLEAN 1.0, Crops, Livestock and Emissions from Agriculture in the Netherlands.
- CONTOUR 2.0
- CP-BKF3, Cultures Pluviales - Burkina Faso.
- CPIDS 1.0, Crop Parameter Intelligent Database System.
- CRAMBE, CRAMBE.
- CROP ECOLOGY, Crop Growth Simulation.
- CropSyst 3.0, Cropping Systems Modeling Framework.
- CSYMBA 1.0, Cropping Systems Model Building Assistant.
- Cucumber model
- Daisy
- DanStress
- DBS, Delwag-Bloom II-Switch.

- DNDC, DeNitrification - DeComposition.
- DUR-PCN, DURability of Resistance to Potato Cyst Nematodes.
- Dynamics of partial anaerobiosis, denitrification and water in soil
- DYNAMITE, DYnamics of Nutrients And Moisture In Tropical Ecosystems.
- ECOLUMN BLOOM II
- ECOSAT 4.0, Equilibrium Calculation Of Speciation And Transport.
- ECOZONE, A knowledge based system for training about the environmental impacts of agricultural development projects.
- EMB-RUBBER 1.1
- EMIR, Economic Module for Investment Ranking.
- EPIC, Erosion Productivity Impact Calculator. Environmental Policy Integrated Climate.
- ERHYM - II, Elakala Rangeland Hydrology and Yield Model.
- ETPOT 1.0, Module for the calculation of potential transpiration and evaporation.
- EVAPOTRA 1.1, A simulation program to calculate the required amount of irrigation.
- EWQTPR 2.14, EPIC* Phase (real time).
- Expert-N 1.0, A building block system for nitrogen simulation models.
- FARM 1.6, A whole FARM model.
- FGS, Fish Growth Simulator.
- FIRE-BGC, FIRE BioGeoChemical process model.
- FIRESUM, Fire Succession Model.
- FLOCR 2.0, FLOW in CRacking soils.
- FLOWEX 1.1
- FLUNIT 1.0, System for NITrate FLUXes in ground water.
- ForGroForest Growth Model.
- FSE 1, Fortran Simulation Environment.
- FSEOPT 2.1
- FST 2.0, Fortran Simulation Translator.
- FSU 2.0, FSU: a generic user interface for crop growth simulation models.
- FUSSIM2 1.0, Flow in Unsaturated Soil SIMulation Model in 2 dimensions (Heinen and De Willigen, 1992).
- GENUCHT.LIB, FORTRAN library containing van Genuchten - Mualem hydraulic functions.
- GLOBAL 1, Soil Water Transport and Crop Production.
- GOA ble
- GOA mais 1.3
- GOAL-QUASI, A case study on the EC study 'Ground for choices'.
- GRASMOD, A GRASSland management MODel to calculate nitrogen losses from grassland.
- GROW (Growth curve modelling, analysis and optimum design)Model choice from a clan of monotonically increasing or decreasing functions
- Growth Respiration Model, 1973
- HEDGEROW 1.0, Hedgerow canopy gross photosynthesis.
- HORTISIM 1.0 beta, Greenhouse and crop simulator.
- HSG, Harvester Schedule Generator Forest Modelling System Demonstration Version.
- HTICP.CSM, Helianthus tuberosus Industrial Crops and Products.
- INSIM, Phenology and population simulator.
- INTERCOM 1.1, An ecophysiological model for crop-weed interactions.
- Land Evaluation II-land use system analysis

- LEACHM, Leaching Estimation and Chemistry Model.
- LINTUL, Light INTerception and UtILization simulator.
- LOWBAL 1.0, Water balance for puddled lowland (rice) soils.
- MACROS, Modules of an Annual CROp Simulator.
- MAIZE
- MANAGE-N 1.0, Decision Support System for Nitrogen Management in Rice.
- MASQUE 1.0, Mulch Application Simulation to Quench Unchecked Erosion.
- MAX 0.34, Farming for MAXimum efficiency.
- MGOPT_DAIRY, Multiple Goal OPTimization model for DAIRY farming.
- Microweather94
- MIKE SHE 5.23, Systeme Hydrologique Europeen.
- MILLETO, Potential and water-limited MILLET grOwth in Niger.
- MOD-C-LECT 1.0, Model Selecting Tool for Agricultural Nonpoint Source Water Quality Simulations.
- MODFLOWP 2.3, MODFLOW - Parameter Estimation version.
- MODGRID 1.00
- MOMASS: SUCROS* Assimilation interactively
- MOSOM, MOdelling Soil Organic Matter.
- MOTOR, Modular description of Organic matter TurnOveR.
- MOTOTN 1.2
- Multinary gas diffusion program (STEMAX)
- MUST 2.4, Model for Unsaturated flow above a Shallow water-Table.
- NCSOIL, Nitrogen-Carbon Transformations in Soil.
- N-DICEA, Nitrogen Dynamics In Crop rotations in Ecological Agriculture.
- NGROW.RICE, Simple growth model for rice under N-limited conditions.
- NITCROS, NITrogen balance and CROp production Simulation.
- NTARG and NTEXT, Simple N balance model.
- Nwheat 1.0, Nitrogen Winter Wheat.
- OILCROP-SUN 4.1
- OMIS 6.0, Operational Management for Irrigation Systems.
- On systems analysis and simulation of ecological processes with examples in CSMP* and FORTRAN , Kluwer Academic Publishers, ISBN 0-7923-2435-8 (paperback)
- ONTO-WW 1, Ontogenesis model winter wheat.
- OPTIMA 1.0, Whole farm planning with dynamic linear programming.
- OPUS1 & 2, Oil Palm sUmmary Simulator.
- ORYZA_0, A simulation model for cotton crop management
- ORYZA_N 1.0, Model for Potential and Nitrogen limited rice production.
- ORYZA_W 2.1, Rice model for irrigated and water-limited conditions.
- ORYZA1 1.3, An ecophysiological model for irrigated rice production.
- OZCOT
- (P)CSMP, Continuous Systems Modelling Program for PC.
- PESTLA 2.3, PESTicide Leaching and Accumulation.
- PGWA 1.0, Perennial grasses for West Africa conditions.
- PLAXIS 5.0, PLane strain and AXI Symetric.
- POPDYN, POPulation DYNamics of greenhouse whitefly and the parasitoid Encarsia formosa.
- POTPLANT

- PRE-AP 2.0, PRE-Application/Pesticide Registration and Environment Assessment Program.
- Principles of theoretical production ecology
- PTARG, RC and RECPF, Simple P balance model.
- QUASI, QUAntitative Analysis of (agro-eco-) Systems at higher Integration levels.
- RANGETEK
- RECAFS 1.0, Modelling resource competition and cycling in agroforestry systems.
- RENLEM 2, REgional Nitrate LEaching Model.
- ReSAM 1.0, Regional Soil Acidification Model.
- Ribasim 6.0, River Basin Simulation model.
- RIGAUS 1.0, Random Input Generator for the Analysis of Uncertainty in Simulation.
- ROTHC-26.3, A model for the turnover of carbon in soil.
- RUSLE, Revised Universal Soil Loss Equation.
- RZWQM, Root Zone Water Quality Model.
- SAWAH 2.0, Simulation Algorithm for Water flow in Aguiic Habitats.
- SBFLEVO, Growth model to simulate crop growth, optical reflectance and radar backscatter of sugar beet.
- SBFLEVO_OPT, Program to calibrate crop growth model SBFLEVO* for sugar beet in Flevoland on optical reflectance and/or radar backscatter data.
- SBORER 2, Model for the crop-pathosystem rice - stem borer.
- SCUAF, Soil Changes Under AgroForestry.
- SHAW 2.0, Simultaneous Heat and Water model.
- SHIELD 1.0, Simulation of Hedgerows Intervention against Erosion and Land Degradation.
- SIBIL, Simulare BILant (Balance Simulation - in Romanian).
- SIBQUICK, Simulation Balance QUICK.
- Sigma +
- SIMGRO 2.1, Simulation of ground water flow and surface water levels.
- SIMPOTATO 1.52, The SIMPOTATO growth simulation model.
- SIRATAC (obsolete, been superseded by entomoLOGIC)
- SMARAGD
- SNAPS 1.0, Simulation Network Atmosphere-Plant-Soil.
- SOIL DATA, Estimation of the waterholding-capacity of soils in Europe. The compilation of a soil dataset.
- SOIL 7.51
- Soil_Depl, Soil Depletion Estimates Model
- SOILN 8.0
- SOL4 2.1
- SOLTRANS, SOLute TRANsport Simulator.
- SOMM, A model of Soil Organic Matter dynaMics.
- SOS, Spreadsheet Oriented Simulation.
- SOYBEAN
- SOYCROS 1.0, Soybean Crop Simulator.
- SPATANAL, CROSS, MAPIT, WLSFIT and SURFER, Geostatistical software.
- Spring wheat 2.0
- SUCRBARL 1.0, SUCROS*-model applied on spring barley (competition and plant density effects included).
- SUCROS1, Simple and Universal CROp growth Simulator.
- SUCROS2, Simple and Universal CROp growth Simulator.

- SUKAM 1.1
- SUNDIAL 93-7, SimUlation of Nitrogen Dynamics In Arable Land.
- SWACROP 2.02, A Water Management and Crop Production Simulation Model.
- SWAGMAN Destiny, A simulation model for Salt, Water and Groundwater Management.
- SWAP 1.0, Soil Water Atmosphere Plant.
- SWELTER, Synthetic Weather Estimator for Land use and Terrestrial Ecosystem Research.
- TCG_CROP 1.0
- TCG_CROP_BULB, Technical coefficient generator for bulb crops.
- TETrans, Trace Element Transport.
- The major soils of the world
- TOPMODEL
- Torbert N
- TPE-Aphdam 2.0, Simulation of damage by aphids in winter wheat.
- TPE-Uncon/Risk 1.0, UNCertainty analysis applied to supervised CONtrol of aphids and brown rust in winter wheat.
- TRANSECT 2.04, Tillage and Crop Residue Transect.
- TRANSOL 2.3, TRAnsport of a SOLute.
- TREGRO 3.0, TREe GROwth.
- TRESTLE, Tree Response, Establishment and Succession in the Transient Landscape of Europe.
- TRIWACO 7.0
- TTSELECT 2.21
- TTUTIL, FORTRAN utility library.
- TUCROS
- UCD/LLNL MAS Model, Mesoscale Atmospheric Simulation Model.
- UPDA3 1.0
- Wageningen Carbon Cycle Model, The Global Carbon Cycle.
- WASTEN, A model for nitrogen behaviour in soils irrigated with liquid waste.
- WATBAL 2.0, WATER BALance.
- WATCROS, WATER balance and CROp production Simulation
- WAVE 2.0, A mathematical model for simulating Water and Agrochemicals in the soil and Vadose Environment.
- WEPP 95.7, The Water Erosion Prediction Project Model.
- WEPS (Beta version), Wind Erosion Prediction System
- WHCO2T 3
- Wheat
- WINDINGS wssa11, winding stairs sample analyzer
- WOFOST 6.0, World FOod STudies: crop growth simulation model.
- WOFOST-TULIP, Simulation of potential growth of tulip.
- WWFLEVO, Growth model to simulate crop growth, optical reflectance and radar backscatter of winter wheat.
- Yet to be baptised (version 1 December 1994)

Models

GENERAL OVERVIEW

Name and version: ACCESS-I

Title: Agro Climatic Change and European Soil Suitability.

Date first profile: March, 1996.

Date last profile: March, 1996.

Update: Autumn 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, soil science, farming systems, and land use studies.

Aggregation level: Region, and supra region.

Description: A mechanistic model of crop development, crop growth, water use and soil moisture status on a monthly time-step. The model was built for climate change impact studies and land suitability issues.

Number of rate variables: 75.

Number of state variables: 104.

Input data: Climate, control, crop, diary, options, perturbation, region, soil.

Number of input data: Approximately 65.

Number of output data: Approximately 38.

Time interval of simulation: Monthly.

Basic spatial unit: Soil unit.

References general validation:

Loveland, P.J., M. Rounsevell, J-P. Legros, D. de la Rosa, A. Armstrong, J. Glinski, K. Rajkai, C. Simota (Eds.), 1995. ACCESS Agro-Climatic Change and European Soil Suitability: a spatially-distributed, soil, agro-climatic and soil hydrological model to predict the effects of climate change on land-use within the European Community. Volume I: a description of the ACCESS Project. 361 pp.

Loveland, P.J., M. Rounsevell, J-P. Legros, D. de la Rosa, A. Armstrong, J. Glinski, K. Rajkai, C. Simota (Eds.), 1995. ACCESS (1995b). Agro-Climatic Change and European Soil Suitability: a spatially-distributed, soil, agro-climatic and soil hydrological model to predict the effects of climate change on land-use within the European Community. Volume II: user manual. 62 pp.

1996. ACCESS Project summary. Commission of the European Communities. 27 pp. (In press).

Mayr, T.R., M.D.A. Rounsevell, P.J. Loveland & C. Simota, 1996. Agroclimatic Change and European Soil Suitability: regional modelling using monthly time-step data. International Agrophysics, 00, 000-000 (In press).

Loveland, P.J., J-P. Legros, M.D.A. Rounsevell, D. de la Rosa & A.C. Armstrong, 1994. A spatially distributed soil, agroclimatic and soil hydrological model to predict the effects of climate change on land use within the European Community. Transactions of the 15th World Congress of Soil Science, Acapulco, Mexico. International Society of Soil Science, Commission V: Symposia, Volume 6a. 83-100

Rounsevell, M.D.A., T.R. Mayr & P.J. Loveland, 1994. The ACCESS project: Part 1, background and the simple modelling approach. Transactions of the 15th World Congress of Soil Science, Acapulco, Mexico. International Society of Soil Science, Commission V: poster sessions, Volume 6b. 4-5

Rounsevell, M.D.A., P.J. Loveland, T.R. Mayr, A.C. Armstrong, D. de la Rosa, J-P. Legros, C.

Simota & H. Sobczuk, 1996. ACCESS: a spatially-distributed, soil water and crop development model for climate change research. Aspects of Applied Biology No. 45.

Stand alone model: Yes.

Parentage: SIBIL*, AFRCWHEAT.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC 486.

Programming language: Microsoft FORTRAN.

Other software required: No.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Approximately 200 Eng. pounds as part of ACCESS package.

CONTACT(S):

Name: **Dr. T. Mayr.**

Address: **Soil Survey and Land Research Centre, Silsoe, Bedfordshire MK45 4DT UNITED KINGDOM.**

Telephone number: **+44.1525.86.3269**

Fax number: **+44.1525.86.3253**

Email: th.mayr@cranfield.ac.uk

GENERAL OVERVIEW

Name and version: ACCESS-II

Title: Agro Climatic Change and European Soil Suitability.

Date first profile: March, 1996.

Date last profile: March, 1996.

Update: Autumn 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, soil science, farming systems, and land use studies.

Aggregation level: Farm.

Description: A detailed mechanistic model of crop growth, crop water use and soil moisture conditions for climate change and land suitability studies.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Soil parameters (up to 10 layers); crop parameters.

Number of rate variables: 100.

State variables: Soil moisture conditions, crop stage, height, leaf area, root length.

Number of state variables: 20.

Input data: Soil data, by horizon; crop data, crop sequence meteorological input (precipitation, temperature, PET).

Number of input data: 100 + daily meteorological data.

Output data: Crop and soil moisture states - user defines daily, monthly or annual output.

Number of output data: 12 time step output.

Time interval of simulation: Daily.

Basic spatial unit: Ha.

References general validation:

Loveland, P.J., M. Rounsevell, J-P. Legros, D. de la Rosa, A. Armstrong, J. Glinski, K. Rajkai, C. Simota (Eds.), 1995. ACCESS Agro-Climatic Change and European Soil Suitability: a spatially-distributed, soil, agro-climatic and soil hydrological model to predict the effects of climate change on land-use within the European Community. Volume I: a description of the ACCESS Project. 361 pp.

Loveland, P.J., M. Rounsevell, J-P. Legros, D. de la Rosa, A. Armstrong, J. Glinski, K. Rajkai, C. Simota (Eds.), 1995. ACCESS (1995b). Agro-Climatic Change and European Soil Suitability: a spatially-distributed, soil, agro-climatic and soil hydrological model to predict the effects of climate change on land-use within the European Community. Volume II: user manual. 62 pp. 1996. ACCESS Project summary. Commission of the European Communities. 27 pp. (In press).

Loveland, P.J., J-P. Legros, M.D.A. Rounsevell, D. de la Rosa & A.C. Armstrong, 1994. A spatially distributed soil, agroclimatic and soil hydrological model to predict the effects of climate change on land use within the European Community. Transactions of the 15th World Congress of Soil Science, Acapulco, Mexico. International Society of Soil Science, Commission V: Symposia, Volume 6a. 83-100

Rounsevell, M.D.A., P.J. Loveland, T.R. Mayr, A.C. Armstrong, D. de la Rosa, J-P. Legros, C. Simota & H. Sobczuk, 1996. ACCESS: a spatially-distributed, soil water and crop development model for climate change research. Aspects of Applied Biology No. 45.

Stand alone model: Yes.

Parentage: MOBIDIC, EPIC*.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC 486.

Programming language: Microsoft FORTRAN.

Other software required: No.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Approximately 200 Eng. pounds as part of ACCESS package.

CONTACT(S):

Name: Dr. M.D.A. Rounsevell.

Address: Cranfield University, Soil Survey and Land Research Centre, Silsoe Campus,
Silsoe, Bedfordshire MK45 4DT UNITED KINGDOM.

Telephone number: +44.1525.863268

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Email: <mailto:ssmr@silsoe.cranfield.ac.uk%20/%20m.rounsevell@cranfield.ac.uk>

GENERAL OVERVIEW

Name and version: ALES 4.54

Title: Automated Land Evaluation System.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: -

Program type: Other: expert system shell.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

Subject: Land use studies.

Aggregation level: Farm.

Description: ALES allows land evaluators to build expert systems to evaluate land according to the method presented in the FAO's 'Framework for Land Evaluation' (FAO: Food and Agriculture Organization of the United Nations). It is intended for use in project or regional scale land evaluation. ALES evaluates map units, which may be defined broadly (e.g. reconnaissance surveys and general feasibility studies) or narrowly (e.g. detailed resource surveys and farm-scale planning). Evaluators build their own expert systems taking into account local conditions and objectives. ALES does not include by itself any knowledge about land and land use; it is a framework within which evaluators can express their own knowledge. ALES includes the following components: (1) a framework for a knowledge base describing proposed land uses, in both physical and economic terms; (2) a framework for a database describing the land areas to be evaluated; (3) an inference mechanism to relate these two, thereby computing the physical and economic suitability of a set of map units for a set of proposed land uses; (4) and explanation facility that allows model builders to understand and fine-tune their models; (5) a report generator; and (6) an import/export module that allows data to be exchanged with external databases, geographic information systems, and spreadsheets.

Stand alone model: Yes.

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM PC-XT or better.

Programming language: Mumps.

Other software required: Mumps run-time (included).

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes.

Costs: \$ 500 commercial/government. \$ 250 education/individual.

CONTACT(S):

Address: ALES project, Cornell University, Dept. Soil, Crop and Atmospheric Sciences, Bradfield Hall, 10th floor, Ithaca, New York 14853 UNITED STATES.

Telephone number: +1.607.255.8615

Fax number: +1.607.255.1736

Email: ales@cornell.edu

GENERAL OVERVIEW

Name and version: ALMANAC

Title: Agricultural Land Management Alternatives with Numerical Assessment Criteria.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: March, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, and soil science (biogeochemical).

Aggregation level: Field level.

Description: ALMANAC is a predictive and process oriented model which simulates the hydrology and erosion as in the EPIC* model, but it is also able to simulate competition between 2-10 plant species. It includes detailed functions for water balance, nutrient cycling, plant growth, light competition, population density effects, and vapour pressure deficit effects. ALMANAC is a useful tool for simulation management strategies related to weed control (Kiniry, J.R. et al., 1992). The model requires readily available weather and soil inputs and parameters specific to plant species which can be derived from the literature. The model simulates daily time steps on the field level which can be aggregated to annual and multi-year runs. Due to its process-oriented approach ALMANAC should be useful for simulating intercropping, brush and grass competition, and the effect of climate change on inter-species competition. ALMANAC was the result of a major emphasis by the Agricultural Research Service to develop mathematical models for use in predicting the effects of climate and CO₂ change on agricultural management practices, crop yields, and water supplies. Keywords: crop, hydrology, erosion, inter-species competition, management.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Processes involved in plant growth and competition, applicable to a wide range of soils, climates and crops.

State variables: Rotation, crop, fertilizer, irrigation, tillage.

Input data: The model requires readily available weather and soil inputs and parameters specific to plant species which can be derived from the literature. Model input data source: Literature.

Output data: Output on crop yields, crop stresses and fertilizer uptake.

Time interval of simulation: The model simulates daily time steps which can be aggregated to annual and multi-year runs.

Basic spatial unit: Farm / field.

Stand alone model: Yes.

Parentage: EPIC*.

TECHNICAL SPECIFICATIONS

Hardware: 640 K, 3 megabytes.

Programming language: Microsoft FORTRAN.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: AMBLE

Title: Atmospheric Model - Boundary Layer Emphasis.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: October 12th, 1995.

Program type: Simulation model/module.

Purpose: The model is used primarily to study interactions of the atmosphere with terrain and land use.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science (atmosphere), and land use studies.

Aggregation level: Supra region.

Description: AMBLE is a predictive 1-,2-,or 3-dimensional model based on primitive equations of atmospheric flow. It includes sub-models for soil physics, vegetation, and the upper ocean. The model is used primarily to study the interactions of the atmosphere with terrain and land use. Time dependent atmospheric equations are solved, as discretized onto a 1-D, 2-D, or 3-D finite difference grid. Fully-coupled, 2-way interaction exists amongst the various sub-models. Global change implications: The model's primary use is to study interactions of the atmosphere with terrain and land use, making it a potentially useful model in examining the relationships between atmospheric conditions and vegetation.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Varies with application.

Number of rate variables: Varies with application.

State variables: Varies with application.

Number of state variables: Varies with application.

Input data: Atmospheric sounding plus information on terrain, land use, and soil moisture.

Number of input data: Varies with application.

Output data: Binary output files which include the basic variables of state plus derived quantities such as radiation and turbulent fluxes.

Number of output data: Varies with application.

Time interval of simulation: Typically a few hours to 2 days, although coupled ocean-atmosphere simulations have run 30 days.

Basic spatial unit: From 1 km (non-hydrostatic version) to several hundred km in the horizontal, typically 4 - 15 km in the vertical.

Stand alone model: Yes.

Parentage: Portions of the code were adapted from routines developed by M. McCumber and J. Kain.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: A broad variety of hardware from MS-DOS PCs to Cray Y-MP supercomputers. Run time varies from seconds to days, depending on the application and available hardware.

Programming language: Strict adherence to ANSI FORTRAN-77 is observed in order to

ensure cross-platform portability.

Other software required: None.

Application reports:

Arritt, R.W., 1987. *Boundary-Layer Meteorology* 40: 101-125

Arritt, R.W., 1989. *Quarterly Journal of the Royal Meteorological Society* 115: 547-570

Clark, C.A. & R.W. Arritt, 1995. *Journal of Applied Meteorology* 34: 202-2045

Segal, M. et al., 1993. *Monthly Weather Review* 121: 1871-1873

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes.

Costs: None.

CONTACT(S):

Name: **Prof. R.W. Arritt.**

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GENERAL OVERVIEW

Name and version: ANIMO 3.3

Title: Agricultural Nitrogen Model.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Soil science, and environmental science.

Description: Dynamic simulation of carbon, nitrogen and phosphorus cycles in an unsaturated and saturated soil system. The model was developed to analyze the leaching of nitrogen from the soil surface to ground water and surface waters. The phosphorus cycle was added to Hydrological data must be supplied by another model. Model system is a multi-layer one-dimensional soil column. The upper boundary is the soil surface, the lower boundary is the depth of the local ground water flow and the lateral boundary is defined by the surface water system(s). Main processes included in the model are: mineralization and immobilization, crop uptake, denitrification related to (partial and temporal) anaerobiosis and decomposing organic materials, oxygen and temperature distribution in the soil, nitrification, desorption and adsorption of ammonium and phosphorus to the soil complex, runoff, discharge to different surface water systems and leaching to ground water.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Oxygen demand, exudate production, decomposition rates of 4 different types of organic matter, nitrification rate, sorption rates for ammonium and phosphorus, 14 different water fluxes (precipitation, runoff, seepage, leaching, 1st, 2nd and 3rd order drainage and infiltration, 3 evaporation terms, transpiration).

Number of rate variables: About 50.

State variables: Moisture contents, quantities of exudates, humus, fresh and soluble organic matter, adsorbed ammonium and phosphorus, nitrate, ammonium and phosphate in soil solution.

Number of state variables: > 75.

Input data: An extended soil water balance, fertilizer management (amount, kind of fertilizer, time and depth of application), soil physical properties (pF, bulk density, 5 temperature parameters, diffusion coefficients for oxygen in soil), soil chemical properties (pH, sorption coefficients, sorption rates), boundary and initial conditions.

Number of input data: About 80.

Output data: All terms of complete balances of a soil-water-crop system for water, nitrate-N, ammonium-N, organic-N, ortho-P, organic P.

Number of output data: Variable (> 1000).

Time interval of simulation: 1-30 days.

Basic spatial unit: m².

References general validation:

Rijtema, P.E., P. Groenendijk, J.G. Kroes & C.W.J. Roest, 1991. Formulation of the nitrogen and phosphorus behaviour in agricultural soils, the ANIMO model. Report 30 in preparation. DLO Winand Staring Centre, Wageningen.

Rijtema, P.E. & J.G. Kroes, 1991. Some results of nitrogen simulations with the model ANIMO. Fertilizer Research 27: 189-198

Vereecken, H., E.J. Jansen, M.J.D. Hack-ten Broecke, M. Swerts, R. Engelke, S. Fabrewitz & S. Hansen, 1991. Comparison of simulation results of five nitrogen models using different datasets. In: Soil and Groundwater Research Report II, Nitrate in Soils, Final report of contracts EV4V-0098-NL and EV4V-00107-C, Commission of the European Communities.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX, IBM compatible PC with co-processor.

Programming language: Microsoft FORTRAN-77.

Other software required: -

User's guide available:

Kroes, J.G., 1993. ANIMO Version 3.3. User's Guide. Interne mededeling 102, DLO Winand Staring Centre, Wageningen.

Technical reference:

Kroes, J.G., 1993. ANIMO Version 3.3. Programmer's Guide. Interne mededeling 103, DLO Winand Staring Centre, Wageningen.

Source code available: No (for research contact DLO Winand Staring Centre).

Executable available: Yes.

User contract mandatory: Yes.

Costs: 0 - 300 ECU.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: APSIM

Title: The Agricultural Production Systems SIMulator.

Date first profile: March, 1996.

Date last profile: March, 1996.

Update: -

Program type: A daily time-step farming systems model based on physiological, physical and chemical knowledge of system processes.

Purpose: To combine crop and pasture models to simulate various production systems using soil and crop processes at levels that are balanced and appropriate to proposed applications.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Aggregation level: Crop/herd, and cropping system/animal husbandry system (including pastures).

Description: APSIM is a flexible software environment for simulating systems rather than a model of a particular cropping system. Within APSIM there is a library of modules, each describing specific processes, that can be combined in meaningful ways to represent agricultural systems. Modules can be either biological (e.g. crop, pasture, surface residue), environmental (e.g. water balance, N balance, soil erosion), managerial (e.g. tillage, irrigation, fertilization) or economic and they communicate with each other via the APSIM "engine". The engine passes information between modules according to a standard protocol which allows modules to be plugged in or pulled out of the engine depending on the specifications for the simulation task. In this way, the simulation capacity of APSIM is limited only by the availability of modules to simulate aspects of the system of interest. Modules are grouped into crop, crop management, soil water, soil nutrient, surface management, economic and climatic modules. At present, crop modules are operational in APSIM for wheat, barley, sorghum, sunflower, maize, sugarcane, cotton, peanuts, chickpea and pastures. Modules for soybean, mungbean and cowpea are under development. APSIM provides a versatile and flexible infrastructure for model development, testing and application. Known good points: Ability to simulate agricultural systems (crop rotations, inter-species competition). Known limitations: Few skilled operators/trainers.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Variable, depending on configuration.

Number of rate variables: Variable, depending on configuration.

State variables: Variable, depending on configuration.

Number of state variables: Variable, depending on configuration.

Input data: Climate (mostly daily data of temperature, solar radiation and rainfall), site characterisation and parameters for crop model, soil water balance, soil nitrogen balance, surface residue and soil erodability.

Number of input data: Variable, depending on configuration.

Output data: Anything, depending on user request.

Number of output data: Variable, depending on configuration.

Time interval of simulation: Daily, however some modules can have variable time steps.

Basic spatial unit: Paddock.

Stand alone model: Yes, once desired module configuration has been chosen.

Parentage: The efforts of the PERFECT and AUSIM teams were combined to produce APSIM.

TECHNICAL SPECIFICATIONS

Hardware: PCs (Pentium, min. 16 Mb RAM), UNIX workstation or equivalent.

Programming language: Shell: C++. Engine: Microsoft FORTRAN. Scientific modules: Microsoft FORTRAN.

Other software required: WINDOWS platform.

Technical reference:

McCown, R.L., G.L. Hammer, J.N.G. Hargreaves, D.P. Holzworth & D.M. Freebairn, 1996. APSIM: A novel software system for model development, model testing, and simulation in agricultural systems research. *Agricultural Systems* 50: 255-271

Application reports:

Carberry, P.S., S.G.K. Adiku, R.L. McCown & B.A. Keating, 1996a., 1996. Application of the APSIM cropping systems model to intercropping systems. *Proceedings of an International Workshop on Dynamics of roots and nitrogen in cropping systems of the Semi-Arid Tropics*, ICRISAT, in press.

Source code available: No.

Executable available: No.

User contract mandatory: Yes. APSIM is developed and managed by APSRU. To maintain code quality and version control, strict control is maintained over distribution. APSIM is only available by negotiation. Generally, this involves either close collaboration with APSRU, e.g. through collaborative projects, exchange of modules or datasets, or by some funding arrangement.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: AQ-AP 3.X

Title: AQuisoft-AP.

Date first profile: November 27th, 1995.

Date last profile: November 27th, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: No.

Subject: Soil science: hydrology.

Description: Computer program package for ground water potential problems analysis (analytical solutions).

Input data: Aquifer transmissivity, aquitard resistance, well rates graphs, maps, profiles, value at selected points in space.

Output data: Graphs, maps, profiles, value at selected points in space

Time interval of simulation: Variable.

References general validation:

Kovar, K. & A. Leijnse, 1992. AQ-AP, Computer Program Package for Groundwater Potential Problems Analysis (Analytical Solutions). RIVM.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN-77.

Other software required: -

User contract mandatory: Yes.

Costs: Commercial price.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: AQ-AS 3.X

Title: AQuisoft-AS.

Date first profile: November 27th, 1995.

Date last profile: November 27th, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: No.

Subject: Soil science: geohydrology.

Description: Computer program package for ground water pathlines and isochrones (analytical solutions).

Input data: Aquifer transmissivity and porosity, aquitard resistance and porosity, layer thickness, natural flow, well rates.

Output data: Plot of pathlines and travel times.

Time interval of simulation: Variable

References general validation:

Kovar, K. & A. Leijnse, 1988. AQ-AS, Computer Program Package for Groundwater Pathlines and Isochrones (Analytical Solutions). RIVM.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN-77.

Other software required: -

User contract mandatory: Yes.

Costs: Commercial price.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: AQ-AT 3.X

Title: AQuisoft-AT.

Date first profile: November 27th, 1995.

Date last profile: November 27th, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: No.

Subject: Soil science: geohydrology.

Description: Computer program package for pumping test analysis (analytical solutions).

Input data: Aquifer transmissivity, aquitard resistance, well rates, observed ground water drawdowns.

Output data: Optimal ground water parameter values, plot of observed and optimized ground water heads, confidence countours.

Time interval of simulation: Variable.

Basic spatial unit: Variable.

References general validation:

Kovar, K. & A. Leijnse, 1988. AQ-AT, Computer Program Package for Pumping Test Analysis (Analytical Solutions). RIVM.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN-77.

Other software required: -

User contract mandatory: Yes.

Costs: Commercial price.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: ASKAM 1.1

Title: CO₂-ASSimilatie KAsgewasModel.

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: May, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: ASKAM calculates instantaneous gross and net photosynthesis of greenhouse crops based on short term (e.g. half-hourly) data on global radiation outside the greenhouse, and temperature and CO₂ concentration inside the greenhouse. ASKAM can serve as a submodel in a larger model that calculates the CO₂ balance of the greenhouse air, e.g. for optimization of the CO₂ concentration. The model is composed of several submodels, which can be validated separately.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Gross and net crop photosynthesis, greenhouse light transmission.

Number of rate variables: About 10.

State variables: None.

Number of state variables: None.

Input data: Greenhouse cover transmissivity data, crop data, experimental data, greenhouse climate.

Number of input data: 15.

Output data: Photosynthetic active radiation inside greenhouse, crop gross and net photosynthesis.

Number of output data: 3.

Time interval of simulation: Any < day.

Basic spatial unit: m².

References general validation:

Gijzen, H., 1992. Simulation of photosynthesis and dry matter production of greenhouse crops. CABO/TT. Simulation Report nr. 28. 69 + 49 pp.

Gijzen, H., 1994. Ontwikkeling van een simulatiemodel voor transpiratie en wateropname en van een integraal gewasmodel. AB-DLO Report nr. 18. AB-DLO, Wageningen, The Netherlands. 90 + 116 pp. (partly in Dutch).

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Any computer.

Programming language: Microsoft FORTRAN-77.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: BACROS

Title: Basic CROp growth Simulator.

Date first profile: September, 1994.

Date last profile: December, 1995.

Update: October, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: This model for simulation of crop growth and production was developed at the Department of Theoretical Production Ecology of the Agricultural University in Wageningen and the Centre for Agrobiological Research, and exists in two versions. One version concerns the seasonal gross assimilation, respiration and transpiration of C3 and C4 crops with optimal supply of water and nutrients and the meso-weather as input, morphogenesis being in part introduced by forcing functions. The other version simulates the daily course of these processes and is especially geared to the interpretation of measurements in crop enclosures. Both versions are verified under a wide range of conditions and the influence of the main parameters and structural features is studied by a sensitivity analysis. The simulation models are presented in CSMP*, but the text may be read without any previous knowledge of this language. The physiological, biochemical and physical aspects of the crop growth simulation model are treated extensively and examples are given of how the results can be applied.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Detailed rates of photosynthesis, respiration and transpiration of crop components, crop development.

Number of rate variables: > 50.

State variables: Organ weights, leaf area, carbohydrate status, water content.

Number of state variables: > 50.

Input data: Weather, ambient CO₂, initial values state variables; observations for comparison.

Number of input data: About 40.

Output data: Any rate of state variable, accumulated values.

Number of output data: Typically 20.

Time interval of simulation: 1 h, or less.

Basic spatial unit: 1 ha.

References general validation:

Wit, C.T. de, 1978. Simulation of assimilation, respiration and transpiration of crops. Simulation Monograph Series. 141 pp.

Stand alone model: Yes.

Parentage: ELCROS (1972), SUCROS* (1982, 1987) and MACROS* (1989).

Check internal consistency or material balance present: Some.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: >= 640 Kb RAM.

Programming language: CSMP*.

Other software required: None.

Application reports:

Penning de Vries, F.W.T., 1977. Simulation der Assimilation und Transpiration der Pflanzendecke nach grundlegender Gesetzen In: Unger, K. Biophysikalische Analyse pflanzlicher Systeme. Fischer Verlag, Jena. 301 pp.

Penning de Vries, F.W.T., 1983. Modelling of growth and production. In: Lange et al. (Eds.). Encyclopedia of Plant Physiology. New Series, Vol 12. D.O.L. Springer Verlag Berlin, Heidelberg. Physiological Plant Ecology IV: 118-150

Wit, C.T. de & F.W.T. Penning de Vries, 1985. Predictive models in agricultural production. Philosophical Transactions of the Royal Society of London. Series B: Biological Science B310. 309-315

Source code available: Yes

Executable available: No.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

COMMENTS: The model has been summarized (SUCROS*, MACROS*) and is used as such in many studies. BACROS appeared too unwieldy for further development as whole. The second version, used for periods of days for detailed evaluation studies, goes also under the name of PHOTON.

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GENERAL OVERVIEW

Name and version: BALANCE

Title: A simple soil water BALANCE model.

Date first profile: June, 1995.

Date last profile: June, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: 1995.

Subject: Environmental science: hydrology.

Aggregation level: Cropping system.

Description: A one dimensional daily soil water balance model.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Actual evapotranspiration, drainage.

State variables: Soil water content in two layers.

Input data: Climate: daily reference crop (potential) evapotranspiration and rainfall. Soil: volume water fractions at saturation, field capacity and permanent wilting point. The soil can be split into two contrasting layers. Crop: dates of planting, emergence, 20% cover, full cover, etc. Maximum rooting depth.

Output data: Estimated soil evaporation, crop transpiration, actual evapotranspiration, soil water content (or deficit) and hydrologically effective rainfall (i.e. drainage plus surface runoff). Plus an estimate of evapotranspiration deficit.

Time interval of simulation: The output can be generated daily, 10-daily, monthly or annually.

Basic spatial unit: 0.1 to 1.0 ha.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: The program has been written in Microsoft Visual BASIC and is available for DOS or Windows.

User's guide available:

Hess, T.M., 1994. BALANCE - A soil water balance program. Silsoe College, unpublished.

Source code available: No.

Executable available: Yes.

Costs: Available commercially from Cranfield University at approximately US \$ 230.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: BLAYER

Title: Boundary Layer Model.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: 1993.

Program type: Simulation model/module.

Purpose: To describe the diurnal variations in temperature and wind fields in the atmospheric boundary layer. It has been adapted to forecast the timing and location of insect pest migration into the United States cornbelt.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

Subject: Crop protection, and environmental science: atmosphere.

Aggregation level: Supra region.

Description: The BLAYER model simulates atmospheric flows within the lowest few kilometers of the earth's atmosphere. The model is used to describe diurnal variations in temperature and wind fields and has been adapted to forecast the timing and location of insect pest migrations into the United States cornbelt. The model uses a 5-10 minute time step and is generally run for 1-3 day time intervals. The model uses soil texture and moisture information, fields of atmospheric variables and DEM (Digital Elevation Model) data as input. It has been used to examine cutworm dispersion in the cornbelt. The model provides output in ASCII format and data for a grid. Output includes: temperature, wind vectors, pressure, soil moisture, soil temperature, turbulent energy and insect concentrations at any time interval. Other: This model could be useful for the study of short-term atmospheric dynamics and possible changes that may occur in this area of the atmosphere as a result of climate change. It may be of particular importance to the study of pest migration and the potential changes in dispersal patterns of crop damaging pests brought on by changes in climatic conditions. Because the output is in a spatial format (e.g. grid pattern), the output of the model may be brought into a GIS (Geographic Information System) for further spatial analyses.

Input data: Soil texture information, soil moisture levels, fields of atmospheric variables at different pressure levels, (e.g. 850 MB geopotential heights). Initial 'insect' concentration field. Terrain data. Model input data source: Rawinsonde observations taken by NWS (National Weather Service). Gridded NGM (Nested Grid forecast Model) forecast fields. Cutworm trapping data (gridded). Soil moisture data (gridded). Soil texture data (gridded).

Number of input data: Quantity of input data is quite small; less than 1 MB per simulation. There are no real problems with data quantity.

Output data: Model output data: ASCII formatted, (graphics plotting programs are available). Gridded fields of temperature, wind vectors, pressure, soil moisture, soil temperature, turbulent energy (kinetic), insect concentrations at any interval of time chosen by the user, (usually every three to six hours).

Time interval of simulation: Five to ten minute time steps, run out for one to three days.

Basic spatial unit: Spatial scale: Forty to one hundred km grid spacing; usually the domain will cover an area the size of the United States.

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: For DEC 5000 workstation- a 72 hour simulation (5 minutes of a 30 X 30

(horizontal) X 24 (vertical) will take one hours of clock time. On a DEC AXP the same simulation will take 15 minutes.

Programming language: Microsoft FORTRAN-77.

Other software required: NCAR graphics 3.2.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: BLIGHT 2

Title: Model for the crop-pathosystem rice - bacterial leaf blight and sheath blight.

Date first profile: September, 1994.

Date last profile: October, 1995.

Update: July, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop protection.

Description: BLIGHT is a combination model with sections on crop growth and development, and sections which account for the plant x disease interaction. The crop sections are, apart from some minor changes, very similar to ORYZA1*. Effects of the disease on crop growth processes comprise the effects on the characteristics of the photosynthesis light response curve. Effects of the disease on crop on green leaf and stem area, dry matter partitioning, leaf nitrogen content, and relative senescence rate are described in the input data. These and other plant characteristics have to be introduced as forcing functions. Three types of leaf area are introduced into the model, viz. as fractions healthy and diseased leaf area, from which fraction dead leaf area is calculated. Diseased leaf area and diseased stem area are described by their respective disease severities. In contrast to ORYZA1*, in which a single leaf layer is considered, in BLIGHT the canopy is subdivided into three layers which are characterized separately. (Photosynthesis rates per canopy layer are combined to daily gross canopy photosynthesis.) The effects on photosynthesis of diseased leaf area are introduced into the model as correction factors related to disease severity on the initial light use efficiency and the assimilation rate at light saturation. Similarly, the maintenance respiration of diseased leaf area is given a correction factor. Photosynthesis rates of healthy and dead leaf area are assumed to be unaffected and zero, respectively.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Crop growth and senescence, development, relative growth rate.

Number of rate variables: > 25.

State variables: Plant organ weights, disease severity, leaf area.

Number of state variables: > 25.

Input data: Disease severity, leaf area, development rate, relative growth rate.

Number of input data: > 25.

Output data: Plant organ weights.

Number of output data: As desired, maximum > 25.

Time interval of simulation: 1 day.

Basic spatial unit: 1 ha.

Stand alone model: Yes.

Parentage: ORYZA1* and L1DFDE.

Check internal consistency or material balance present: Yes.

Input check in model: No, the inputs are not checked in the program, however if the inputs are not available, the model terminates.

TECHNICAL SPECIFICATIONS

Hardware: >= 640 Kb RAM.

Programming language: Microsoft FORTRAN-77.

Other software required: FORTRAN and MS-DOS.

Technical reference:

Elings, A., 1993. Damage by bacterial leaf blight and sheath blight in rice: a quantitative simulation model. In: Rossing, W.A.H., E.G. Rubia, K.L. Heong, M. Keerati-Kasikorn & P.R. Reddy (Editors). Mechanisms of damage by stem borer, bacterial leaf blight and sheath blight, and their effects on rice yield. SARP Research Proceedings. Proceedings of workshops in Khon Kaen, Thailand, 3-5 August 1992, and Cuttack, India, 3-5 March 1993. DLO-Centre for Agrobiological Research, Wageningen. Dept. of Theoretical Production Ecology, Wageningen. IRRI, Los Banos. 79-109

Elings, A. & E.G. Rubia, 1994. Models for the crop-pathosystems rice - bacterial leaf blight, sheath blight and stem borer. AB-DLO, TPE-WAU, Wageningen, IRRI, Los Banos. 102 pp.

Elings, A., W.A.H. Rossing & P.S. Teng, 1994. Structure and development of BLIGHT, a model to simulate the effects of bacterial leaf blight and sheath blight on rice. In: Elings, A. & E.G. Rubia (Editors). Analysis of damage mechanisms by pests and diseases and their effects on rice yield. SARP Research Proceedings. AB-DLO, TPE-WAU, Wageningen. IRRI, Los Banos. 9-30

Application reports:

Marimuthu, T., W.A.H. Rossing, E.G. Rubia & T.B. Ranganathan, 1995. Onset of bacterial leaf blight epidemics and their effects on growth and yield of IR64. In: Marimuthu, T. (Ed.). Effects of bacterial leaf blight on crop growth and yield of rice. AB-DLO and WAU-TPE, Wageningen. 1-17

Narasimhan, V. & A. Abdul Kareem, 1994. Simulation of the effect of bacterial leaf blight infection on yield reduction in rice. In: Elings, A. & E.G. Rubia (Editors). Analysis of damage mechanisms by pests and diseases and their effects on rice yield. SARP Research Proceedings. AB-DLO, TPE-WAU, Wageningen. IRRI, Los Banos. 59-68

Reddy, P.R., S.K. Nayak & L. Bastiaans, 1991. Simulation of the effect of bacterial blight disease on crop growth and yield. In: Penning de Vries, F.W.T., H.H. van Laar, M.J. Kropff (Ed.). Simulation and systems analysis for rice production (SARP): selected papers presented at the workshops on crop simulation of an network of National and International Research Centres of several Asian countries and The Netherlands. Pudoc-DLO, Wageningen, The Netherlands. 340-347

Reddy, P.R., 1994. Effect of bacterial blight disease scenarios and their impact on crop growth and yield of rice. In: Reddy, P.R. (Editors). Simulation of the effect of bacterial blight disease on crop growth and yield of rice. AB-DLO, TPE-WAU, Wageningen.

Reddy, P.R., 1994. Exploration of the effect of bacterial leaf blight disease on crop growth and yield of rice through simulation. In: Elings, A. & E.G. Rubia (Editors). Analysis of damage mechanisms by pests and diseases and their effects on rice yield. SARP Research Proceedings. AB-DLO, TPE-WAU, Wageningen. IRRI, Los Banos. 43-58

Reddy, P.R., S.K. Nayak & A. Elings, 1994. Yield reduction due to different severity levels of bacterial leaf blight disease of rice. In: Elings, A. & E.G. Rubia (Editors). Analysis of damage mechanisms by pests and diseases and their effects on rice yield. SARP Research Proceedings. AB-DLO, TPE-WAU, Wageningen. IRRI, Los Banos. 31-42

Reddy, P.R., 1995. Bacterial blight disease scenarios and their impact on crop growth and yield of rice. Paper presented at SARP workshop, August 1995, New Delhi.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: Advise/request: E.G. Rubia (to be contacted through SARP/International Rice Research Institute (IRRI): e.rubia@cgnet.com / stelosa@cgnet.com) may be aware of more application reports. I would appreciate if you could contact her.

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GENERAL OVERVIEW

Name and version: BLOCKPHOT 1.0

Title: Block canopy gross photosynthesis.

Date first profile: December, 1995.

Date last profile: December, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

Subject: Crop science.

Description: Canopy gross photosynthesis is calculated of a plant stand. The plant stand is represented as a block of given height, width, and depth. The model is an adapted version of the row crop model of Gijzen & Goudriaan (1989; Agric. For. Meteor. 48: 1-20). Diffuse and direct light distribution and absorption are calculated taking account of scattering and reflection. Leaf photosynthesis is calculated from absorbed light and integrated over the block.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Photosynthetic active radiation absorption, leaf gross photosynthesis, crop gross photosynthesis.

Number of rate variables: 3.

State variables: -

Number of state variables: None.

Input data: Leaf photosynthesis parameters, leaf area index, block width, height and depth, latitude, day of year, hour of day, fraction diffuse photosynthetic active radiation.

Number of input data: 11.

Output data: Instantaneous crop gross photosynthesis, canopy photosynthetic active radiation absorption.

Number of output data: 2.

Time interval of simulation: Instantaneous.

Basic spatial unit: m².

Stand alone model: Yes.

Parentage: HEDGEROW* 1.0.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Any computer.

Programming language: Microsoft FORTRAN.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: BLOOM II

Date first profile: November 1995.

Date last profile: November 1995.

Update: November 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Environmental science.

Aggregation level: Other: species/groups.

Description: BLOOM II is a general phytoplankton model. The model calculates phytoplankton time series based on external physical, chemical and biological parameters, species composition and numerous other output such as limiting factors, chlorophyll etc. It has been integrated with various other model systems.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Consult author.

Number of rate variables: Consult author (dozens).

State variables: Consult author (dozens).

Number of state variables: Consult author (dozens).

Input data: Consult author (dozens).

Number of input data: Consult author (dozens).

Output data: Consult author (dozens).

Number of output data: Consult author (dozens).

Time interval of simulation: Days - decades.

Basic spatial unit: 1 m³ - lake or reservoir.

References general validation:

Los, F.J., 1991. Mathematical simulations of algae blooms by the model BLOOM II. Documentations report. Delft Hydraulics, The Netherlands.

Stand alone model: Yes, and no: both.

Parentage: Adaptation of General Eco Model (Randcap).

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN-77.

Other software required: None.

User's guide available:

Los, F.J., 1985. User's manual BLOOM II. R1310. Delft Hydraulics, The Netherlands.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Consult author.

COMMENTS: Various applications, fresh and marine phytoplankton. Implementation as module with in various complex water quality models, multi segment schematizations (> 100

segments), networks etc.

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GENERAL OVERVIEW

Name and version: BOSMest

Title: A decision support system to optimize the application and processing of manure.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: February, 1991.

Program type: Optimization model.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: No.

Subject: Environmental science.

Aggregation level: Region.

Description: The model calculates the manure optimization of the farms of origin and in the vicinity and it optimizes the application elsewhere and the processing of manure. In this way, the Decision Support System (DSS) gives insight into the logistic problem on a regional level. It can be used on tactical and strategical levels.

SCIENTIFIC SPECIFICATIONS FOR OPTIMIZATION MODELS

Type of variables/activities: Manure flows between nodes in a network.

Number of variables/activities: 10000.

Type of constraints: Capacity restrictions, balance equations.

Number of constraints: 1000.

Type of objective functions: Costs of flows.

Number of objective functions: 1.

Basic spatial unit: Tonnes of manure.

Time horizon: Year.

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: Micro-computer.

Programming language: SCICONIC.

User's guide available:

MGG User guide Version 2.1 Scicon Ltd. London.

SCICONIC/VM User guide Version 1.4 Scicon Ltd. Wavendon, United Kingdom.

Application reports:

Mol, R.M. de & P. van Beek, 1991. An OR contribution to the solution of the environmental problems in the Netherlands caused by manure. European Journal of Operational Research, Volume 52, Number 1. 16-27

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

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GENERAL OVERVIEW

Name and version: BRUSPLAN 2.00

Title: Optimum planting plan for brussels sprouts.

Date first profile: September, 1995.

Date last profile: September, 1995.

Update: January, 1994.

Program type: Simulation model/module, and optimization model.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science, and agricultural economics.

Aggregation level: Crop/herd.

Description: BRUSPLAN is another decision support system which has been developed at Silsoe Research Institute, this time to assist vegetable growers. It has been funded by the Ministry of Agriculture, Fisheries and Food. BRUSPLAN produces planting plans for Brussels sprouts. The grower is given advice on which varieties to grow, at what spacing and at what time of year to meet a market demand for sprouts in specific size ranges from several customers. The system simulates growth and timing of development of buttons at different planting densities from different methods of raising. The two main aims of the system are to maximise profit and to satisfy market demand.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Leaf area, radiation, soil moisture.

State variables: Leaf area index, button size and number, yield, ...

Input data: Weather data, variety, spacing, trials summary data, ...

Output data: Yields at any size at any harvest.

Time interval of simulation: Day.

Basic spatial unit: Ha.

Stand alone model: Provides data for optimization model.

Parentage: -

Input check in model: Yes.

SCIENTIFIC SPECIFICATIONS FOR OPTIMIZATION MODELS

Type of variables/activities: Area of variety / planting data / spacing / method harvested in a week.

Number of variables/activities: 0 - 1000.

Type of constraints: Demand for sizes of sprouts per week.

Number of constraints: 0 - 200.

Type of objective functions: Profit.

Number of objective functions: 1

Basic spatial unit: Ha.

Time horizon: 1 Year.

Optimization interval: -

Stand alone model: Needs data from crop simulation model.

Parentage: -

TECHNICAL SPECIFICATIONS

Hardware: IBM PC.

Programming language: Microsoft FORTRAN.

Other software required: XPRESSMP LP software.

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

Costs: Eng. pounds 100.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: BYM 1.4

Date first profile: August 31st, 1995.

Date last profile: August 31st, 1995.

Update: August 24th, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: -

Subject: Crop science.

Aggregation level: Crop/herd.

Description: Agrometeorological soil water balance for crop simulation models. The use of crop simulation models on a large scale for agrometeorological purposes is often limited by their inputs being non routinely collected data, especially with regard to their soil water balance compartment. The objective was to develop a water balance submodel which can be run with readily available inputs. The model predicts water use, soil evaporation, crop transpiration throughout the growing season. Physiological reduction factors, as influenced by water stress, are derived from the soil water availability. This was achieved by using empirical relationships such as the reservoir analogy to assess water availability in relation to root development. The framework of using conditions is assessed by sensitivity analyses performed on inputs: the model can be run with an incrementing time step of ten days and soil information given by soil maps, i.e. soil texture and depth, which fits to agrometeorological purposes. Moreover, the model is shown to realistically describe soil water depletion, crop evapotranspiration and rooting depth. Yet incorporating effective rainfall simulation, i.e. both runoff and rainfall interception by the canopy, would advantageously improve the model.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evaporation, transpiration.

Number of rate variables: -

State variables: Soil water content, rooting depth.

Number of state variables: 25.

Input data: Weather data (temperature, global radiation, potential evapotranspiration, rainfall), crop driving variables (irrigation amount, leaf area index), soil properties (initial soil moisture, soil depth, texture).

Number of input data: -

Output data: Stress factors.

Number of output data: 25.

Time interval of simulation: 1 Day or 10 days.

Basic spatial unit: -

References general validation:

Brisson, N., 1992. Agricultural and Forest Meteorology 59: 267-287

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: -

Input check in model: -

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC AT.

Programming language: Microsoft FORTRAN-77.

Other software required: No.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: -

Costs: No.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: BYMPRAI

Date first profile: July, 1995.

Date last profile: July, 1995.

Update: March, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: Yes.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: Grassland simulation model incorporating water and nitrogen stress.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evaporation, transpiration.

Number of rate variables: -

State variables: Leaf area index, crop biomass (potential and water-limited), soil water content, water use.

Number of state variables: 25.

Input data: Weather data (temperature, global radiation, potential evapotranspiration, rainfall), crop management, soil properties (initial soil moisture, soil depth, texture), plant parameters.

Number of input data: 40.

Output data: Crop cycle summaries (harvesting date, biomass, water requirement, water stress indicators).

Number of output data: 30.

Time interval of simulation: Day.

Basic spatial unit: -

References general validation:

Capitant, L., 1994. Calage et validation du modele de croissance de graminees fourrageres. DEA de statistiques.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: -

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC AT.

Programming language: Microsoft FORTRAN-77.

Other software required: No.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: -

Costs: No.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: CABO/TPE Weather System

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Simulation tool: utility program.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Utility program for providing daily weather data from a weather database to a simulation model in runtime.

Description: The weather program consists of two subroutines, STINFO and WEATHR, that respectively read the meteorological data from file and serve them to the simulation model in runtime.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: -

State variables: Not applicable.

Number of state variables: -

Input data: Not applicable.

Number of input data: -

Output data: Not applicable.

Number of output data: -

Stand alone model: No.

Parentage: -

Check internal consistency or material balance present: Not applicable.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Any system with a FORTRAN-77 compiler.

Programming language: Microsoft FORTRAN-77.

Other software required: -

User's guide available:

Kraalingen, D.W.G. van, W. Stol, P.W.J. Uithol & M.G.M. Verbeek, 1991. User manual of CABO/TPE Weather System. CABO/TPE internal communication. Wageningen. 28 pp.

Source code available: Yes.

Executable available: No.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 150,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: CAPSEV

Title: A program to calculate steady-state moisture profiles in 1 dimension.

Date first profile: December, 1995.

Date last profile: December, 1995.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 3

Subject: Soil science.

Description: CAPSEV determines hydraulic conductivity from grain size distribution and steady state water flow in layered soil profiles.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Moisture flux, storage coefficient.

Number of rate variables: 15.

State variables: Capillary rise.

Number of state variables: 100.

Input data: Soil physical data, required flux density.

Number of input data: $25 < x < 100$.

Output data: Tables with capillary rise, print plots, infiltration profiles.

Number of output data: As required.

Time interval of simulation: -

Basic spatial unit: cm.

References general validation:

Wesseling, J.G., G.W. Bloemen & W.A.J.M. Kroonen, 1984. Computer program 'CAPSEV' to calculate: I. soil hydraulic conductivity from grain size distributions. II. steady state water flow in layered soil profiles. Nota Instituut voor Cultuurtechniek en Waterhuishouding no 1500.

I.C.W. Wageningen. 46 pp.

Wesseling, J.G., 1991. CAPSEV: steady state moisture flow theory: program description, user manual. Report DLO Winand Staring Centre no. 37. SC-DLO, Wageningen. 51 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: CAPSEVPC 1.1

Title: A program to calculate steady-state moisture profiles in 1 dimension.

Date first profile: November 11th, 1995.

Date last profile: November 11th, 1995.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 3

Subject: Soil science.

Description: CAPSEVPC calculates capillary rise in a heterogeneous soil profile.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Moisture flux, storage coefficient.

Number of rate variables: 15.

State variables: Capillary rise.

Number of state variables: 100.

Input data: Soil physical data, required flux densities.

Number of input data: $25 < x < 100$.

Output data: Tables with capillary rise.

Number of output data: As required.

Time interval of simulation: -

Basic spatial unit: cm.

References general validation:

Wesseling, J.G., 1991. CAPSEV: steady state moisture flow theory: program description, user manual. Report DLO Winand Staring Centre no. 37. SC-DLO, Wageningen. 51 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: -

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GENERAL OVERVIEW

Name and version: CARMA

Title: CAse-based Range Management Advisor.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Farming systems.

Aggregation level: Farm.

Description: CARMA is a model designed for use by ranchers as a decision support tool for grasshopper pest management. The model integrates elements of case-, model-, and rule-based reasoning to efficiently guide the user to an extreme, with a full explanation of the aggravating and mitigating factors. Inquiries are structured for a well-, moderately- and un-informed user to extract key features of a rangeland/grasshopper scenario without assuming any particular entomological or ecological background.

Input data: Input data includes (depending on the specific case): development stage, taxonomic composition, pest density, weather, location, range condition, etc.

Number of input data: 5 - 15 parameters.

Output data: Estimated forage loss and treatment recommendation, including short - and extended - version explanations of how the decision was made.

Number of output data: 2 Elements and explanations.

Time interval of simulation: 1 Season.

Basic spatial unit: Ranch.

References general validation:

Aslyng, H.C. & S. Hansen, 1985. Radiation, water and nitrogen balance in crop production. Field experiments and simulation models WATCROS and NITCROS. Hydrotechnical Laboratory. The Royal Veterinary and Agricultural University, Copenhagen. 146 pp.

Keulen, H. van & N.G. Seligman, 1987. Simulation of water use, nitrogen nutrition and growth of a spring wheat crop. Simulation Monographs. Pudoc-DLO, Wageningen, The Netherlands. 308 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible, 486.

Programming language: LISP.

Other software required: Windows.

Technical reference:

Hastings, J. PhD dissertation, University of Wyoming.

Application reports:

Hastings, J.D., L.K. Branting & J.A. Lockwood, 1995. A multiple paradigm for rangeland pest management. (In Press).

Hastings, J.D., L.K. Branting & J.A. Lockwood, 1995. Case adaptation using an incomplete causal model. Proceedings of the First International Conference Case-based Reasoning, Sesimbra, Portugal, October 23-26, 1995.

Lockwood, J.A., L.K. Branting & J. Hastings, 1993. A case-based approach to rangeland grasshopper management. United Nations, Food and Agricultural Organization, Desert Locust Register No. 5.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: Negotiable.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: CARMEN

Title: CAuse effect Relation Model for Environmental policy Negotiations.

Date first profile: September 27th, 1995.

Date last profile: September 27th, 1995.

Update: September 25th 1995.

Program type: Simulation model/module. Simulation tool: database.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science.

Aggregation level: Region.

Description: CARMEN is an integrated assessment tool that allows the simultaneous analysis of several environmental issues from sources to effects. It shows the connection between pressure and impact in the form of socio-economic developments, local emissions - caused by unsound industrial, agricultural, or domestic practices - and pollution problems and their ecological and public health consequences. It will be used to scope environmental policy scenarios for pan-Europe.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Emission factors, transport matrices, transformation rates.

Number of rate variables: More than 100.

State variables: Gross Domestic Product (GDP), energy use, CO₂-, SO₂-, NH₃-, NO_x-emission, concentration and deposition, etc.

Number of state variables: More than 100.

Input data: Economic growth, technical measures, environmental standards, unit costs.

Number of input data: Many.

Output data: Economic, environmental and public health indicators.

Number of output data: Many.

Time interval of simulation: One year.

Basic spatial unit: Country for policy and compliance values; 1/2 x 1 (degrees) for physical values.

Stand alone model: Yes.

Parentage: None.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Workstation.

Programming language: MATLAB.

Other software required: None.

Application reports:

The CARMEN Status report 1995.

Source code available: No.

Executable available: No.

User contract mandatory: -

Costs: -

COMMENTS: The model consists of several (RIVM-made) modules.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: CASE2

Title: CAcao Simulation Engine level 1 & 2.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: May, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 3

New release expected: Yes.

Subject: Crop science.

Aggregation level: Crop/herd, and cropping system/animal husbandry system.

Description: The general crop growth model SUCROS has been adapted to simulate the growth and production of cocoa crops. The model can be used to simulate the growth and yield of cocoa stands under potential and/or water limited production conditions. Long term assimilate pools are included. Competition for light and water with shade crops based on INTERCOM* is explicitly included. Growth and yield differences between years rather than variation within years, are modelled. The model has been tested for growing periods up to 25 years.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Daily canopy photosynthesis, maintenance and growth respiration, evapotranspiration, yield, organ death rates, development of pods.

Number of rate variables: 23.

State variables: Weight of leaves, wood, roots and fruits, and reserve pool, weight of death and harvested organs.

Number of state variables: 13.

Input data: All state and rate variables, site information and daily weather.

Number of input data: 61.

Output data: All state and rate variables plus intermediate values.

Number of output data: > 50.

Time interval of simulation: 1 Day.

Basic spatial unit: Ha.

References general validation:

Anten, N.P.R., W. Gerritsma & M. Wessel, 1993. Modelling as a tool for cocoa research, preliminary results. Proceedings of the 11th International Cocoa Research Conference, 18-24 July, 1993, Yamoussoukro, Ivory Coast.

Gerritsma, W. & M. Wessel, 1994. Calculated yield trends in various countries. Paper presented at the Malaysian International Cocoa Conference '94. 21-22 October 1994, Kuala Lumpur, Malaysia.

Gerritsma, W., 1995. Physiological aspects of cocoa agronomy and its modelling. Wageningen, Vakgroep Agronomie, Landbouw Universiteit Wageningen, 129 pp.

Stand alone model: Yes.

Parentage: SUCROS1* & 2*, INTERCOM* and DRSAHE.

Check internal consistency or material balance present: Yes.

Input check in model: Partly.

TECHNICAL SPECIFICATIONS

Hardware: Mainframe, mini, Mac or PC.

Programming language: Microsoft FORTRAN and FSE*.

Other software required: TTUTIL* and CABO/TPE Weather System*.

Technical reference:

Gerritsma, W., 1995. Physiological aspects of cocoa agronomy and its modelling. Wageningen, Vakgroep Agronomie, Landbouw Universiteit Wageningen, 129 pp.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: Catastrophe Theory Model

Title: -

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: 1993.

Program type: Simulation model/module (may be used in forecasting).

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: No.

Subject: Crop protection: pest.

Aggregation level: Region.

Description: The Catastrophe Theory Model is a predictive model for the area of infestation in coming years based on climate information (mean daily temperature and precipitation) and historic site-specific data. Based on the weather data and the previous year intensities, the model predicts the intensities in the coming year using catastrophe theory. Keywords: predictive, site specific, historic. Global change implications: The ability to forecast grasshopper infestations has significant relevance to global change. Insects like grasshoppers respond to changing climatic conditions.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: Not applicable.

State variables: Grasshopper infestation expressed in various ways (e.g. area infested at > 10 m², etc.).

Number of state variables: One.

Input data: Average daily temperature and precipitation for two month period. Model input data source: NCSA.

Number of input data: Two features.

Output data: Grasshopper infestation level. Numeric and graphic output.

Number of output data: Not applicable.

Time interval of simulation: Temporal scale: 50 years, 1944-1994.

Basic spatial unit: Spatial scale: Ecophysiographic regions within a state, 6 ecophysiographic regions, state-wide regions under development.

References general validation:

Anonymous. Installing and running the EPIC model on an IBM-PC or compatible, 11-21-90.

Stand alone model: Yes.

Parentage: Cobb (1980).

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: 386 Math co-processor-IBM compatible.

Programming language: Turbo Pascal.

Other software required: None.

Technical reference:

Lockwood, J.A. & D.R. Lockwood, 1991. Rangeland grasshopper population dynamics: Insights from catastrophe theory. *Environmental entomology* 20: 970- 980

Application reports:

Lockwood, J.A. & D.R. Lockwood, 1993. A unified paradigm of rangeland ecosystem dynamics through the application of catastrophe theory. *Journal of Range Management* 46: 282-288

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: Negotiable.

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GENERAL OVERVIEW

Name and version: CERCOT

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module: Empirical process models for management applications, less top down than OZCOT*.

Purpose: All that OZCOT* does (i.e. management and decision making at both strategic and tactical levels; regional climatic analysis) plus long term soil sustainability issues by use of a more robust soil N model.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, and crop protection.

Aggregation level: Farm, and region.

Description: The plant model from OZCOT* was linked to a later generation of the Ritchie water balance model as configured in the CERES family of models, together with the soil nitrogen model. Plant dry matter and nitrogen models were added. Improved simulation of soil N dynamics, and runoff and drainage compared to OZCOT*, as a result of incorporating the soil N and water sub-models from CERES. CERCOT is expected to simulate yield, yield components, fruiting dynamics, leaf area index, N uptake, evapotranspiration and soil water content as accurately as OZCOT*, but validation is not yet complete. The model has to date been calibrated against data from the Namoi valley, but has not yet been validated against data from other area. The ability of CERCOT to differentiate between varieties is currently limited. The model can not yet simulate fibre quality, and currently can only partially simulate skip-row planting configurations. CERCOT is valid for dryland and irrigated cotton crops. CERCOT unlike OZCOT* is not specific to vertisols. CERCOT, limited application to date pending completion. Target use/user group: On-farm, consultants, extension workers, planning, research, water allocation policy.

Input data: All the requirements of OZCOT*, plus soil N initial conditions, thus: Weather data: rainfall, maximum and minimum temperature, solar radiation, optionally wet and dry bulb.

Agronomic data: variety, plant population and row spacing, sowing date or sowing window, irrigation dates or parameters for irrigation, expected seasonal uptake of non-fertilizer N (previous crop or soil test), date and amount of N fertilizer. Soil data: bulk density, SCS runoff curve number, plant available soil water capacity, saturation water content, initial content of water, nitrogen and organic matter by layers.

Output data: Yield, yield components, fruiting dynamics, leaf area index, N uptake, evapotranspiration and soil water content.

Parentage: OZCOT*.

TECHNICAL SPECIFICATIONS

Application reports:

Godwin, D.C., A.T. Wells & A.B. Hearn, 1992. Modelling nitrogen dynamics in cotton cropping systems. Sixth Australian Cotton Conference, Broadbeach, 12-14 August, 1992. ACGRA, Wee Waa. 103-109

User contract mandatory: See 'Comments'.

COMMENTS: Not available yet.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: CERES-Canola 3.0

Date first profile: August 1th, 1995.

Date last profile: August 1th, 1995.

Update: March 20th, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: -

Subject: Crop science, soil science, and environmental science.

Aggregation level: Crop/herd.

Description: The model simulates the growth and development of a rapeseed (canola) crop, in relation to soil nitrogen and water status, at the field scale. It operates on a daily time step and comprises 3 main modules: - crop growth (including C assimilation, distribution within the plant, root elongation, N demand). - soil CN turnover (mineralization, immobilization, nitrification, denitrification). - heat, water and nitrate transfer in the soil profile (one-dimensional scheme).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Plant: canopy photosynthesis, N and water uptake leaf elongation, senescence. Soil: mineralization, immobilization, denitrification, water drainage, N leaching.

Number of rate variables: 100.

State variables: Plant: dry matter of roots, leaves, stems, pods and grains, aerial and root N content. Soil: temperature, water, mineral N, organic C and N contents in the profile.

Number of state variables: 100

Input data: Standard daily weather record (radiation, air temperature, rain), soil hydraulic properties (saturated conductivity, field capacity), soil C content, texture. Crop and soil management information.

Number of input data: 80.

Output data: As rate and state variables.

Number of output data: 100.

Time interval of simulation: Day.

Basic spatial unit: Ha.

References general validation:

Gabrielle, B., S. Menassari & S. Houot, 1995. Analysis and field evaluation of the CERES models' water balance component. Soil Science Society of America Journal. (In Press).

Stand alone model: Yes.

Parentage: CERES-N Maize (1986) and NCSOIL*.

Check internal consistency or material balance present: -

Input check in model: -

TECHNICAL SPECIFICATIONS

Hardware: IBM-PC, UNIX.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: Not yet.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: CICICP.CSM

Title: Chicory Industrial Crops and Products.

Date first profile: October, 1994.

Date last profile: December, 1995.

Update: November, 1991.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: The model calculates root dry matter of chicory (*Cichorium intybus*) during the growing season under non-limiting conditions. Root dry matter is described as an exponential function of the accumulative intercepted radiation. The parameters used, are based on a field trial in 1987 with the cultivar Pevele under non-limiting conditions (Meijer and Mathijssen, 1992). The model has been used to compare inulin production of Jerusalem artichoke and chicory (Meijer and Mathijssen, 1993).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

Number of rate variables: 0.

State variables: Leaf area index, fraction intercepted photosynthetic active radiation, cumulative intercepted photosynthetic active radiation, weight roots.

Number of state variables: 4.

Input data: Parameters for leaf area index, fraction intercepted photosynthetic active radiation, light use efficiency roots, weather.

Number of input data: About 15.

Output data: Fraction intercepted photosynthetic active radiation, cumulative intercepted photosynthetic active radiation, dry weight roots.

Number of output data: 3.

Time interval of simulation: Day.

Basic spatial unit: Ha.

References general validation:

Meijer, W.J.M. & E.W.J.M. Mathijssen, 1992. Crop characteristics and inulin production in chicory. *European Journal of Agronomy* 1(2): 99-108

Meijer, W.J.M. & E.W.J.M. Mathijssen, 1993. Experimental and simulated production of inulin by chicory and Jerusalem artichoke. *Industrial Crops and Products* 1: 175-183

Stand alone model: Yes.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Programming language: CSMP*.

Other software required: CSMP*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,-.

COMMENTS: The model has been tested with results of field trials in 1988 with the same cultivar.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: CLEAN 1.0

Title: Crops, Livestock and Emissions from Agriculture in the Netherlands.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: August, 1993.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science.

Aggregation level: Crop/herd, and region.

Description: The model simulates production, transportation and application of manure on combination of crops and soil types in 31 regions in the Netherlands. It is used to estimate effects of environmental policy options on emissions of ammonia into the air and of nutrients and heavy metals onto soil. It also estimates the use of chemical fertilizer. The main policy options to evaluate are: manure application standards, application techniques, low-emission housing. This administrative model is very flexible in its dimensions. With an intelligent user interface and sufficient data it can reach a high spatial resolution and it is able to cope easily with regional differentiation in policy options.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

Number of rate variables: 0.

State variables: All output data per crop-soil type combination, nutrient requirements per crop-soil type, manure content for 12 manure types and 8 compounds.

Number of state variables: 30 000.

Input data: Animal numbers for 35 classes in 31 regions, cropping area for 7 classes per region, excretion per animal per compound (for 20 animal categories, national average per grazing system and type of stable) etc.

Number of input data: 10 000.

Output data: Emissions to air and soil (per compound and region), manure production, surplus, processing quantities (per compound and region) plus national aggregates.

Number of output data: 1 000.

Time interval of simulation: 1 Year.

Basic spatial unit: Ha.

Stand alone model: No.

Parentage: Manure models from LEI-DLO: MESTTV and MESTOP.

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: HP-9000/730.

Programming language: C++.

Other software required: Ingres and W4GL for user interface.

Technical reference:

Mooren, M.A.M. & N.J.P. Hoogervorst, 1993. CLEAN, het RIVM-landbouwmodel. Deel 1:

modelstructuur, versie 1.0. Rijksinstituut voor Volksgezondheid en Milieuhygiene (RIVM)
report no. 259102005. Bilthoven, The Netherlands. 60 pp.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes.

COMMENTS: Testing is to be completed in 1995. An update is planned in 1996 to improve the regional differentiation; we change from 31 regions to about 800 municipalities as the spatial unit.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: CONTOUR 2.0

Date first profile: October 6th, 1995.

Date last profile: October 6th, 1995.

Update: January 4th, 1991.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Soil science, farming systems, and environmental science.

Aggregation level: Farm, region, and supra region.

Description: CONTOUR calculates ground water potentials, for 3 cases: (1) Half-infinite deep aquifer with a natural ground water flow, infiltration, partial well screens and drains, (2) one aquifer with recharge, wells, natural ground water flow, and (3) system of N coupled aquifers with specified boundary isohypses and wells. Input for pathline programs FLOPZ1, FLOPZN can be used for cases 2 and 3, respectively.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Input parameters to characterize the subsoil and the extractions and infiltrations.

Input data: Strength natural ground water flow, strength infiltration, location and strength partial well screens, location and strength drains.

Output data: Graphical presentation of ground water potential as contour plots, also ground uwater potential in specified points.

Number of output data: ASCII-files, plot-files in ASCII.

Time interval of simulation: Not applicable.

Basic spatial unit: Free.

Stand alone model: Yes.

Parentage: See under 'A. General overview'.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC's with co-processor.

Programming language: Microsoft FORTRAN-77.

Other software required: Graphical software (included).

User's guide available:

Veling, E.J.M., 1991. CONTOUR, A computer program to draw isohypse patterns. Rijksinstituut voor Volksgezondheid en Milieuhygiene (RIVM) Internal Memorandum, version 2.

Application reports:

Beugelink, G.P. & J.H.C. Muelschlegel, 1989. Winning van freatisch grondwater in Nederland; hoe lang nog? H twee O: tijdschrift voor watervoorziening en afvalwaterbehandeling - H2O 22: 590-594

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Commercial.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: CP-BKF3

Title: Cultures Pluviales - Burkina Faso.

Date first profile: September, 1995.

Date last profile: September, 1995.

Update: March, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science, soil science, and farming systems.

Aggregation level: Crop/herd.

Description: CP-BKF is a dynamic simulation model developed by the DLO Research Institute for Agrobiolgy and Soil Fertility (AB-DLO). The model has been developed for the simulation of cereal growth (sorghum, millet and maize) under semi-arid conditions in West-Africa (Burkina Faso and Mali). CP-BKF3 is based on mechanistic relations between crop performance and environmental conditions such as climate and soil. Several modules of the TTUTIL* library for FORTRAN are used. The model handles cereal growth at three levels: 1) not limited, 2) water limited and 3) water and nitrogen limited. It simulates dry matter production and partitioning in a pest-, disease- and weed-free environment. The water module is based on tipping-bucket principles extended with water redistribution by capillary rise. Soil horizons to a depth of 50 cm are partitioned in layers of 5 cm, deeper ones in layers of 25 cm. Residues are partitioned in 3 fractions: decomposable, structural and resistant material, and soil organic matter in 2 fractions: stable and labile organic matter. Other processes account for emergence, evapo(transpi)ration, maintenance, root distribution and extension, development and death of plant organs, N fertilization, N uptake, N mineralization and immobilization, N leaching, run off, and drainage. Management practices include fertilization (type, quantity and split dose), ploughing and the construction of borders and ridges to increase water storage. The model has a user-friendly interface which allows parameter change in rerun files and scenario studies over a continued or discontinued period of 15 years. Rotation of crops is an option in rerun files.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Soil: per layer: percolation, capillary rise, N uptake, N leaching, evaporation, transpiration, root extension, mineralization and more. Crop: per organ: N demand, death and growth rates; assimilation; N flux through root surface and more.

Number of rate variables: Circa 25.

State variables: Weather: daily (effective) rainfall, daily temperature. Soil: per layer: water content, matric potential, evaporation, root length and density, N content, organic matter content, N mineralization and immobilization, soil temperature; drainage; N leaching and more. Crop: per organ: living and dead dry matter, N content, N uptake, leaf area index, transpiration, rooting depth, specific root length and surface, dry matter for maintenance and more.

Number of state variables: Circa 25.

Input data: Weather: year, Julian day number, daily minimum and maximum temperature, precipitation, global radiation, vapour pressure and wind speed. Soil: type, physiographic position, slope, total mineral N in profile. Per horizon: texture class, % C, % N, bulk density, pF (4.2, 3.0, 2.5). Crop: development rates, leaf life span, initial biomass, row spacing, sowing depth, critical pF for emergence, maximal rooting depth and others.

Number of input data: Circa 50 (most of it in validated soil, weather and crop files). Soil files can be generated in DBASE application program named BAOBAB (contact R.E.E. Jongschaap, address below).

Output data: The graphic part of the model shows 3 graphs during simulation in which many state and rate variables (> 50) can be followed (also underground !). During simulation the same or other requested variables are sent to tables in output files. TTSELECT* enables the examination of results in graphic mode.

Number of output data: On request.

Time interval of simulation: Calculation and integration take place in time steps of 1 day. Output can be generated every 1-365 days. Output is generated at emergence, flowering, harvest and end of year.

Basic spatial unit: 1 ha.

References general validation:

Bazi, M.H., E.L.J. Verberne, G.H. Dijksterhuis & A.A. Sanou, 1995. Les modeles de simulation comme outils de gestion des sols et de developpement agricole: exemple du modele << Cultures Pluviales du Burkina Faso >>. AB-DLO Rapport PSS No. 11. 53-66

Stand alone model: Yes.

Parentage: CP-BKF2 and CP-BKF1.

Check internal consistency or material balance present: Yes: on water, nitrogen and carbon balances, dry matter partitioning and dry matter ratios. Anomalies in development process are noted (no emergence, early maturity etc.). Warnings and error messages appear on the screen.

Input check in model: Yes: on weather data, Julian day numbers, latitude and others. Warnings and error messages appear on the screen.

TECHNICAL SPECIFICATIONS

Hardware: >= 386 DX and co-processor.

Programming language: Microsoft FORTRAN-77.

Other software required: TTUTIL*, TTSELECT*, ...

User's guide available:

Bazi, M.H., A.A. Sanou, E.L.J. Verberne, R.E.E. Jongschaap, G.H. Dijksterhuis & M. Bonzi, 1995. Manuel du logiciel interactif (CP-BKF3): sorgho, mil et mais. AB-DLO Nota 20. 29 pp.

Technical reference:

Verberne, E.L.J., G.H. Dijksterhuis, R.E.E. Jongschaap, M.H. Bazi, A.A. Sanou & M. Bonzi, 1995. Simulation des cultures pluviales au Burkina Faso (CPBKF3): sorgho, mil et mais. AB-DLO Nota 18. 53 pp. + annexes.

Source code available: Yes: printed.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: The model has been developed in Burkina Faso by ASMVS (Appui au Service de Suivi de la Mise en Valeur des Sols). ASMVS is the co-operation between AB-DLO in The Netherlands, BUNASOL (Bureau National des Sols) and INERA (Institut d'Etudes et de Recherches Agricoles) in Burkina Faso and financed by DGIS (Directoraat Generaal Internationale Samenwerking), The Netherlands.

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GENERAL OVERVIEW

Name and version: CPIDS 1.0

Title: Crop Parameter Intelligent Database System.

Date first profile: November 28th, 1995.

Date last profile: November 28th, 1995.

Update: July, 1994.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, and environmental science.

Aggregation level: Crop/herd.

Description: CPIDS is a Microsoft Windows based program which allows users to access a large database of published information as well as unpublished data on crop growth. CPIDS assists users in developing input plant growth data parameter files for the WEPP* and RUSLE* models, and may also assist users parameterizing other models, such as RWEQ and WEPS*, which contain crop growth components.

TECHNICAL SPECIFICATIONS

Hardware: IBM or compatible PC.

Other software required: DOS 5.0 or greater; Windows 3.1.

Technical reference:

Deer-Ascough, L., G.A. Weesies, J.C. Ascough II & J.M. Laflen, 1995. Plant parameter database for erosion prediction models. Applied Engineering in Agriculture 11 (5): 659-666

Source code available: Not currently.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: CPIDS 1.0 can currently be obtained via anonymous FTP connection to the USDA-ARS NSERL file server 'soils.ecn.purdue.edu', or through connection to our World-Wide-Web location: 'http://soils.ecn.purdue.edu:20002/~wepp/nserl.html'. Future works on CPIDS will be conducted by USDA-NRCS, Baton Rouge, LA, United States.

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GENERAL OVERVIEW

Name and version: CRAMBE

Title: CRAMBE.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: This model is based on the proportionality between the light interception of crops and their growth rate under favourable conditions. The parameters used are based on a field trial in 1991 under non-limiting conditions (Kreuze et al., 1995). The model has been used to analyze the results from field trials in 1993 and 1994 and to compare rapeseed and Crambe in their ability to produce erucic acid.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

Number of rate variables: 0.

State variables: Dry matter crop, seed and erucic acid, intercepted photosynthetic active radiation.

Number of state variables: 8.

Input data: Weather, initial states, plant parameters, field parameters.

Number of input data: 20.

Output data: Weather, plant- and field parameters, dry matter production crop, seed and erucic acid.

Number of output data: 30.

Time interval of simulation: Day.

Basic spatial unit: Hectare.

References general validation:

Mathijssen, E.W.J.M. & W.J.M. Meijer, 1995. Ontwikkeling en toepassing van een gewasgroeimodel voor Crambe. Rapport AB-DLO no. 38. DLO-Instituut voor Agrobiologisch en Bodemvruchtbaarheidsonderzoek (AB-DLO). Wageningen, Nederland. 28 pp.

Kreuzer, A.D.H., E.W.J.M. Mathijssen & W. Meijer, 1995. Gewasgroei en zaadvorming van Crambe. Experimenteel Onderzoek 1990-1993. Rapport AB-DLO no. 46. DLO-Instituut voor Agrobiologisch en Bodemvruchtbaarheidsonderzoek (AB-DLO). Wageningen, Nederland. 34 pp.

Stand alone model: Yes.

Parentage: LINTUL*.

TECHNICAL SPECIFICATIONS

Hardware: PC 286.

Programming language: FSE* 2.0.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

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GENERAL OVERVIEW

Name and version: CROP ECOLOGY

Title: Crop Growth Simulation.

Date first profile: September, 1994.

Date last profile: October, 1995.

Update: August, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for TEACHING: 1

Subject: Crop science.

Description: CROP ECOLOGY is a specifically for educational purposes developed version of the SUCROS* crop growth model. It calculates canopy photosynthesis and crop growth and development of several crops. It uses crop physiological and ecological processes as function of environmental (soil and climate) and plant conditions. Through an interface the user supplies the following input: (1) production level: (1) potential production (growth and development determined by radiation, temperature and crop characteristics) or (2) water-limited production (growth and development determined by radiation, temperature, water availability, crop evapotranspiration and crop characteristics); (2) crop: spring wheat, winter wheat, maize (early, late and tropical cultivar), potato (early and late cultivar), sugarbeet, oil-seed rape, soybean, rice (different numbers of days in seedbed before transplanting), tulip or faba bean; (3) weather data: standard data for Finland, India, Israel, Italy, Kenya, The Netherlands or Philippines, or alternative data; (4) soil (only for production level 2): coarse sand, fine sand, loam, sandy clay loam, clay loam, light clay, heavy clay or peat; (5) a shift of the radiation profile; (6) a shift of the temperature profile; (7) irrigations of 25 mm each on specified days (only for production level 2); (8) maximum gross CO₂ assimilation rate; (9) initial light use efficiency; (10) maximum rooting depth (only for production level 2); (11) Q₁₀; (12) maintenance coefficients; (13) conversion factor of storage organs; (14) extinction coefficient; (15) plant density; and (16) day of emergence. The user can obtain tabular and graphical output for different output variables.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Above ground: development rate, leaf and canopy photosynthesis (gross and net), maintenance and growth respiration, organ growth, evaporation, transpiration; Below ground: root extension.

Number of rate variables: > 50.

State variables: Above ground: organ weight, leaf area index, development stage, absorbed radiation; Below ground: rooting depth.

Number of state variables: 50.

Input data: Plant and soil characteristics, latitude, daily irradiance, minimum and maximum temperature, precipitation, vapour pressure and wind speed.

Number of input data: 50.

Output data: Irradiance, absorbed radiation, total weight, storage organ weight, precipitation, potential and actual evapotranspiration, CO₂ assimilation, maintenance respiration, leaf area index, growth rate, growth rate storage organ, temperature, rooting depth, development stage.

Number of output data: 15.

Time interval of simulation: 1 day.

Basic spatial unit: Typically 1 km².

Stand alone model: Yes.

Parentage: SUCROS*.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC, internal memory 512 Kb or more, MS-DOS 3.2 or more.

Programming language: TenCore.

Other software required: No.

User's guide available:

Courseware Midden Nederland b.v., 1993. Crop Ecology - Crop Growth Simulation. Utrecht, Courseware Midden Nederland b.v. 31 pp.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: 1000 ECU, exclusive VAT.

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GENERAL OVERVIEW

Name and version: CropSyst 3.0

Title: Cropping Systems Modeling Framework.

Date first profile: January, 1995.

Date last profile: December 30th, 1995.

Update: January, 1996.

Program type: Other: expandable simulation framework with at present several models included.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, and soil science.

Aggregation level: Cropping system/animal husbandry system.

Description: CropSyst was originally written to facilitate the simulation of crop yield and soil erosion as a function of climate, soil, crop rotation and soil tillage system in the Pacific Northwest of the United States. It has since been expanded to include other processes as well and the framework has been developed into a general cropping systems modeling framework. We used object-orientation to create both the models and a simulation environment that allows: 1. incremental model building without rewriting existing code, 2. simultaneous maintenance of more than one model of any component, 3. interchanging of component models within and between system models, and 4. construction of a user-friendly interface from which all parameters can be assigned and all models run. CropSyst 3.0 has several new features. Communication between component models now takes place via messages with the help of a central mechanism. The messaging system allows for extremely flexible coupling of components and allows all inputs and outputs to be range-checked in one place. CropSyst 3.0 is integrated with a database which contains both experiment data (some of which may be inputs for simulation runs) and simulation outputs. Simulation models written in other languages can be run under CropSyst by compiling them into a DLL and "wrapping" them in a CropSyst object. CropSyst 3.0 is written in Borlands Delphi and takes advantage of that languages exception handling, database connectivity components, and application building features; it runs under Windows 3.1 and Windows 95.

State variables: Crop: above-ground dry matter, below-ground dry matter, grain dry matter. leaf area index, thermal time from sowing. Crop residue: residue on the soil surface, water content of surface residue, residue buried less than 10 cm deep. Soil: volumetric water content in each layer (layers are typically 20 cm thick). Sowing: running average of air temperature. Crop rotation: for each crop in the rotation: identification of model and parameter set for crop, tillage system and sowing. Field operation: fraction of surface residue buried, fraction fo shallowly buried residue that is buried deeply, change in surface roughness. Soil tillage: identification of date, model and parameter set for each field operation comprised in the tillage system.

Input data: Crop: base temperature and thermal timefor each phenological period, radiation use efficiency, dry matter-water ratio, maximum rooting depth, leaf area at emergence, relative growth rate of leaf area, life span of leaves, fraction ofdry matter transferred to grain at flowering. Crop residue: maximum water holding capacity. Soil: characteristic water contents. Sowing: seed rate, thousand-kernel weight, either date of planting or minimum running average temperature required to allow sowing. Crop rotation: see above, plus a pointer to the next crop. Field operation: see above. Soil tillage: see above, plus a pointer to the next field operation.

Time interval of simulation: 1 day.

Basic spatial unit: m².

References general validation:

Yan, Y., 1989. A model for predicting soil loss ratio and crop production in Eastern Washington. M.Sc. Thesis, Washington State University, Pullman, WA, USA.

Evert, F.K. van, 1992. Modeling agricultural systems with CropSyst. PhD thesis, Washington State University, Pullman, WA, USA.

Stand alone model: Yes.

Parentage: Soil water balance: Campbell, G.S. & R. Diaz, 1988. Simplified soil water balance models to predict crop transpiration. In: Bidinger, F.R. & C. Johansen (Eds.). Drought research priorities for the dryland tropics. ICRISAT, Patancheru, Andhra Pradesh, India, 15-26 Crop growth and development: Campbell, G.S. & R. Diaz, 1988. Op.Cit. Field operation: McCool, D.K. Washington State University, personal communication. Crop residue decomposition: Strook, H.F., K.L. Bristow, L.F. Elliott, R.I. Papendick & G.S. Campbell, 1989. Predicting rates of wheat residue decomposition. Soil Scie.Soc.Am.J. 35: 91-99 Soil loss: McCool, D.K. Washington State University, personal communication, and Soil Conservation Service, 1972. National Engineering Handbook. USDA-SCS, Washington, D.C.

Check internal consistency or material balance present: Yes, in component models.

Input check in model: Yes, the framework does range checking on all messages that are exchanged between component models.

TECHNICAL SPECIFICATIONS

Hardware: IBM-PC or compatible under MS Windows 3.1 or MS Windows 95.

Programming language: Borland Delphi 1.0.

Other software required: No.

Application reports:

Evert, F.K. van, 1992. Modeling agricultural systems with CropSyst. PhD thesis, Washington State University, Pullman, WA, USA.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: Finalizing work is being done on components: aphid population dynamics, pesticide movement in soil. Papers in preparation: - Evert, F.K. van, Y. Ying, F. Young & G.S. Campbell. Managing crop yield and soil loss with a simulation model. - Evert, F.K. van, B.G. McConkey, A.E. Grable & G.S. Campbell. Simulation of crop damage by the Russian wheat aphid and the fate of insecticide residues in the environment.

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GENERAL OVERVIEW

Name and version: CSYMBA 1.0

Title: Cropping Systems Model Building Assistant.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: June, 1995.

Program type: Modelling environment.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 2

New release expected: Yes, June 1996.

Subject: Standardization of process submodels, system models development.

Aggregation level: Cropping system/animal husbandry system.

Description: CSYMBA is an integrated software package to implement, update, and validate modular cropping system simulation models. Re-usable submodels for process simulation can be added to the system by writing Visual BASIC subroutines. System models can be built by selecting submodels and inserting them in a daily/hourly/semihourly loop. The system models can be exported as standalone programs. CSYMBA maintains three databases: The input database contains model input parameters. Modellers may define new input parameters as needed. - The knowledge base consists of submodels for process simulation, user defined functions and state/rate variables. Submodels can be exported/imported for sharing with other modellers. Documentation of submodels is an integral part of their implementation facilitating well documented system models. State/rate variables declared by the user are also well documented since the name, description and units must be provided. - The model base is a library of system models. During model building the user is assisted by consistency checks on input/output variables for each selected submodel. The build procedure generates a BASIC program containing the submodels, all the statements required to declare variables, and procedures to read data from the input database and to output data to report files and runtime graphic displays. CSYMBA has utilities to plot data, to validate model simulation results vs. measured data, and to run a sensitivity analysis on system models.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: As defined by models.

Number of rate variables: As defined by models.

State variables: As defined by models.

Number of state variables: As defined by models.

Input data: Location, soil, crop, weather (daily/parameters), and management: each list can be upgraded when new parameters are required to implement a new submodel.

Number of input data: As required by models.

Output data: As defined by models.

Number of output data: As defined by models.

Time interval of simulation: 1 day / 1 hour / 0.5 hour.

Basic spatial unit: Ha.

Stand alone model: Yes.

Parentage: Every model from which submodels are extracted.

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC/AT, 4 Mb RAM, MS-DOS.

Programming language: MicroSoft Visual BASIC for DOS.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: -

COMMENTS: The available version is incomplete and it is released for preliminary testing purposes.

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GENERAL OVERVIEW

Name and version: Cucumber model

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: February, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Crop science.

Aggregation level: Plant/animal.

Description: A simulation model of the greenhouse environment and the growth of cucumbers. Validated against data collected from a cucumber crop cv. 'Sandra'. Used to test economics of carbon dioxide enrichment and closed greenhouses under New Zealand conditions.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Node formation rate, leaf expansion rate, fruit growth, photosynthesis, respiration, dynamic partitioning.

Number of rate variables: 200.

State variables: Nodes, leaf area, fruit size, assimilate pool.

Number of state variables: 100.

Input data: Leaf temperature, direct and diffuse radiation, carbon dioxide concentration, humidity.

Number of input data: 10.

Output data: Fruit harvested, fruit aborted, fruit weight, leaf area, number of nodes.

Number of output data: 15.

Time interval of simulation: 5 Minutes.

Basic spatial unit: M2.

Stand alone model: No.

Parentage: The cucumber model is based on several sources. Plant development and leaf growth are modelled according to the allometric template developed by Horie (Horie, et al., 1979).

Photosynthetic active radiation interception is based on Campbell (1990) with a few twists on my own. Canopy photosynthesis is based on the SUCROS* model (Gijzen & ten Cate, 1988; Spitters, et al., 1989). Dynamic partitioning is based on Schapendonk & Brouwer (1984).

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM PC or compatible 286 or better.

Programming language: ESL, Salford University.

Source code available: No.

Executable available: No.

User contract mandatory: Not applicable.

Costs: Not applicable.

COMMENTS: Plan to port model (including greenhouse model) to Turbo Pascal and extend capabilities to other crops, e.g. tomato and roses.

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GENERAL OVERVIEW

Name and version: Daisy

Title: -

Date first profile: January, 1995.

Date last profile: January, 1995.

Update: No major update since July, 1990.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Crop science, soil science, and environmental science.

Aggregation level: Cropping system/animal husbandry system.

Description: Model for the simulation of soil water and nitrogen dynamics in the crop-soil system. The main modules simulate: 1) water dynamics, including snow accumulation and melting, evaporation from open water surfaces and soil, transpiration and water uptake by plants (based on the single root uptake and root density), infiltration, percolation and soil water dynamics (Richards' equation); 2) soil heat, including freezing and melting and soil temperature; 3) nitrogen dynamics, including turnover of organic matter (based on carbon pools, microbial biomass, and first order kinetics), mineralization/immobilization (a consequence of the carbon turnover), nitrification, denitrification, nitrogen uptake by plants (based on single root uptake and root density), and nitrogen transport (convection-dispersion equation) and leaching; 4) crop growth, i.e. crop development, dry matter production, crop nitrogen demand, crop nitrogen content, photosynthesis, water stress, nitrogen stress, assimilate partitioning, maintenance and growth respiration, leaf area development, root penetration and root density distribution. The model allows for the simulation of different management strategies and crop rotations.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Important rate variables in the soil (arrays): Flux of soil water, flux of ammonium and nitrate, uptake of water, ammonium and nitrate, net mineralization, nitrification and denitrification.

Number of rate variables: > 100.

State variables: Important state variables in the soil (arrays): Water content, water pressure potential, ice content, temperature, organic matter in pools, nitrate concentration, ammonium concentration.

Number of state variables: > 100.

Input data: Soil physical properties (water retention, hydraulic conductivity, thermal conductivity, heat capacity etc.), turnover rate parameters, crop specific parameters, initialization of state variables.

Number of input data: > 100.

Output data: Main state variables.

Number of output data: > 100 (some are arrays).

Time interval of simulation: External 1 day or 1 hour depending on process described (internal shorter time steps).

Basic spatial unit: m² - ha.

References general validation:

Hansen, S., H.E. Jensen & N.E. Nielsen, 1990. Daisy - A Soil Plant Atmosphere System Model. NPo-research from the National Agency of Environmental Protection No. A10. 272 pp.

Hansen, S., H.E. Jensen, N.E. Nielsen & H. Svendsen, 1991. Simulation of nitrobiomass

production, nitrogen uptake and nitrogen leaching by using the Daisy model. In: Soil and Groundwater Research Report II, Nitrate in Soils, Final report of contracts EV4V-0098-NL and EV4V-00107-C, Commission of the European Communities. 300-309

Hansen, S., H.E. Jensen, N.E. Nielsen & H. Svendsen, 1991. Simulation of nitrogen dynamics and biomass production in winter wheat using the Danish simulation model Daisy. Fertilizer Research 27: 245-259

Hansen, S., H.E. Jensen, N.E. Nielsen & H. Svendsen, 1991. Simulation of nitrogen dynamics in the soil plant system using the Danish simulation model Daisy. In: Kienitz, G., P.C.D. Milly, M.Th. van Genuchten, D. Rosbjerg & W.J. Shuttleworth (Ed.). Hydrological Interactions Between Atmosphere, Soil and Vegetation. IAHS Publication No. 204: 185-195

Jensen, C., B. Stougaard & H.S. Ostergaard, 1994. Simulation of water and nitrogen dynamics in farmland areas of Denmark (1989-1993). Soil Use and Management 10: 111-118

Jensen, C., B. Stougaard & P. Olsen, 1994. Simulation of water and nitrogen dynamics at three Danish locations by use of the Daisy model. Acta Agriculturae Scandinavica, Sect B 44: 75-83

Svendsen, H., S. Hansen & H.E. Jensen, 1995. Simulation of crop production, water and nitrogen balances in two German agro-ecosystems using the Daisy model. Accepted in Modelling of Geobiosphere Processes.

Vereecken, H., E.J. Jansen, M.J.D. Hack-ten Broecke, M. Swerts, R. Engelke, S. Fabrewitz & S. Hansen, 1991. Comparison of simulation results of five nitrogen models using different datasets. In: Soil and Groundwater Research Report II, Nitrate in Soils, Final report of contracts EV4V-0098-NL and EV4V-00107-C, Commission of the European Communities. 321-338

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC or Workstation.

Programming language: Microsoft FORTRAN-77.

Other software required: MS-DOS or UNIX.

Application reports:

Jensen, H.E., S. Hansen, B. Stougaard, C. Jensen, K. Holst & H.B. Madsen, 1993. Using GIS-information to translation of soil type patterns to agro-ecosystem management - the Daisy model. In: Eijsackers, H.J.P. & T. Hamers (Eds.). Integrated soil and sediment research: a basis for proper protection. Kluwer Academic Publisher. 401-428

Styczen, M. & B. Storm, 1993. Modelling of N-movement on catchment scale - a tool for analysis and model description. 1. Model description. Fertilizer Research 36: 1-6

Styczen, M. & B. Storm, 1993. Modelling of N-movement on catchment scale - a tool for analysis and model description. 1. A case study. Fertilizer Research 36: 7-17

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

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GENERAL OVERVIEW

Name and version: DanStress

Date first profile: April, 1996.

Date last profile: April, 1996.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

Subject: Crop science.

Aggregation level: Plant/animal, and crop/herd.

Description: DanStress integrates effects of soil crop and climatic conditions. Crop transpiration is calculated by Monteith's combination equation for vapour flow. Crop conductance is scaled up from an empirical stomatal conductance model. Transpirational water loss originates from root water uptake and changes in crop water storage. Pressure volume curves of leaves describe crop water storage and crop water relations. The root zone is separated into layers. Root water uptake is calculated by a single root model combined with a root contact model.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Root hydraulic conductivity, stomatal conductivity, drainage, capillary rise.

Number of rate variables: 4.

State variables: Crop water content, soil water content, structural leaf area, root density.

Number of state variables: 4.

Input data: Rain, humidity, light, wind speed, temperature, pressure volume curves, crop conductance models.

Number of input data: 7.

Output data: Plant water status RWC, transpiration, crop conductance, soil water content.

Number of output data: 4.

Time interval of simulation: 10 minutes.

Basic spatial unit: Field based.

References general validation:

Jensen, C.R., H. Svendsen, M.N. Andersen & R. Losch, 1993. Use of the root contact concept, an empirical leaf conductance model and pressure-volume curves in simulating crop water relations. *Plant and Soil* 149: 1-26

TECHNICAL SPECIFICATIONS

Hardware: PC IBM compatible min. 386.

Programming language: Turbo Pascal version 5.0, Borland.

Other software required: No.

Application reports:

Jensen, C.R., H. Svendsen, M.N. Andersen & R. Losch, 1993. Use of the root contact concept, an empirical leaf conductance model and pressure-volume curves in simulating crop water relations. *Plant and Soil* 149: 1-26

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: DanStress is meant as a mechanistic approach in simulation of crop water relations. Crop water loss is modelled using PV curves and stomatal conductance modelling in relation to crop water potential and micrometeorological conditions (light, temperature, humidity).

CONTACT(S):

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GENERAL OVERVIEW

Name and version: DBS

Title: Delwag-Bloom II-Switch.

Date first profile: Version III.

Date last profile: Version III.

Update: October 1996.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science.

Aggregation level: Other: lake, network, river etc.

Description: Water quality model, includes phytoplankton species model, light attenuation model, sediment-water exchange module. Physical, chemical and biological processes. Multi segment applications, transport framework, phosphorus species, nitrogen, silicium, and carbon, BOD zooplankton.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Consult author.

Number of rate variables: Consult author.

State variables: Consult author.

Number of state variables: Consult author.

Input data: Consult author.

Number of input data: Consult author.

Output data: Consult author.

Number of output data: Consult author.

Time interval of simulation: Week - decades.

Basic spatial unit: m³.

References general validation:

Los, F.J., M.T. Villars & M.R.L. Ouboter, 1992. Model validation study, DBS in networks. Research report T 12110. Delft Hydraulics, The Netherlands.

Stand alone model: Yes.

Parentage: Delwag, Bloom II*, Switch, Uitzicht.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN-77.

User's guide available:

Los, F.J., 1992. Proces form. DBS. Research report T 542. Delft Hydraulics, The Netherlands.

Technical reference:

Vat, M. van der, 1992. DBS versie 4.10. System Document. Delft Hydraulics, The Netherlands.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Consult author.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: DNDC

Title: DeNitrification - DeComposition.

Date first profile: April, 1995.

Date last profile: April, 1995.

Update: April, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, soil science, environmental science, farming systems, and land use studies.

Aggregation level: Cropping system.

Description: DNDC is a process-oriented simulation model of soil C and N biogeochemistry. The model contains 4 interacting submodels: soil climate, crop growth, decomposition, and denitrification. The soil climate submodel uses soil texture, air temperature, and precipitation data to calculate soil temperature and moisture profiles and soil water fluxes through time. The crop submodel simulates N-uptake and crop biomass growth. The decomposition submodel calculates daily decomposition, nitrification, ammonia volatilization processes, and CO₂ production. The denitrification submodel calculates hourly denitrification processes and N₂O and N₂ production during wet periods. Effects of tillage, fertilization, manure amendment, and irrigation are incorporated into the model.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Soil climate profile, evapotranspiration, infiltration, decomposition, denitrification, crop growth, trace gas emissions, leaching.

Number of rate variables: > 100.

State variables: Soil temperature, soil moisture, decomposition rates, denitrification rates, gas diffusion, N-uptake, cropping practices.

Number of state variables: > 400.

Input data: Air temperature, precipitation, soil texture, bulk density, pH, soil organic carbon, tillage, fertilization, irrigation, manuring.

Number of input data: > 40.

Output data: Daily or annual soil C/N pools, fluxes of CO₂, N₂O, NO, N₂, NH₃, crop yield, N leaching, water budget.

Number of output data: > 50.

Time interval of simulation: Hour or day.

Basic spatial unit: Ha.

References general validation:

Li, C. et al., 1992. A model of N₂O evolution from soil driven by rainfall events. JGR, 91: 9111-9183

Li, et al., 1994. Modeling carbon biogeochemistry in agricultural soils. Global Biogeochemical Cycles 8: 237-254

Li, et al., 1994. Modeling N₂O emissions from agriculture: A Florida case study. Chemosphere 28: 1401-1415

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC with speed higher than 50 Mhz.

Programming language: Quick Basic.

Other software required: None.

Application reports:

Li, C., 1995. Modeling impact of agricultural practices on soil C and N₂O emissions. In: Lai, R. et al. (Eds.), Soil Management and Greenhouse Effect 1. Lewis Publishers, London.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: DUR-PCN

Title: DURability of Resistance to Potato Cyst Nematodes.

Date first profile: November 1st, 1995.

Date last profile: November 1st, 1995.

Update: November 1st, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop protection.

Aggregation level: Plant/animal.

Description: The rate of selection to virulence of potato cyst nematodes is simulated. Effects of number of resistance genes, level of resistance and alternation of different potato cultivars on durability of resistance is simulated.

State variables: Frequency of virulence genes, number of nematodes per cm³, genotypes of males and females of the nematodes, virulence of the population.

Number of state variables: 25.

Input data: Number of resistance genes of the host. Initial frequency of virulence genes. Level of resistance per resistance gene to virulent nematodes and to avirulent nematodes.

Number of input data: 12.

Output data: Virulence of the population in the course of time.

Number of output data: 1.

Time interval of simulation: 1 Year.

Basic spatial unit: 1 focus (m²).

Stand alone model: Yes.

Parentage: Spitters, C.J.T. & S.A. Ward, 1988. Euphytica S: 87-98.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC, DOS.

Programming language: Turbo Pascal.

Other software required: -

Application reports:

Schouten, H.J., 1993. Netherlands Journal of Plant Pathology 99 Suppl. 3: 191-200

Schouten, H.J., 1994. Phytopathology 84: 771-773

Schouten, H.J., 1994. Prophyta 48, nr. 2: 26-27

Source code available: No.

Executable available: No.

User contract mandatory: Yes.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: Dynamics of partial anaerobiosis, denitrification and water in soil

Title: -

Date first profile: July, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: Yes, end of 1996.

Subject: Soil science: microbiology.

Description: The model (DENLEFWAT) gives a detailed description of the processes of respiration and denitrification as affected by and as affecting the surroundings in an individual soil aggregate. The model comprises four submodels: i) biological respiration and denitrification, ii) water transport including a description to account for hysteresis, iii) solute transport, and iv) gas transport including a new description to simulate the integral soil atmosphere. The submodels were experimentally tested to a large extent. The denitrification module has been used by Li, Frohling and Frohling (1992, Journal of Geophysical Research 97: 9759-) to study nitrous oxide evolution from field soils.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Dynamics of the rate variables mentioned in 'State variables'.

Number of rate variables: 18, excluding the spatial subdivision of these state variables. Including the spatial subdivision about 225.

State variables: Soil water, gas mixtures (e.g. oxygen, carbon dioxide, nitrous oxide, molecular nitrogen), microbial biomass (strict aerobes and denitrifiers), (simple) organic matter.

Number of state variables: See 'Number of state variables'.

Input data: Soil water characteristics, initial gas pressures, microbiological data like yield coefficients, maintenance coefficients, relative growth rates, initial biomasses, Michaelis-Menten kinetical data, gas data to calculate binary diffusion coefficients.

Number of input data: About 60.

Output data: A great number of output data files is produced. These may be inspected on the screen and selections may be printed. Output concerns all the state variables and most of the rate variables.

Number of output data: 11 files are produced.

Time interval of simulation: The maximum time step amounts to 5 seconds, and is strongly dependent on the spatial resolution and the non-linearity of the problem (for 5 seconds maximum time step the spatial co-ordinate is 2 to 5 millimetre).

Basic spatial unit: A soil aggregate is simulated.

References general validation:

Leffelaar, P.A., 1986. Dynamics of partial anaerobiosis, denitrification, and water in a soil aggregate: experimental. Soil Science 142: 352-366

Leffelaar, P.A. & W.W. Wessel, 1988. Denitrification in a homogeneous, closed system: experiment and simulation. Soil Science 146: 335-349

Leffelaar, P.A., 1988. Dynamics of partial anaerobiosis, denitrification, and water in a soil aggregate: simulation. Soil Science 146: 427-444

Stand alone model: Yes.

Parentage: Program(s) developed by P.A. Leffelaar, W.W. Wessel and a number of students.
Check internal consistency or material balance present: Yes, with respect to N, C, and water.
Input check in model: Units are given in the initial section for each variable to minimize erroneous inputs in the model.

TECHNICAL SPECIFICATIONS

Hardware: VAX, PC.

Programming language: CSMP* 5% /(standard) Microsoft FORTRAN 95%

Other software required: CSMP* (VAX) or PCSMP*, and FORTRAN plus the IMSL library.

Technical reference:

A number of student reports are available about preliminary versions of the denitrification module and the water module.

Source code available: Yes.

Executable available: Source code should be compiled on your machine.

User contract mandatory: No.

Costs: None.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: DYNAMITE

Title: Dynamics of Nutrients And Moisture In Tropical Ecosystems.

Date first profile: November 20th, 1994.

Date last profile: November 20th, 1994.

Update: November 20th, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Plant nutrition, soil science, nutrient cycling, and forestry.

Description: The model simulates nutrient and moisture cycling in tropical forests. The rationale behind the model is that the availability of nutrients (N, P, K) and water is limiting the growth. The model keeps track of the vegetation, litter pools, organic pools and soil solution. The moisture cycling submodel is an adapted box model derived from ILWAS. The nutrient uptake and growth by the vegetation is calculated as a function of the quantities of available nutrients in the soil solution and nutrient concentrations in the vegetation compartments (leaf, wood, fine roots and coarse roots). Litter fall is simulated as a first order process dependent on nutrient concentration or the age of the vegetation. Dissimilation and transfer of organic pools are calculated using relative decomposition rates that decrease in course of time. The objective purpose of the model is to study the effects of soil fertility, nutrient cycling, and climate variables on the growth of forest vegetation and secondary fallow vegetation. The ultimate goal is to predict the effects of different management scenarios in forested areas.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Uptake, growth, litter production, nutrient transfer between the different pools, mineralization, immobilization, decomposition, leaching.

Number of rate variables: > 100.

State variables: Nutrient contents and dry matter in vegetation compartments, litter pools and organic pools of N, P, K and dry matter; nutrient contents in inorganic soil pools.

Number of state variables: > 60.

Input data: Rainfall, initial state, intrinsic system parameters like minimum and maximum nutrient concentrations, decomposability of organic pools, etc.

Number of input data: 240.

Output data: State variable and rate variables after regular intervals. The output can be viewed with a hypertext browser.

Number of output data: 160 times the number of logged intervals.

References general validation:

Eikelboom, K.G. & B.H. Janssen, 1994. The program of the model. Dynamite: DYNAMICS of Nutrients And Moisture In Tropical Ecosystems. Tropenbos document. (In Press).

Noij, I.G.A.M., B.H. Janssen, L.G. Wesselink & J.J.M. van Grinsven, 1993. Modeling Nutrient and Moisture Cycling in Tropical Forests. Tropenbos Series 4, The Tropenbos Foundation, Wageningen. 195 pp.

Stand alone model: Yes.

Parentage: NUTCYC, MINIP and ILWAS.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: 386 DX IBM compatible.

Programming language: Turbo Pascal 6.0 from Borland (inclusive Turbo vision).

Other software required: Hyplus hypertext reader (included).

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Info at The Tropenbos Foundation.

Costs: Info at The Tropenbos Foundation.

COMMENTS: The model **DYNAMITE** was developed by the Dept. of Soil Science and Plant Nutrition of the Wageningen Agricultural University by order of the Tropenbos Foundation, Wageningen.

GENERAL OVERVIEW

Name and version: ECOLUMN BLOOM II

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Environmental science.

Aggregation level: Other, water column.

Description: Chemical and biological processes. Nutrient dynamics and phytoplankton species succession zooplankton grazing. 2-Dimensional vertical water column model. The model is used to zoom in on locations of interest and its boundary conditions are derived from a more general model (2-dimensional horizontal) such as Delwag-Dynamo and NZSTRAT (stratification model).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Consult author.

Number of rate variables: Consult author.

State variables: Species composition, nutrients.

Number of state variables: Consult author.

Input data: Consult author.

Number of input data: Consult author.

Output data: Consult author.

Number of output data: Consult author.

Time interval of simulation: Week - decades.

Basic spatial unit: m³.

Stand alone model: No.

Parentage: GREWAQ, BLOOM II*.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN-77.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Consult author.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: ECOSAT 4.0

Title: Equilibrium Calculation Of Speciation And Transport.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: October, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Soil science, and environmental science.

Aggregation level: Other: soils.

Description: ECOSAT calculates the chemical equilibrium composition of soil-water systems in dependency of speciation (including heterogenic sorption models), slow reaction kinetics (mass transfer and biodegradation) and 1-dimensional multi-component transport in water or gas phase. The program includes databases for model parameters. Applications: simulation of soil column leaching; in situ bioventing.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: For all components in the system: transport, slow mass transfer and biodegradation.

Number of rate variables: -

State variables: Total amount of components.

Number of state variables: About 100.

Input data: Components, total amount of concentration, soil characteristics (flow type and flux, model parameters from database, species, gasses, minerals, organic liquids).

Number of input data: Variable.

Output data: Components, total amount of concentration or activity, species concentrations, etc.

Number of output data: Many. Output manager available.

Time interval of simulation: -

Basic spatial unit: 1 litre water or soil solution.

Stand alone model: Yes.

Parentage: MINEQL.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: 386 or more. 2 Mb extended memory.

Programming language: Pascal and C++.

Other software required: DOS.

User's guide available:

Keizer, M.G., 1991. ECOSAT: a computer program for the calculation of speciation in soil-water systems. Wageningen Agricultural University, Wageningen, Department of Soil Science and Plant Nutrition.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes

Costs: Dfl. 2500,- ex Sales Tax.

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GENERAL OVERVIEW

Name and version: ECOZONE

Title: A knowledge based system for training about the environmental impacts of agricultural development projects.

Date first profile: November 1995.

Date last profile: November 1995.

Update: June 1992.

Program type: Knowledge based system.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

New release expected: Yes, October 1996.

Aggregation level: Other: global - split into regions.

Description: A knowledge-based system has been developed to help a multilateral agency train natural resource planners to be more aware of the full environmental impacts of agricultural development projects. This system, ECOZONE, has been used successfully in training, but its generic nature limits its ability to capture the true complexity of any given development project. As such its use in training is constrained. In order to enhance the utility of training sessions several specific case studies have been developed which utilize the ECOZONE framework in order to provide a more in depth representation of the impacts associated with a given development project.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: Toolbook.

Other software required: Windows.

Technical reference:

Edwards-Jones, G. & M. Gough, March 1994. ECOZONE: a computerised knowledge management system for sensitising planners to the environmental impacts of development projects. Project Appraisal, volume 9, number 1. Beech Tree Publishing, 10 Watford Close, Guildford, Surrey GU1 2EP, England. 37-45

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: EMB-RUBBER 1.1

Date first profile: November, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 2

New release expected: -

Subject: Crop science, forestry, farming systems, and agricultural economics.

Description: Rubber model for potential and water limited conditions. It consists of a carbon and water balance and simulates the dry matter accumulation, the girth of the trees and the rubber yield, among other variables. The photosynthesis process is calculated based on the light response curve of the leaves, the light distribution within the canopy and the amount of radiation intercepted by the canopy. Maintenance respiration is simulated according to the amount of dry matter and to the protein and mineral content of each plant organ. Partition of assimilates is distributed to the plant parts in function of their growth rate and energy content. Growth rate of rubber pool is preferential over other plant parts and is calculated in a specific section of the model. Simulation of rubber biosynthesis and accumulation in the bark is sink and source limited. The maximum size of the sink (rubber pool) is set as a fraction of the weight of stems. The tapping frequency is depicted by an impulse function. The daily rubber yield is a function of the girth size and the latex flow parameters. EMB-RUBBER can be used for experimental studies and for extrapolation purposes.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Phenological development, leaf and canopy photosynthesis, maintenance and growth respiration, crop growth, growth of plant organs, growth rate of rubber pool, transpiration (and others).

Number of rate variables: > 60.

State variables: Biomass (total and per crop organ e.g. leaf, stem, trunk, roots), leaf area index, rubber yield (and others).

Number of state variables: > 30.

Input data: Geographical latitude and longitude, weather data (daily rainfall, monthly sunshine hours, relative humidity, minimum and maximum temperature, wind speed), crop physiological and morphological properties, physical soil properties, crop management information.

Number of input data: 45.

Output data: Crop rate and state variable (e.g. biomass, leaf area index, number of trees, rubber yield).

Number of output data: 10.

Time interval of simulation: 1 day.

Basic spatial unit: m² and ha.

References general validation:

Bernardes et al., 1994. Evaluation of the 'EMB-RUBBER' model for estimating growth and yield. Proceedings 3rd ESA Congress, Abano-Padova, 1994. 314-315

Castro, A.M.G, 1988. A systems approach to determining priorities for natural rubber research in Brazil. PhD thesis. Reading, University of Reading. 294 pp.

Stand alone model: -

Parentage: SUCROS*, FORGRO*, and BACROS*.

Check internal consistency or material balance present: Yes, water balance and carbon balance.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC/AT >= 640 Kb RAM.

Programming language: PCMP/CSMP* (IBM).

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: In the near future a new version in FSE* will be available.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: EMIR

Title: Economic Module for Investment Ranking.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: October, 1995.

Program type: Simulation tool, and optimization model.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Description: EMIR is meant for use in economic: - evaluation of projects, - scheduling of projects. EMIR is composed of the following components: - database of projects costs and benefits, - scheduling component (by hand or using optimization).

Time interval of simulation: Years.

References general validation:

Waterloopkundig Laboratorium, december 1994. Economische module, verkennende studie. (in Dutch).

Stand alone model: Yes.

Parentage: Functionality of the INVEST model is included.

SCIENTIFIC SPECIFICATIONS FOR OPTIMIZATION MODELS

Type of variables/activities: Start year of projects (integer).

Type of constraints: Budget constraints, capacity constraints, demand curve constraints.

Number of constraints: Up to the user.

Type of objective functions: Cost minimization or maximization of net benefits.

Number of objective functions: 1, using penalty coefficients for soft constraints.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: Uniface; Microsoft FORTRAN.

Source code available: No.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: EPIC

Title: Erosion Productivity Impact Calculator. Environmental Policy Integrated Climate.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Purpose: Model examines the long-term effects of various components of soil erosion on crop production.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

Subject: Crop science, soil science, and environmental science: non-point source pollution.

Aggregation level: Farm, and other (field).

Description: EPIC is a mechanistic, simulation model used to examine long-term effects of various components of soil erosion on crop production (Williams et al., 1983). EPIC is a public domain model that has been used to examine the effects of soil erosion on crop production in over 60 different countries in Asia, South America and Europe. The model has several components: - soil erosion, - economic, - hydrologic, - weather, - nutrient, - plant growth dynamics and - crop management. Much of model required input, such as soil, and weather data are provided with the model. Daily weather data can used or daily weather can be generated from monthly statistical inputs. The model also requires management information that can be input from a text file. Currently, there are many management files that exist for EPIC and an effort is underway to catalogue these files and provide them to users. The model provides output on crop yields, economics of fertilizer use and crop values. Model components: (1) Examine long-term effects of soil erosion on crop production. (2) Nutrient and chemical movement with water and soil under alternative crop production systems. (3) Examine effects of changes in CO₂ and other climate variables on crop production, hydrology and environmental variables. (4) Examine sustainable agricultural systems. This model has been developed for a number of crop species including wheat and has been re-calibrated for conditions in south-west France (Charpentreau et al., 1986). Subsequent development has been for crops other than wheat (Cabelguenne et al., 1986). Biomass is incremented daily in response to soil, weather and management. A major weakness for operation at an EC scale appears to be that calibration is necessary for individual pedo-climatic zones. Management features: Drainage, irrigation, water yield, erosion control, weather, fertilizer/lime applications, pest control, planting dates, tillage and crop residue management. Keywords: soil erosion, crop production, hydrology, soil temperature. Global change implications: EPIC has been used widely for the study of global change. The most noteworthy example is the MINK (Missouri-Iowa-Nebraska-Kansas) study conducted by Rosenberg and Crosson (Rosenberg and Crosson, 1991). This study examined the effects of elevated CO₂ (EPIC had to be modified to incorporate sensitivity to CO₂) and temperature on crop yields, soil erosion and economics in this four state region. The MINK study also provides general insights about the use of models for global change research.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Processes involved in erosion, applicable to a wide range of soils, climates, and crops.

State variables: Rotation, crop, fertilizer, irrigation, pesticides, tillage.

Number of state variables: Yes.

Input data: The model required input includes soil series, size of field, slope, and weather data, although the model can generate the necessary weather parameters. The model also requires

management information that can be input from a text file. Currently, there are many management files that exist for EPIC and an effort is underway to catalogue these files and provide them to users.

Output data: The model provides output on crop yields, economics of fertilizer use, crop values, nutrient and pesticide movement and erosion and sediment yield.

Time interval of simulation: 1 day. Temporal scale: Annual / seasonal.

Basic spatial unit: Farm / field.

References general validation:

Bryant, K.J., V.W. Benson, J.R. Kiniry, J.R. Williams & R.D. Lacewell, 1992. Simulating corn yield response to irrigation timings: validation of the EPIC model. *J.Prod.Agric* 5: 237-242

Cabelguenne M., C. A. Jones, J.R. Marty, P.T. Dyke & J.R. Williams, 1990. Calibration and validation of EPIC for crop rotations in southern France. *Agricultural Systems* 33: 153-171

Williams, J.R., P.T. Dyke, W.W. Fuchs, V.W. Benson, O.W. Rice & E.D. Taylor, 1990. EPIC - Erosion/Productivity Impact Calculator. 2. User Manual. U.S. Department of Agriculture Technical Bulletin No. 1768. 127 pp.

Stand alone model: Yes.

Parentage: CREAMS, and GLEAMS.

TECHNICAL SPECIFICATIONS

Hardware: 640K, about 3 megabytes.

Programming language: Microsoft FORTRAN.

Other software required: UTIL.

User's guide available:

Anonymous. Installing and running the EPIC model on an IBM-PC or compatible, 11-21-90.

Williams, J.R., P.T. Dyke, W.W. Fuchs, V.W. Benson, O.W. Rice & E.D. Taylor, 1990. EPIC - Erosion/Productivity Impact Calculator. 2. User Manual. U.S. Department of Agriculture Technical Bulletin No. 1768. 127 pp.

Technical reference:

Sharpley, A.N., & J.R. Williams (Eds.), 1990. EPIC - Erosion/Productivity Impact Calculator. 1. Model Documentation. U.S. Department of Agriculture Technical Bulletin No. 1768. 235 pp.

Williams, J.R., P.T. Dyke & C.A. Jones, 1983. EPIC: a model for assessing the effects of erosion on soil productivity. In: Laurenroth, W.K. et al. (Eds.). *Analysis of Ecological Systems: State-of-the-Art in Ecological Modeling*. Elsevier, Amsterdam. 553-572

Application reports:

Rosenberg, N.J. & P.R. Crosson, 1992. The MINK project: a methodology for identifying regional influences of, and response to, increasing atmospheric CO₂ and climate change. *Environmental Conservation* 18: 313-322

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None

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GENERAL OVERVIEW

Name and version: ERHYM - II

Title: Elakala Rangeland Hydrology and Yield Model.

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Soil science: hydrology, range science.

Aggregation level: Other: rangeland site (homogeneous soil and vegetation).

Description: ERHYM - II is a deterministic simulation model which simulates daily water-balance and calculates annual yield indices based on the ratio of actual to potential transpiration. The model runs on a daily time step with daily inputs of maximum and minimum air temperatures and solar radiation. Water added to the soil profile is the difference between precipitation and runoff. Potential evapotranspiration is calculated by the Jensen-Haise method. Actual soil and plant evaporation are based on potential evapotranspiration, soil water content, average site yield, and a relative growth curve. The model calculates daily values of potential and actual soil and plant evaporation from each soil layer, daily soil water contents, and cumulative actual and potential transpiration.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evaporation, transpiration, soil water dynamics, plant growth.

Number of rate variables: < 20.

State variables: Soil water, bulk density, root factor, average site yield.

Number of state variables: < 40.

Input data: Input data include daily precipitation, maximum and minimum air temperatures and solar radiation, field capacity and permanent wilting water contents for each soil layer, initial soil water content, average site herbage yield at peak standing crop, and dates for start of growing season, peak standing crop, and end of growing season.

Number of input data: < 40.

Output data: The model calculates daily values of potential and actual soil and plant evaporation from each soil layer, daily soil water contents, and cumulative actual and potential transpiration.

Number of output data: < 20.

Time interval of simulation: The model runs on a daily time step.

Basic spatial unit: The spatial scale is range site specific.

Stand alone model: Yes.

Parentage: CREAMS, EPIC*, and SPUR.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: The model runs on a PC in a DOS environment.

Programming language: The model is programmed in BASIC.

User's guide available:

Wight, J.R., 1987. ERHYM-II: Model description and user guide for the BASIC version. U.S.

Department of Agriculture ARS No. 59.

Technical reference:

Wight, J.R., 1987. ERHYM-II: Model description and user guide for the BASIC version. U.S. Department of Agriculture ARS No. 59.

Wight, J.R. & R.J. Hanks, 1981. A water-balance, climate model for range forage production. Journal of Range Management 34: 307-311

Wight, J.R. & E.L. Neff, 1983. Soil-vegetation-hydrology studies. Volume II. A User Manual for ERHYM: The Elakala Rangeland Hydrology and Yield Model. USDA-ARS, Agricultural Research Results AR-W-29.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: ETPOT 1.0

Title: Module for the calculation of potential transpiration and evaporation.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: March, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop science, and soil science.

Description: Calculation of Penman reference value for potential evapotranspiration of a reference crop and open water (mostly from formulation as given in Van Laar et al., 1992). Calculation of potential transpiration of a true crop (with a soil or a water layer background).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Radiation, wind speed, potential (evapo-)transpiration.

Number of rate variables: 13.

State variables: Relative soil water content in first soil layer, volumetric water content at saturation in first soil layer, total area index (leaves and stems), daily average temperature, daily actual vapour pressure.

Number of state variables: 5.

Input data: Relative soil water content in first layer, volumetric water content at saturation in first soil layer, total area index (leaves and stems), daily average temperature, solar radiation, extraterrestrial radiation, actual vapour pressure, average wind speed.

Number of input data: 8.

Output data: Potential (evapo-)transpiration (due to radiation) of a crop with a water layer, with a soil background, of open water layer, potential evaporation of water layer below a crop, potential transpiration of soil below crop, potential evapotranspiration due to drying power of the air; reference crop or open water layer.

Number of output data: 10.

Time interval of simulation: 1 day.

Basic spatial unit: 1 m².

References general validation:

Bouman, B.A.M., 1993. ORYZA_W, Rice growth model for irrigated and water-limited conditions. SARP report, March 1993. AB-DLO. 67 pp.

Laar, H.H. van, J. Goudriaan & H. van Keulen (editors), 1992. Simulation of crop growth for potential and water-limited production situations, as applied to spring wheat. Simulation Reports 27. 72 pp.

Stand alone model: No (subroutine in growth model, e.g. ORYZA_W*).

Parentage: SUCROS2* routines.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, IBM compatible PC/AT \geq 640 Kb RAM.

Programming language: Microsoft FORTRAN-77 (in FSE*).

Other software required: FORTRAN utility library and TTUTIL*.

User's guide available:

Bouman, B.A.M., 1993. ORYZA_W, Rice growth model for irrigated and water-limited conditions. SARP report, March 1993. AB-DLO. 67 pp.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: EVAPOTRA 1.1

Title: A simulation program to calculate the required amount of irrigation.

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Soil science.

Description: EVAPOTRA calculates the amount of irrigation water needed.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evapotranspiration, amount of water in the profile.

State variables: Amount of irrigation required.

Input data: Meteorological data, soil physical data.

Number of input data: 5 For each day.

Output data: Water balance.

Number of output data: Depends on requirements.

Time interval of simulation: 1 Day.

Basic spatial unit: < m.

References general validation:

1992. Interne mededeling 221, DLO Winand Staring Centre, Wageningen.

Stand alone model: Yes.

Parentage: No.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: Turbo Pascal 6 or 7.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: EWQTPR 2.14

Title: EPIC* Phase (real time).

Date first profile: August, 1995.

Date last profile: August, 1995.

Update: March, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 2

New release expected: -

Subject: Crop science, soil science, and environmental science.

Aggregation level: Crop/herd, and cropping system/animal husbandry system.

Description: The real time EWQTPR model is a modified version of EPIC* model adapted to water management. The new model consider a division of the crop cycle into 4 development phases based on thermal time, the effect of rooting pattern on water extraction profile and a differential sensitivity of the phases to water and nitrogen stress. The real time system allows the user to intervene during the simulation course, to view and possibly to correct some soil and plant indicators. Short-term weather forecast can be introduced to anticipate soil water depletion and decide of supplemental irrigation. EWQTPR has been developed to help decision making in irrigation under limited water resources and to evaluate different water management strategies (crop production, water use and N leaching). The model has been validated for wheat, maize and sunflower.

State variables: Crop biomass, leaf area index, volumetric water content, rooting depth, soil mineral content, plant N status.

Number of state variables: 100.

Input data: Weather data (temperature, radiation, rain), soil properties by layer (texture, available soil water ...), initial water and nitrogen profile, crop parameters (40), crop management.

Number of input data: 100, some are optional.

Output data: State variables, grain yield, harvest index, water use efficiency.

Number of output data: > 100.

Time interval of simulation: 1 day.

Basic spatial unit: Ha.

References general validation:

Cabelguenne, M., Ph. Debaeke & J. Puech, 1994. 17th Conference Reg. Eur. Irrigation and Drainage (ICID), Varna, Bulgarie. 39-48

Debaeke, Ph., 1995. Agricultura Mediterranea 125: 64-78

Quinones, H. & M. Cabelguenne, 1990. Agricultura Mediterranea 120: 241-248

Stand alone model: Yes.

Parentage: EPIC*.

Check internal consistency or material balance present: -

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC (486 DX, RAM 8 Mo, DOS 6.0).

Programming language: Microsoft FORTRAN-77.

Other software required: No.

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: Expert-N 1.0

Title: A building block system for nitrogen simulation models.

Date first profile: March, 1996.

Date last profile: March, 1996.

Update: February 1995

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Crop science, and soil science.

Aggregation level: Plant/animal, and crop/herd.

Description: The scope of Expert-N was the development of a building block system of nitrogen models. This model system contains a collection of different modules for important processes of the nitrogen cycle in soil-crop systems like nitrogen transformation and movement, water and heat balance and crop growth and nitrogen. This model system is supposed to be a tool to compare various models and model approaches and to study their effects in the entire system. The modular structure and the standardized model units allow an easy exchange of the different algorithms to describe single processes. In this way it is possible to fit the model to the actual purpose (research, management) and the conditions of the site (crop, soil, available input parameters). Therefore 'Expert-N' shall be also an extremely flexible nitrogen simulation model itself. The actual release 1.0 contains the algorithms and model approaches of the complex deterministic model LEACHM* and the simpler empirical models N-SIM, CERES-Wheat, CERES-Barley and CERES-Maize. Different hydraulic functions and different mathematical algorithms to solve the partial differential equation are implemented. It is possible to programme new functions and modules and to integrate new function libraries as 'dynamic-link-libraries'.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Plant growth and development processes, soil processes soil water, soil heat and soil nitrogen dynamics.

Number of rate variables: > 50.

State variables: Physical and chemical soil parameters and distribution (e.g. mineral and organic nitrogen contents, water contents, organic matter); plant organ dry weights and nitrogen contents.

Number of state variables: > 50.

Input data: Management (tillage, planting information, fertilization, irrigation); initial soil status; daily weather data.

Number of input data: > 50, depending on used model approach and number of soil layers.

Output data: Water and nitrogen contents of each soil layer; plant growth data; water and nitrogen leaching.

Number of output data: > 50.

Time interval of simulation: 1 day.

Basic spatial unit: 1 ha.

References general validation:

Schaaf, T., E. Wang & T. Engel, 1995. Abschlussbericht fuer das F & E - Vorhaben Bestandesmodellierung.

Stand alone model: Yes.

Parentage: LEACHN, CERES-Models*, N-SIM.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC 80386; 4 MB RAM; 10 MB disk space (recommended: Pentium processor).

Programming language: Visual C++.

Other software required: MS-Windows 3.XX.

User's guide available:

Expert-N - ein Baukastensystem zur Simulation der Stickstoffdynamik in Boden und Pflanze, Version 1.0.

Application reports:

Schaaf, T., E. Wang & T. Engel, 1995. Abschlussbericht fuer das F & E - Vorhaben Bestandesmodellierung.

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: The actual release is only available in German, but an English version of Expert-N is in preparation.

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GENERAL OVERVIEW

Name and version: FARM 1.6

Title: A whole FARM model.

Date first profile: December, 1994.

Date last profile: August 30th, 1991.

Update: August 22nd, 1991.

Program type: Optimization model: linear programming.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Farming systems, environmental science, and agricultural economics.

Description: Quantitative farm analysis requires a lot of information from the individual farms and a lot of calculations. For this purpose this computer model was made in a spreadsheet program. The FARM-model looks at a farm on the fields of mineral balance, soil organic matter development, animal nutrition, labour and economics. It can be used to look at existing farms, to study the effects of changes in existing farms, to create new farms. It contains a module for composing fodder rations using Quattro's linear programming function.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

Number of rate variables: -

State variables: -

Number of state variables: -

Input data: Crops (area, yield, activities), animals (number, weight, growth, production, activities), fodder rations, machines, buildings.

Number of input data: > 12.

Output data: NPK balance, soil organic matter balance, fodder balance, labour balance, labour revenue, economic result.

Number of output data: > 6.

Time interval of simulation: -

Basic spatial unit: Ha.

References general validation:

Habets, A.S.J., 1991. FARM, a more-objective calculating model for arable-, dairy-, beef-, and mixed farms. Thesis. Wageningen, Department of Ecological Agriculture, Wageningen Agricultural University.

Stand alone model: No.

Parentage: -

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC >= 640 Kb RAM.

Programming language: Quattro Pro macro.

Other software required: Quattro Pro for MS-DOS, Borland.

Source code available: Yes.

Executable available: No.

User contract mandatory: -

Costs: -

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GENERAL OVERVIEW

Name and version: FGS

Title: Fish Growth Simulator.

Date first profile: January, 1995.

Date last profile: January, 1995.

Update: November, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Animal production.

Aggregation level: Cropping system/animal husbandry system.

Description: The model simulates fish growth as affected by food quantity and composition, temperature and dissolved oxygen concentration. Fish growth is computed on the basis of the biochemical reaction equations of the intermediary metabolism. Temperature and dissolved oxygen are forcing functions in the current version. The model is parameterized and calibrated for the Nile tilapia (*Oreochromis niloticus*). It is developed in the framework of a PhD thesis on intensive fish production systems in the tropics and temperate regions.

Time interval of simulation: 0.025 day.

Basic spatial unit: Fishpond.

References general validation:

Dam, A.A. van & Pauly, 1995. Aquaculture and Fisheries Management. (In Press).

Dam, A.A. van & F.W.T. Penning de Vries, 1995. Aquaculture and Fisheries Management. (In Press).

Stand alone model: Yes.

Parentage: Based on catfish model by Machiels et al.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC.

Programming language: Professional Dynamo Plus, Pugh-Roberts.

Other software required: -

User's guide available:

Pugh-Roberts, 1986. Professional Dynamo Plus. Simulation Software for the IBM-PC family and hardware compatibles. Reference manual. Pugh-Roberts Associates, Inc. Cambridge, USA.

Source code available: Yes.

Executable available: No.

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GENERAL OVERVIEW

Name and version: FIRE-BGC

Title: FIRE BioGeoChemical process model.

Date first profile: September, 1995.

Date last profile: September, 1995.

Update: September, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Forestry, environmental science, and land use studies.

Aggregation level: Other: stand, landscape.

Description: FIRE-BGC is a mechanistic vegetation dynamics model developed to investigate the role of fire and climate on long-term landscape dynamics in northern Rocky Mountain coniferous forests. FIRE-BGC is a highly complex, individual tree model created by merging the gap-phase, process-based model FIRESUM* with the mechanistic ecosystem biogeochemical model FIRE-BGC. It has mixed spatial and temporal resolution in the simulation architecture. Ecological processes that act at a landscape level, such as fire and seed dispersal, are simulated annually from stand and topographic information contained in spatial data layers. Stand-level processes such as tree establishment, growth, and mortality; organic matter accumulation and decomposition; and undergrowth plant dynamics are simulated both daily and annually on a simulation plot that represents the stand. Daily climate is strongly linked to FIRE-BGC algorithms. FIRE-BGC also explicitly simulates fire behaviour and effects on landscape characteristics and processes.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Driving variables include weather (precipitation, temperature, humidity, radiation), fire (intensity, severity, rate), insects and disease (infections, infestations), and tree growth, death and regeneration (diameter and height increments, carbon balances, cone crops).

Number of rate variables: Over 100 FIRE-BGC variables could be described as rate variables.

State variables: FIRE-BGC state variables represent carbon and nitrogen pools for trees, undergrowth, woody fuels, litter and duff; and structural characteristics of trees, stand and landscape.

Number of state variables: Approximately 56.

Input data: Input variables include an ecophysiological description of tree species (maximal stomatal conductance, etc); initial state and driving variable values, structural and physical description of fuels and undergrowth; and biophysical description of landscape.

Number of input data: There are over 100 variables quantified in the input procedure.

Output data: Spatial data layers and data files of ecosystem processes (e.g. net primary productivity, evapotranspiration). Stand tables, species cover maps, daily and yearly estimates of all state and driving variables.

Number of output data: About 2000 possible values can be printed.

Time interval of simulation: FIRE-BGC explicitly simulates two timesteps: daily and yearly. Decadal and century timesteps are indirectly accounted for in the FIRE-BGC application.

Basic spatial unit: The basic spatial unit is the landscape which is divided into sites that are again divided into stands.

References general validation:

Bevins, C.D., P.L. Andrews & R.E. Keane, 1995. Forest succession modelling using the Loki

software architecture. *Lesnictvi-Forestry* 41(4): 158-162

Keane, R.E., P. Morgan & S.W. Running, 1995. FIRE-BGC: A mechanistic ecological process model for simulating fire succession on coniferous forest landscapes. INT Research Paper. (In Press). 231 pp.

Keane, R.E., K. Ryan & S.W. Running, 1995. Simulating the effects of fire and climate change on northern Rocky Mountain landscapes using the ecological process model FIRE-BGC. USDA Forest Service General Technical Report RM-262. 39-47

Keane, R.E., K. Ryan & S.W. Running, 1995. Simulating the effect of fires on northern Rocky Mountain landscapes using the ecological process model FIRE-BGC. *Tree Physiology* (In Press).

Stand alone model: No.

Parentage: FIRE-BGC is the union of the process-based, gap-replacement model FIRESUM* and the mechanistic biogeochemical simulation model FOREST-BGC. It is implemented in the Loki simulation architecture.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: The program was implemented on a SUN Sparc Model 10 workstation. UNIX.

Programming language: FIRE-BGC was written in the C programming language using a modular approach where each organizational level implemented in the model was developed in separate components.

Other software required: The program accesses several software packages during execution using the Loki simulation system.

Source code available: Yes.

Executable available: No.

User contract mandatory: Yes.

Costs: None.

COMMENTS: FIRE-BGC models the flow of carbon, nitrogen and water across various ecosystem compartments to calculate tree growth. Carbon is fixed by tree leaves (i.e., needles) via photosynthesis using solar radiation adjusted for canopy depth and precipitation inputs, and this carbon is then distributed to leaves, stems and roots. A portion of the leaves, stem and roots are lost each year and accumulate on the forest floor in the woody fuel, litter, duff and soil. These forest floor compartments lose carbon through decomposition. Nitrogen is cycled through the system from the available nitrogen pool. The amount of carbon in each woody fuel compartment is converted to fuel loadings to predict fire behaviour at the site. The weather conditions at the time of fire are taken from daily weather data specified by the user. There are five levels of organization explicitly recognized in FIRE-BGC. The coarsest level is the simulation landscape defined as a large expanse of land (greater than 10,000 hectares) delineated by the natural boundaries that control the major properties of that ecosystem. These properties include climate, vegetation and disturbance. This landscape is divided into units of land called sites that have similar topography, soils, weather, and potential vegetation. The boundaries of each site are static and do not change in a FIRE-BGC simulation. The third level of organization is the stand. Each site is composed of a number of stands that are delineated by successional stage. By definition, stand boundaries cannot extend past site boundaries. The fourth organization level is the species level. The finest level of organization is the tree level. Each tree within a simulation plot is explicitly modeled in the FIRE-BCG architecture but these trees are not spatially defined.

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GENERAL OVERVIEW

Name and version: FIRESUM

Title: Fire Succession Model.

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Forestry, and environmental science.

Aggregation level: Field.

Description: Model type: Deterministic ecosystem process model containing stochastic properties. An ecological process model of succession that simulates long-term stand dynamics of forests of the Northern Rocky Mountains. The model is used to evaluate the effects of various fire regimes, including prescribed burning and fire suppression, on the vegetation and fuel complex of a simulation stand. FIRESUM is a gap-replacement model following the approach used for JABOWA in which individual trees are grown deterministically using an annual time step, difference equation. Tree growth is affected by several site factors including available light, water stress, and growing season warmth. Tree establishment and mortality are modeled stochastically using Monte Carlo techniques. Fuel loadings are calculated yearly. Fires are introduced at various intervals, and the effects of each fire are simulated by reduction of litter, duff, and down woody fuels; and by tree mortality and postfire tree regeneration and growth. The model has been validated by two different procedures. First, the literature was searched for long-term data compatible with the inputs and outputs of FIRESUM. The model was then used to simulate conditions measured by these historic data. Second, two adjacent stands at one site were sampled. One stand was a mature stand while the other was a fire disturbance stand. Sampled values from the mature stand were used as inputs to FIRESUM, which was then executed to simulate effects of a wildfire on the mature stand. Model outputs were then compared to sampled data from the fire disturbance stand at the simulation age that corresponds to the age of the fire-disturbance stand. Keywords: regeneration, tree growth, tree mortality, wildfire, prescribed burn, succession, fire effects, fuel modeling. Global change implications: In a climate scenario involving dryer climates in the Rocky Mountains, this model could be useful in examining the effects of increased fire due to the drier climate.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Monthly weather and site factors.

Number of rate variables: > 50.

State variables: Tree and stand structural characteristics.

Input data: Tree parameters - numbers describing each tree species in terms of the model's algorithms. Tree parameters include such things as maximum attainable height and diameter, maximum attainable age, shade tolerance class, and projected leaf area conversion factor. Site parameters which describe the simulation site. Site parameters include monthly temperature and precipitation, elevation of plot, percent of exposed rock on plot, soil depth, and soil water holding capacity. Simulation parameters that describe aspects of the simulation run such as time span, size of simulation plot, and initial stand table. Model input data source: Input data comes from existing literature and empirical data.

Number of input data: 250.

Output data: FIRESUM stores average basal area for each tree species by simulation year in an external file. The program also stores fuel component loadings, duff depths, number of

established seedlings and fire behaviour statistics.

Number of output data: More than 100.

Time interval of simulation: Year.

Basic spatial unit: Spatial scale: Model works at stand (simulation plot) level.

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: Requires IBM 386 PC or compatible with DOS 3.1 or later. Requires 2 MB disk space, 1 MB RAM and a math co-processor.

Programming language: Microsoft FORTRAN-77. A C++ version is in development.

Technical reference:

Keane, R.E., S.F. Arno & J.K. Brown, 1989. FIRESUM - An ecological Process Model for Fire Succession in Western Conifer Forests, September 1989. USDA Forest Service Intermountain Research Station General Technical Report INT-266

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: FLOCR 2.0

Title: FLOW in CRacking soils.

Date first profile: December, 1994.

Date last profile: December, 1994.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: -

Subject: Soil science.

Description: FLOCR simulates volume changes and vertical water transport in cracking clay soils. With the water retention curve and the hydraulic conductivity curve of the soil matrix and appropriate boundary conditions as input, soil water content profiles are computed, which are subsequently converted into surface subsidence and crack volumes, using the shrinkage characteristics of the soil matrix and a shrinkage-geometry factor. Preferential flow and rapid drainage via shrinkage cracks are computed as well.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water content, hydraulic conductivity, pressure head, volume change of each layer, runoff bypass flow and evapotranspiration.

Number of rate variables: < 25.

State variables: Shrinkage characteristics; tables for the water retention curves and hydraulic conductivity curves.

Number of state variables: < 25.

Input data: Profile description and boundary conditions, soil physical data and climatic data.

Number of input data: < 25.

Output data: Water balances for the profile subsidence, water content, pressure head for each soil layer.

Number of output data: -

Time interval of simulation: 0.2 day

Basic spatial unit: cm.

References general validation:

Oostindie, K. & J.J.B. Bronswijk, 1992. FLOCR - A simulation model for the calculation of water balance, cracking and surface subsidence of clay soils. DLO Winand Staring Centre Report no. 47. Wageningen, The Netherlands, 65 pp.

Stand alone model: Yes.

Parentage: FLOWEX* 1.0.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX-VMS and PC/MS-DOS.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes.

Costs: None.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: FLOWEX 1.1

Date first profile: December, 1994.

Date last profile: December, 1994.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Soil science: water flow through vadose zone.

Description: Water flow can be simulated in a soil profile consisting of up to 5 horizons with different soil physical properties. To simulate water flow the profile is divided into compartments. For each compartment the model computes the incoming and outgoing fluxes, the pressure head and the water content. For the complete soil profile the model computes the groundwater level, the drain discharge, the actual transpiration and the surface runoff.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water content, hydraulic conductivity, pressure head per layer, runoff actual evapotranspiration.

Number of rate variables: < 25

State variables: Tables describing the relation between pressure head, water content and hydraulic conductivities.

Number of state variables: < 25.

Input data: Description of profile and top and bottom boundary conditions; description of soil physical data; climatic data.

Number of input data: < 25.

Output data: Water balance for the profile pressure heads and water contents for each unsaturated layer.

Number of output data: < 25.

Time interval of simulation: 0.2 day.

Basic spatial unit: cm.

References general validation:

Buitendijk, J., 1984. FLOWEX: a numeriek model voor de simulatie van verticaal watertransport door de onverzadigde zone. Nota Institute for Land and Water Management Research No. 1494 Wageningen: ICW. 61 pp.

Stand alone model: Yes.

Parentage: -

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX-VMS.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes.

Costs: -

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GENERAL OVERVIEW

Name and version: FLUNIT 1.0

Title: System for NITrate FLUXes in ground water.

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Aggregation level: Region.

Description: FLUNIT is a system to simulate the nitrate flux from the surface through the unsaturated zone and use the resulting concentrations in the shallow ground water to predict the concentrations in ground water extractions (e.g. for drinking water purposes).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water fluxes and four nitrogen fluxes.

Number of rate variables: 5.

State variables: Water content, concentrations piezometric heads.

Number of state variables: 6.

Input data: Precipitation and evaporation path, crop and soil data, geohydraulic data of the subsurface.

Output data: Concentrations.

References general validation:

Groundwater 33(3): 356-365

Parentage: ARC/INFO is used.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: 80386 and up / DOS.

Programming language: Microsoft FORTRAN, Pascal, ARC INFO SML.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Negotiable.

COMMENTS: FLUNIT is not freely distributed, but only for operation in contact with IWACO B.V.

CONTACT(S):

Address: IWACO B.V., Adviesbureau voor water en milieu, P.O.Box 8064, 9702 KB

Groningen, THE NETHERLANDS.

GENERAL OVERVIEW

Name and version: ForGro

Title: Forest Growth Model.

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: December, 1995.

Program type: Simulation model/module.

Purpose: Aims: validation, and stress assessment.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: Yes, early 1996.

Subject: Soil science, and forestry: forest production ecology.

Aggregation level: Stand.

Description: ForGro is a process-oriented, deterministic model. The model is a physiologically based carbon-balance model of forest growth. It describes the flow of water, carbon and nutrients in the forest ecosystem. The model can be described as an integrated and closed-system Forest-Soil-Atmosphere model. Processes that are included consist of: photosynthesis and respiration, phenology, hydrology (detailed and partly empirical), nutrient cycling (mechanistic), forest growth (detailed and partly empirical), and forest structure development. ForGro includes hydrological submodels for calculating snow-fall, canopy water dynamics, forest-floor water dynamics and soil water dynamics. Compartments: - Hydrology: Solution of water content from nutrient balance model. Transpiration from Penman-Monteith. - Nutrient uptake: Driven by demand and limited by radial diffusion from the bulk soil to the root. - Soil chemistry: ForGro uses NuCSAM as submodel. - Forest growth: Photosynthesis is driven by light interception. Gross carbon assimilation is summed per leaf layer. Fixed allocation scheme. - Effect relations: Nutrient shortage, and stomatal uptake of SO₂ and O₃ in foliage reduce photosynthesis. All effects root growth and nutrient uptake. Direct uptake of NH₃.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Main fluxes of water, carbon and nutrients.

Number of rate variables: 20-50.

State variables: Biomass components.

Number of state variables: 20-30.

Input data: Tree physiology, site characteristics, stand structure.

Output data: Depends on application.

Number of output data: Depends on application.

Time interval of simulation: Day.

Basic spatial unit: 1 Ha.

References general validation:

Mohren, G.M.J., 1987. Simulation of forest growth, applied to douglas fir stands in the Netherlands. PhD, Wageningen, the Netherlands. 184 pp.

Stand alone model: Yes.

Parentage: SUCROS*.

Check internal consistency or material balance present: Yes.

Input check in model: Partly.

TECHNICAL SPECIFICATIONS

Hardware: Mainframe/PC.

Programming language: Microsoft FORTRAN-77.

Technical reference:

Mohren, G.M.J., H.H. Bartelink, I.T.M. Jorritsma & K. Kramer, 1993. A process-base growth model (ForGro) for analysis of forest dynamics in relation to environmental factors. In: Broekmeyer, M.E.A., W. Vos & H. Koop (Eds.). European Forest Reserves. Proceedings of the European Forest Reserves Workshop, 6-8 May 1992, The Netherlands. Pudoc-DLO, Wageningen, The Netherlands. 273-280

Source code available: Early 1996.

Executable available: -

User contract mandatory: No.

Costs: Nominal.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: FSE 1

Title: Fortran Simulation Environment.

Date first profile: January 26th, 1995.

Date last profile: January 26th, 1995.

Update: 1993.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: General simulation tool.

Aggregation level: Not applicable.

Description: FSE is an environment for continuous simulation in FORTRAN-77. FSE consists of a main program, weather data interface and utilities for performing specific tasks. The model equations have to be defined in one or more subroutines that are called by the main program. The environment is flexible, provides weather data, easy input of parameters and initial states, easy output in the form of tables or graphs, and time control. The FSE program is highly portable to other computers. The FSE program overcomes many programming problems that crop modellers face when programming in FORTRAN. By making use of this environment they can concentrate more on the scientific aspects of modelling than on the technical ones.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: -

State variables: Not applicable.

Number of state variables: -

Input data: Not applicable.

Number of input data: -

Output data: Not applicable.

Number of output data: -

Time interval of simulation: Not applicable.

Basic spatial unit: Not applicable.

References general validation:

Kraalingen, D.W.G. van, 1991. The FSE system for crop simulation. Simulation Report CABO-TT no. 23. Centre for Agrobiological Research and Dept. of Theoretical Production Ecology. Wageningen. The Netherlands. 77 pp.

Stand alone model: No.

Parentage: None.

Check internal consistency or material balance present: Not applicable.

Input check in model: Yes, some checks.

TECHNICAL SPECIFICATIONS

Hardware: Any machine with FORTRAN-77 compiler.

Programming language: Microsoft FORTRAN-77.

Other software required: Works in co-operation with TTUTIL*, CABO/TPE Weather System*, and TTSELECT*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 350,=.

COMMENTS: FSE is an important simulation tool of AB-DLO.

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GENERAL OVERVIEW

Name and version: FSEOPT 2.1

Date first profile: September, 1994.

Date last profile: June, 1994.

Update: -

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: Yes, January 1995.

Subject: Crop science, soil science, and environmental science.

Description: FSEOPT is an environment for calibration of simulation models, that are implemented within the FORTRAN Simulation Environment (FSE*) to experimental data. Global optimization algorithm implemented; controlled random search according to Price (1979), local optimization algorithm; downhill simplex method according to Nelder and Mead (1965).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: -

State variables: Not applicable.

Number of state variables: -

Input data: Not applicable.

Number of input data: -

Output data: Not applicable.

Number of output data: -

Time interval of simulation: Not applicable.

Basic spatial unit: Not applicable.

References general validation:

Stol, W., D.I. Rouse, D.W.G. van Kraalingen & O. Klepper, 1992. FSEOPT a FORTRAN Program for Calibration and Uncertainty analysis of Simulation Models. Simulation Report CABO-TT no. 24. Centre for Agrobiological Research and Dept. of Theoretical Production Ecology. Wageningen. The Netherlands. 24 pp.

Stand alone model: Not applicable.

Parentage: Not applicable.

Check internal consistency or material balance present: Not applicable.

Input check in model: Not applicable.

TECHNICAL SPECIFICATIONS

Hardware: PC, VAX, Apple, Sun workstation.

Programming language: Microsoft FORTRAN-77.

Other software required: TTUTIL*.

Source code available: Yes.

Executable available: Not applicable.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

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GENERAL OVERVIEW

Name and version: FST 2.0

Title: Fortran Simulation Translator.

Date first profile: January 26th, 1995.

Date last profile: February 19th, 1996

Update: November, 1994.

Program type: Simulation tool: simulation language.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: General simulation language.

Aggregation level: Not applicable.

Description: The FST language and corresponding FST software features a powerful and easy to use simulation language providing clear error messages. The syntax of the FST language was based on the syntax of CSMP* III (IBM, 1975). FST was developed because there was a need for a simple simulation language which, at the same time, allows the user to shift to the more powerful and flexible simulation environment that FORTRAN provides. This shift is made easy because the FST translates the FST source file into a clean and versatile FORTRAN program and also generates corresponding data files. When FST is used on IBM compatible computers, an easy to use shell is available through which facilities are available for running the model, and graphical display of the model results among other. Primarily, FST should be seen as a language for education and simple modelling purposes. The quality of the generated FORTRAN, however, provides an excellent starting point for users who need flexibility that FST does not provide. FST will be fully documented by Van Kraalingen & Rappoldt (in preparation).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: -

State variables: Not applicable.

Number of state variables: -

Input data: Not applicable.

Number of input data: -

Output data: Not applicable.

Number of output data: -

References general validation:

Kraalingen, D.W.G., C. Rappoldt & H.H. van Laar, 1994. The Fortran Simulation Translator (FST), a simulation language. In: Goudriaan, J. & H.H. van Laar. Modelling Crop Growth Processes. Kluwer Academic Publishers. Printed in the Netherlands. 219-230

Stand alone model: Yes.

Parentage: None.

Check internal consistency or material balance present: No.

Input check in model: None.

TECHNICAL SPECIFICATIONS

Hardware: Any machine with decent FORTRAN-77 compiler.

Programming language: FST.

Other software required: TTUTIL*, TTSELECT*, FORTRAN-77 compiler (preferably MS-

FORTRAN 5.1).

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 350,=.

COMMENTS: FST is an important simulation language of AB-DLO.

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GENERAL OVERVIEW

Name and version: FSU 2.0

Title: FSU: a generic user interface for crop growth simulation models.

Date first profile: January 19th, 1996.

Date last profile: January 19th, 1996.

Update: January 19th, 1996.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: -

Aggregation level: Other, all depending on model (thus, organ, plant/animal, crop/herd, cropping system/animal husbandry system, farm, region, and supra region).

Description: FSU is an easy-to-use environment for agricultural simulation models that are programmed in FSE* (van Kraalingen, 1995). The FSU system takes care of communication to and from selected models. On the input side, FSU provides 1) selection of models and input data files, 2) the setting of model options (as defined by the chosen model), 3) user-defined modification of model parameters, 4) swapping observed (forced) and simulated state-variables and 5) the generation of random data (using selected statistical distributions) for chosen parameters. After running a model, FSU provides the user with tabulated output of the model, time-coursed plots of variables, scatter plots, frequency plots and cumulative frequency plots. Settings of input can be stored as scenarios, and retrieved later on. FSU can be used for validation of (parts of) the models, detailed study of model behaviour, comparison of experimental versus model results, sensitivity/uncertainty and risk analysis, agroecological zonation and validation of (parts of) the models. FSU is developed in such a way that the user can easily interact with any model written in FSE* and add data files for use under the simulation environment.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: As defined by the models.

Number of rate variables: As defined by the models.

State variables: As defined by the models.

Number of state variables: As defined by the models.

Input data: As defined by the models.

Number of input data: As defined by the models.

Output data: As defined by the models.

Number of output data: As defined by the models.

Time interval of simulation: As defined by the models.

Basic spatial unit: As defined by the models.

References general validation:

Riethoven, J.J.M., H.F.M. ten Berge & H. Drenth (Eds.), 1995. Software developments in the SARP project: a guide to applications and tools. SARP Research Proceedings. AB-DLO/Wageningen, WAU-TPE/Wageningen, IRRI/Los Banos: 301 pp.

Stand alone model: Not applicable.

Parentage: Not applicable.

Check internal consistency or material balance present: Not applicable.

Input check in model: Not applicable.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC or true compatible, CPU 8088 or higher, FPU (co-processor) recommended, graphics CGA and up. 3 Mb of disk space total, including model and datafiles.

Programming language: Microsoft FORTRAN-77 / FSE* 2.0 for the models.

Other software required: PC/MS-DOS 3.30 or higher.

Application reports:

Bouman, B.A.M., H.H. van Laar & Wang Zhaoqian (Editors), 1993. Application of simulation and systems analysis in rice cropping optimization. In: Proceedings of international Workshop on Agro-Ecological Zonation of Rice' held at the Zhejiang Agricultural University, Hangzhou, P.R. of China, 14-17 April 1993. DLO-CABO, Wageningen. WAU-TPE, Wageningen. IRRI, Los Banos. 1-15

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 350,=.

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GENERAL OVERVIEW

Name and version: FUSSIM2 1.0

Title: Flow in Unsaturated Soil Simulation Model in 2 dimensions (Heinen and De Willigen, 1992).

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: November 30th, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: Yes, 1996 - applicable to partially saturated soils.

Subject: Soil science (crop science, and forestry).

Aggregation level: Cropping system/animal husbandry system.

Description: Solves the non-linear Richards' equation in 2 dimensions (x,z). Soil hydraulic properties described by Van Genuchten-Mualem functions. Richards' equation is left in mixed 0-h form. Method proposed by Celia et al. (1990; WRR 26: 1483-96) is used to assure perfect mass balance. Solution is obtained numerically using the control volume finite element method. The resulting matrix problem is solved via an iterative alternating direction implicit method. Top and bottom boundary conditions can be of prescribed pressure head or prescribed flux density type; left and right boundaries are no flow boundaries.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Flux density in x and z, actual sink term (transpiration), rain/irrigation, actual soil evaporation.

Number of rate variables: Many.

State variables: Pressure head h, volumetric water content θ , differential moisture capacity C, hydraulic conductivity K, total water storage, total change in water storage, van Genuchten-Mualem parameters: O_s , O_r , α , n, K_s , λ .

Number of state variables: Many.

Input data: Number of columns and layers, thickness of columns and layers, van Genuchten-Mualem parameters: O_s , O_r , α , n, K_s , λ , type of top boundary condition, rain/irrigation per time unit, actual soil evaporation, sink term distribution, type of and values of bottom boundary condition, initial h distribution, initial time step, maximum time step, maximum allowable change in θ per time step, print interval, stop time, iterations convergence criterion, maximum allowable iterations, desired output data.

Output data: Summary of input data, grid point locations, time, total water storage, total change since start, error in mass balance, θ per node, h per node, K per node, C per node, total head H per node, F_x and F_z at control volume boundaries.

Number of output data: Variable, depending on print times and desired output.

Time interval of simulation: Constant or variable; unit depending on units of input data.

Basic spatial unit: cm.

References general validation:

Heinen, M. & P. de Willigen, 1992. FUSSIM2: a simulation model for two-dimensional flow of water in unsaturated soil. DLO-Instituut voor Bodemvruchtbaarheid Nota 260. 146 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Available as output.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible, VAX, ALPHA.

Programming language: Microsoft FORTRAN-77.

Other software required: TTUTIL*.LIB, GENUCHT.LIB*.

Source code available: Available upon request.

Executable available: Available.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 110,=.

COMMENTS: Currently the model is being extended to include partially saturated conditions. For this purpose a different solution procedure (incomplete Cholesky decomposition) is used. Hysteretic hydraulic properties can be considered. The second author has modules available to compute actual transpiration by a root system. Moreover, conservative mass transport and nutrient uptake modules are available by the second author.

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GENERAL OVERVIEW

Name and version: GENUCHT.LIB

Title: FORTRAN library containing van Genuchten - Mualem hydraulic functions.

Date first profile: November 30th, 1995.

Date last profile: November 30th, 1995.

Update: -

Program type: Other: FORTRAN-77 library.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Soil science.

Aggregation level: -

Description: Soil hydraulic properties described by Van Genuchten - Mualem functions. Based on known Van Genuchten - Mualem parameters the following can be computed: $h(0)$, $\theta(h)$, $C(h)$, $K(h)$, $K(0)$, dK/dh , $D(0)$, $\psi(h, h_{ref})$. Symbols: h = pressure head, θ = volumetric water content, K = hydraulic conductivity, C = differential moisture capacity, D = diffusivity, ψ = matric flux potential, h_{ref} = reference pressure head.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

Number of rate variables: -

State variables: Pressure head, volumetric water content, differential moisture capacity, hydraulic conductivity, matric flux potential, diffusivity van Genuchten-Mualem parameters: θ_s , θ_r , α , n , K_s , λ .

Number of state variables: 12.

Input data: Depending on which function is used: θ , h , h_{ref} , van Genuchten-Mualem parameters: θ_s , θ_r , α , n , K_s , λ . It is assumed that $m-1-1/n$.

Number of input data: < 8.

Output data: θ , h , K , C , D or ψ .

Number of output data: 1 per function.

Time interval of simulation: -

Basic spatial unit: cm.

References general validation:

Heinen, M. & P. de Willigen, 1992. FUSSIM2: a simulation model for two-dimensional flow of water in unsaturated soil. DLO-Instituut voor Bodemvruchtbaarheid Nota 260. 146 pp.

Stand alone model: No.

Parentage: -

Check internal consistency or material balance present: -

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible, VAX, ALPHA.

Programming language: Microsoft FORTRAN-77.

Other software required: TTUTIL*.LIB, main program of user.

Source code available: Available upon request.

Executable available: Available as GENUCHT.LIB.

User contract mandatory: Yes, in principle this software product may be used only for non-

commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: GLOBAL 1

Title: Soil Water Transport and Crop Production.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science, soil science, and land use studies.

Aggregation level: Crop/herd.

Description: The model GLOBAL 1 simulates water flow in one-dimensional non-homogeneous cropped soil profile. Saturated and unsaturated flow is simulated using Richards' equation. The original method of evapotranspiration and its structure estimation is used. Output of this part of models are used for the prediction of crop production. Until now, maize growth is simulated.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water (soil) rate, root extraction rate, evapotranspiration and its structure.

State variables: Soil water content, soil water potential, meteorological data, crop data.

Number of state variables: 11.

Input data: Standard meteorological data, soil hydrophysical characteristics, crop data (leaf area index, root mass distribution, etc.).

Number of input data: 35.

Output data: Soil water content, soil water potential, evapotranspiration, root extraction rate, crop production rate.

Number of output data: 40.

Time interval of simulation: Year.

Basic spatial unit: m.

References general validation:

Novak, V. & J. Majercak, 1992. Simulation of the soil-water dynamics in the root zone during the vegetation period. II. The course of state variable of soil water below maize canopy. Journal of Hydrology and Hydromechanics 40: 380-397

Stand alone model: Yes.

Parentage: Some subroutines worm code (USSL).

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC-AT 386, 4 Mb RAM.

Programming language: Microsoft FORTRAN-77.

Other software required: -

User's guide available:

1994. GLOBAL User's guide. Institute of Hydrology SAS. 75 pp.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

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GENERAL OVERVIEW

Name and version: GOA ble

Date first profile: July, 1995.

Date last profile: July, 1995.

Update: January, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: Yes.

Subject: Crop science, and land use studies.

Aggregation level: Crop/herd, farm, region and supra region.

Description: As GOA mais*.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evaporation, transpiration.

Number of rate variables: -

State variables: Leaf area index , crop biomass (potential and with stress), soil water content, rooting depth

Number of state variables: 20.

Input data: Weather data (temperature, global radiation, potential evaporation, rainfall), crop management, soil data, plant parameters.

Number of input data: 50.

Output data: Crop cycle summaries (phenological stages, yield, water requirement, water stress indicators).

Number of output data: 30.

Time interval of simulation: 10 days.

Basic spatial unit: 20 km x 20 km.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: -

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC AT.

Programming language: Microsoft FORTRAN-77.

Other software required: No.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: -

Costs: No.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: GOA mais 1.3

Date first profile: August, 1995.

Date last profile: August, 1995.

Update: March, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: Yes.

Subject: Crop science, and land use studies.

Aggregation level: Crop/herd, farm, region and supra region.

Description: A crop model to evaluate land suitability (a case-study for maize). Devised to study spatial variation and uses readily available input data. The model is incorporated within procedures that allow the description of crop environment variability both in space and time and the model is run under a GIS (Geographic Information System). Input data are stored in soil, climate and crop management data bases for 20 x 20 km areas and constitute the basic information for crop growth simulation. From the network of synoptic meteorological stations, climatic variables are spatially interpolated to give predicted values for each elementary area. The model computes every 10 days: (i) potential crop productivity, and (ii) productivity in limited-water situation. The modelling principles for the soil-plant-atmosphere system are simple: development depends on thermal time, growth depends on energy use efficiency and the calculated water balance uses a reservoir model. Because of 10-day time step, attention was given to the way in which water stress affects the growth-development functions. The model was reliable for estimating maize productivity in various locations. Discrepancies occurred for intermediate variables in extreme environmental conditions. Map outputs of land suitability over France were established using GOA-maize.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evaporation, transpiration.

Number of rate variables: -

State variables: Leaf area index , crop biomass (potential and with stress), soil water content, rooting depth.

Number of state variables: 20.

Input data: Weather data (temperature, global radiation, potential evaporation, rainfall), crop management, soil data, plant parameters.

Number of input data: 50.

Output data: Crop cycle summaries (phenological stages, yield, water requirement, water stress indicators, maximum leaf area index).

Number of output data: 30.

Time interval of simulation: 10 days.

Basic spatial unit: 20 km x 20 km.

References general validation:

Brisson, et al., 1992. European Journal of Agronomy 1 (3): 163-175

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: -

Input check in model: -

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC AT.

Programming language: Microsoft FORTRAN-77.

Other software required: No.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: -

Costs: No.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: GOAL-QUASI

Title: A case study on the EC study 'Ground for choices'.

Date first profile: July, 1994.

Date last profile: January, 1995.

Update: 1995.

Program type: Optimization model: linear programming.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 1

use of model for APPLICATIONS: 3

New release expected: -

Subject: Land use studies.

Description: GOAL-QUASI is a case study on the EC study 'Ground for choices - Four perspectives for the rural areas in the European Community' (WRR, 1992). The case study is used in the Wageningen Agricultural University course QUASI* to illustrate the methodology for explorative land use studies at the regional level. The EC study has been carried out to explore future land use options in the 12 member states of the European Community under 4 different policy views: A. Free market, free trade; B. Rural development; C. Nature and landscape; D. Environment. By confronting technical information on land use with different objective functions (distilled from the various policy views) in an Interactive Multiple Linear Programming model (GOAL), quantitative land use scenarios can be generated. These land use scenarios show the consequences of different aims for land use. The case study has been derived from the original model by aggregation and simplification. The results of the case study model are very similar to the results of the original model. The case study should be used together with the QUASI* course, which is described in a separate form.

SCIENTIFIC SPECIFICATIONS FOR OPTIMIZATION MODELS

Type of variables/activities: Land use activities, conversion activities, animal husbandry activities.

Number of variables/activities: 950.

Type of constraints: Product balances, area constraints, water constraints, manure balances.

Number of constraints: 340.

Type of objective functions: Optimum values.

Number of objective functions: 9.

Basic spatial unit: EC member state.

Time horizon: 25 years.

TECHNICAL SPECIFICATIONS

Hardware: Mini and PC/386.

Programming language: OMP from Beyers & Partners, Belgium.

Other software required: -

User's guide available:

Ittersum, M.K. van, R.J. Hijmans & D. Scheele, 1995. Description and user guide of GOAL-QUASI. An IMGLP model for the exploration of future land use. Quantitative Approaches in Systems Analysis No. 2. DLO Research Institute for Agrobiolgy and Soil Fertility & The C.T. de Wit Graduate School for Production Ecology, The Netherlands. 19 pp.

Ittersum, M.K. van & N. de Ridder, 1995. Quantitative analysis of (agro-eco-)systems at higher integration levels (QUASI). Wageningen Agricultural University. Department of Agronomy &

department of Theoretical Production Ecology.

Technical reference:

Beyers & Partners, 1993. OMP manual (preliminary release 10.06.1993). Beyers & Partners, Brasschaat, Belgium. 360 pp.

Application reports:

WRR (Scientific Council for Government Policy), 1992. Grond voor keuzen; vier perspectieven voor de landelijke gebieden in de Europese Gemeenschap. (Ground for choices; four perspectives for the rural areas in the European Community). Rapporten aan de regering, nr. 42. SDU Uitgeverij, 's-Gravenhage. 149 pp.

Executable available: Yes.

User contract mandatory: Yes.

COMMENTS: The methodology uses a static linear programming model. The LP software package OMP is hardware bound.

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GENERAL OVERVIEW

Name and version: GRASMOD

Title: A GRASsland management MODEL to calculate nitrogen losses from grassland.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: September, 1995.

Program type: Simulation model/module: Model to calculate N losses on annual basis.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: -

Subject: Farming systems (crop science, and environmental science).

Aggregation level: Other: field.

Description: A grassland management model to calculate nitrogen losses on annual basis.

Input data: Grassland utilization method, N application rate, herbage supply level, milk production per cow, cattle type.

Number of input data: 5.

Output data: N balance of grass, and animals in summer, production data, N losses are specified, influence of grazing quantified.

Time interval of simulation: Year.

Basic spatial unit: Ha.

References general validation:

Boons-Prins, E.R. & G.W.J. van de Ven, 1993. Uitbreiding van het graslandbeheersmodel GRASMOD: invloed van de opfok van jongvee voor de melkveehouderij op stikstofstromen in grasland. CABO-DLO, Wageningen. Verslag 171. 37 pp.

Ven, G.W.J. van de, 1992. GRASMOD. A grassland management model to calculate nitrogen losses from grassland. Report 158, CABO-DLO, Wageningen. 109 pp.

Stand alone model: Yes.

Parentage: New model.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: ?

Programming language: Microsoft FORTRAN.

Other software required: -

User's guide available:

Ven, G.W.J. van de, 1992. GRASMOD. A grassland management model to calculate nitrogen losses from grassland. Report 158, CABO-DLO, Wageningen. 109 pp.

Executable available: -

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 110,=.

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GENERAL OVERVIEW

Name and version: GROW (Growth curve modelling, analysis and optimum design)

Title: Model choice from a clan of monotonically increasing or decreasing functions.

Date first profile: December, 1993.

Date last profile: December, 1993.

Purpose: - To choose a proper model. - To estimate the parameters, test hypothesis and construct confidence intervals. - To choose measurement points for future research in an optimal way.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

Subject: Growing plants (animals), dynamical processes which increase or decrease in time.

Description: GROW is part of a user-friendly dialogue system CADEMO. It consists of three parts: (1) Model choice: By help of a set of data one out of ten models can be selected which fits best with the data. The user can choose one of the criteria: - residual variance - Akaike criterium - Mallows criterium - Schwartz criterium The three latter contain a penalty function for the number of parameters in the model. (2) Parameter estimation and analysis. By help of the data the model parameters can be estimated (point and interval estimation). Hypotheses can be tested. (3) Experimental design. The sample size needed for a needed precision and an optimal allocation of future measurements can be obtained. The optimal allocation may be due to one of the optimality criteria: - minimum size of a confidence region - minimum variance of the estimate of one of the parameters.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: All growth and decay processes.

Input data: (X_i, Y_i) , $i = 1, \dots, n$

Output data: A report with corresponding results.

Time interval of simulation: Seconds for datasets with not more than 25 pairs.

References general validation:

Rasch, D., V. Guiard & G. Nuernberg, 1992. Statistische Versuchsplanung: Einfuehrung in die Methoden und Anwendung des Dialogsystems CADEMO. Fischer, Stuttgart. 386 pp.
1993. CADEMO-manual.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC.

Other software required: MS-DOS, from 1994 MS-DOS-Windows.

User's guide available:

1993. CADEMO-manual.

Executable available: Yes.

User contract mandatory: Yes (distributed in the United States, the Netherlands and Germany).

Costs: < \$ 200.

COMMENTS: Distributor in The Netherlands, proGAMMA, Groningen.

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GENERAL OVERVIEW

Name and version: Growth Respiration Model, 1973

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: December, 1973.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science.

Aggregation level: Plant/animal.

Description: Using the full stoichiometry of all biochemical conversions that take place during formation of biomass, plus taking into account the energy expenditure for synthesis processes and essential transport, the model computes exactly the weight of biomass produced from a certain quantity of glucose, plus a N source, plus minerals. Simultaneously, the weight of the H₂O and CO₂ produced, plus the weight of O₂ consumed is found. The model can be applied for the full range of biochemical compositions of plant and animal biomass. The model is a static simulation program.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: -

State variables: Not applicable.

Number of state variables: -

Input data: Biochemical composition biomass produced.

Number of input data: -

Basic spatial unit: Plant.

References general validation:

Dam, A.A. van & F.W.T. Penning de Vries. Parametrization and calibration of a model to simulate effects of feeding level and feed composition on growth of *Oreochromis niloticus* (L.) and *Oncorhynchus mykiss* (Walbaum). *Aquaculture Research* 26. (In Press).

Penning de Vries, F.W.T., 1973. Products, requirements and efficiency of biosynthesis; listing of the model and some reruns. Report 7b, Department Theoretical Production, Agricultural University, Wageningen, The Netherlands.

Penning de Vries, F.W.T., A.H.M. Brunsting & H.H. van Laar, 1974. Products, requirements and efficiency of biosynthesis: A quantitative approach. *Journal of theoretical Biology* 45: 339-377

Penning de Vries, F.W.T., J.M. Wiltage & D. Kremer, 1979. Rates of respiration and of increase in structural dry matter in young wheat, ryegrass and maize plants in relation to temperature, to water stress and to their sugar content. *Annals of Botany* 44: 595-609

Vertregt, N. & F.W.T. Penning de Vries, 1987. A rapid method for determining the efficiency of biosynthesis of plant biomass. *Journal of theoretical Biology* 128: 109-119

Stand alone model: Yes.

Parentage: Results used in BACROS* and SUCROS*.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: >= PC 286.

Programming language: Microsoft FORTRAN.

Other software required: -

Source code available: Yes.

Executable available: No.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

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GENERAL OVERVIEW

Name and version: HEDGEROW 1.0

Title: Hedgerow canopy gross photosynthesis.

Date first profile: December, 1995.

Date last profile: December, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: No.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: The model calculates gross photosynthesis of a hedgerow crop (i.e. the rows were assumed to have a rectangular transection and to be infinitely long). Diffuse and direct light distribution and absorption are calculated taking account of scattering and reflection. Leaf photosynthesis is calculated from absorbed light and integrated over the row.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Leaf gross photosynthesis, photosynthetic active radiation absorption, crop gross photosynthesis.

Number of rate variables: 3.

State variables: None.

Number of state variables: None.

Input data: Leaf photosynthesis parameters, leaf area index, row height, path width, latitude, day of year, hour of day, fraction diffuse photosynthetic active radiation.

Number of input data: 10.

Output data: Instantaneous crop gross photosynthesis, canopy photosynthetic active radiation absorption.

Number of output data: 2.

Time interval of simulation: Instantaneous.

Basic spatial unit: m².

References general validation:

Gijzen, H. & J. Goudriaan, 1989. A flexible and explanatory model of light distribution and photosynthesis in row crops. *Agricultural and Forest Meteorology* 48: 1-20

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Any computer.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: HORTISIM 1.0 beta

Title: Greenhouse and crop simulator.

Date first profile: January, 1996.

Date last profile: January, 1996.

Update: January, 1996.

Program type: Simulation model/module, and simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Crop science.

Aggregation level: Organ, plant/animal, and crop/herd.

Description: HORTISIM is a mechanistic simulation model for crop growth, the greenhouse climate and their interaction. It calculates photosynthesis, dry matter production and transpiration for an average C3 greenhouse crop (assuming a closed or a row canopy) and the dry matter production and dry matter partitioning of indeterminate vegetable fruit crops (tomato, cucumber, sweet pepper, melon). It quantifies the energy, CO₂ and water use. It can evaluate a variety of climatic condition, crop management practices and greenhouse designs. The program has advances possibilities to configure the model by switching of modules or replacing their functions by facing functions.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Photosynthesis, transpiration, dry matter production, fruit growth, fruit production, energy use, CO₂ use, water use.

Number of rate variables: > 200.

State variables: Air temperature, CO₂ concentration, air humidity, crop weight, leaf area index, fruit number, fruit fresh weight.

Number of state variables: > 40.

Input data: Weather outside greenhouse (global radiation, air temperature, humidity, wind speed and direction) or climate inside (global radiation, CO₂ concentration, air temperature).

Number of input data: Variable (20 to 100).

Output data: All state variables, all rate variables, balances, cumulative variables.

Number of output data: Variable (up to more than 200).

Time interval of simulation: Cropping season, with steps of 1 minute to 1 day.

Basic spatial unit: m².

References general validation:

Gijzen, H., 1996. HORTISIM, a general purpose greenhouse and crop simulator. Quantitative Approaches in Systems Analysis (In press).

Stand alone model: Yes.

Parentage: SUCROS* and derived models (ASKAM*, TOMSIM), TOMGRO.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: 486 PC or higher, equivalent MAC, 8 Mb RAM.

Programming language: Microsoft FORTRAN with FORTRAN '90 elements.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: -

COMMENTS: The program will be available as a beta-version until the summer of 1996. After that the final version (1.0) is available.

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GENERAL OVERVIEW

Name and version: HSG

Title: Harvester Schedule Generator Forest Modelling System Demonstration Version.

Date first profile: October 12th, 1995.

Date last profile: October 12th, 1995.

Update: January, 1994.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Forestry.

Aggregation level: Other: Forest stand polygon.

Description: This is a demonstration version of the HSG forest inventory projection model.

HSG is a tool designed to assist forest managers and others in the design and evaluation of forest management strategies. Its power lies not only in its functionality but also in its availability to a large number of users (read documentation). Keywords: forest, GIS (Geographic Information System). Other: This software demonstration package contains programs that are copyright, as described in the README.DOS file. In particular, please note the \$ 15 shareware fee that is payable to Computer Tyme Software. This fee covers the cost of the runtime license for the MarxMenu menuing system. If you intended to keep this software for a period beyond a brief evaluation, you must pay the shareware fee. You may freely distribute this zip file providing the README.DOS file describing the copyrights and conditions is included in every copy.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: User-defined harvest rates, silviculture rates, forest stand succession rules, and yield curves.

Number of rate variables: User-defined.

State variables: Each forest stand is described by trees species components, age, area, site class, and volume per hectare.

Number of state variables: User-defined.

Input data: Forest inventory, forest succession rules, yield curves, and silviculture rules.

Number of input data: Variable.

Output data: Predicted forest inventories, harvest and silviculture reports, and maps.

Number of output data: Variable.

Time interval of simulation: User-defined in years.

Basic spatial unit: User-defined (minimum of 0.01 hectares).

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: Recommended minimum of 80386 PC-compatible with 580 KB conventional memory available.

Programming language: C.

Other software required: MS-DOS 5.0.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: See description.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: HTICP.CSM

Title: Helianthus tuberosus Industrial Crops and Products.

Date first profile: October, 1994.

Date last profile: December, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: The model is largely based on the model JALINTUL.CSM (C.J.T. Spitters, 1990).

It calculates the tuber and inulin dry matter during the growing season under non-limiting conditions. This model differs from JALINTUL in the calculation of tuber dry matter as a function of the number of tubers, based on field trials in 1988 (Meijer and Mathijssen, 1991).

The model has been used to compare inulin production of Jerusalem artichoke and chicory (Meijer and Mathijssen, 1993).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Growth of biomass, storage organs (sink and source limited) and stem reserves.

Number of rate variables: 5.

State variables: Biomass, storage organs stem reserves.

Number of state variables: 3.

Input data: Weather data, crop data, start of tubers, storage organs.

Number of input data: About 50.

Output data: Tuber and inulin dry matter.

Number of output data: -

Time interval of simulation: Day.

Basic spatial unit: Ha.

References general validation:

Meijer, W.J.M. & E.W.J.M. Mathijssen, 1991. The relation between flower initiation and sink strength of stems and tubers of Jerusalem artichoke. Netherlands journal of agricultural science 39: 123-135

Meijer, W.J.M. & E.W.J.M. Mathijssen, 1993. Experimental and simulated production of inulin by chicory and Jerusalem artichoke. Industrial Crops and Products 1: 175-183

Spitters, C.J.T., 1990. Modelling the seasonal dynamics of shoot and tuber growth of Helianthus tuberosus L. In: A. Fuchs (ed.). Third seminar on Inulin. National Council for Agricultural Research, The Hague, The Netherlands. 1-8

Stand alone model: Yes.

Parentage: LINTUL*.

Check internal consistency or material balance present: No.

Input check in model: -

TECHNICAL SPECIFICATIONS

Hardware: -

Programming language: CSMP*.

Other software required: CSMP*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

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GENERAL OVERVIEW

Name and version: INSIM

Title: Phenology and population simulator.

Date first profile: December, 1994.

Date last profile: December, 1994.

Update: September 29th, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

Subject: Crop protection.

Description: With this model it is possible to simulate the phenology or the population dynamics (optional) of an insect species without the need of direct programming. By filling out a spreadsheet with the life cycle, giving the temperature-developmental rate relationships of each life stage in a set of tables and the temperature dependent mortality, the model is made. Together with initial data like starting date, time step of integration starting numbers and weather data the model is completed. The model is used for forecasting in orchards, several modules of insect pests are available.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Development rate of life stages and their standard deviation, relative mortality rates, age dependent reproduction.

Number of rate variables: Depending on complexity of life cycle.

State variables: Amount of each stage.

Number of state variables: Maximum 24.

Input data: Development rate, relative mortality of each life stage, stages in life cycles, weather data (maximum and minimum daily temperature).

Number of input data: Variable.

Output data: Relative or absolute numbers of each stage, temperature sums.

Number of output data: Variable.

Time interval of simulation: Variable.

Basic spatial unit: Variable.

References general validation:

Mols, P.J.M., 1990. Forecasting orchard pests for adequate timing of control measures. Proc. Exp. & Appl. Entomol., NEV. Amsterdam vol. 1: 75-81

Mols, P.J.M., 1992. Forecasting an indispensable part of IPM in apple orchards. Acta Phytopatologica Entomologica Hungaria 27(1-4): 449-460

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: > 386 SX; > 33 MHz.

Programming language: Quick BASIC.

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

Costs: -

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GENERAL OVERVIEW

Name and version: INTERCOM 1.1

Title: An ecophysiological model for crop-weed interactions.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: October, 1993.

Program type: Simulation model/module: based on FSE* structure. Modular approach.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: -

Subject: Crop science (weed), intercropping.

Aggregation level: Crop/herd.

Description: Competition between plants for the capture of the essential resources for plant growth (i.e. light, water and nutrients) determines the performance of both natural and agricultural ecosystems. The topic has been studied extensively by ecologists and physiologists, leading to the development of several approaches to describe the outcome of competition. The below mentioned book reviews these modelling approaches and their potential for predicting yield loss as a result of crop-weed competition. The authors provide a detailed description of the model INTERCOM and of methods to parameterize and evaluate the model using experimental data. Examples are given of how the model can be used to understand the effects of weeds on crops in field situations. The book presents a number of new developments and is aimed at theoretical plant ecologists as well as agronomists and weed scientists interested in ecophysiological approaches.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Photosynthesis, respiration, root growth, transpiration, evaporation, etc.

Number of rate variables: > 75.

State variables: Dry weight organs crop and weed, leaf area index, etc.

Number of state variables: > 50.

Input data: Weather, planting dates/sowing dates, species, densities.

Number of input data: Depends on purpose of use.

Output data: State and rate variables.

Number of output data: > 50.

Time interval of simulation: 1 day.

Basic spatial unit: 1 m² or 1 ha.

References general validation:

Kropff, M.J. & H.H. van Laar (eds.), 1993. Modelling crop - weed interactions. Wallingford: CAB International. 274 pp.

Stand alone model: Yes.

Parentage: SUCROS* models were base of the model.

Check internal consistency or material balance present: Partly.

Input check in model: Partly.

TECHNICAL SPECIFICATIONS

Hardware: Any that runs FORTRAN.

Programming language: Microsoft FORTRAN.

Other software required: TTUTIL*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: -

Costs: -

COMMENTS: -

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GENERAL OVERVIEW

Name and version: Land Evaluation II-land use system analysis

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 2

Subject: Crop science, soil science, farming systems, and environmental science.

Description: Well diffused land-use systems with annual food and/or fibre crops are described. Dynamic simulation of biophysical production potential, water-limited production potential and fertilizer (input) requirements for target production on the basis of commonly available data on land (i.e. soil and weather), crops(s) and management/technology. General model and derived version for systems with saline water and/or soils.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Transpiration rate, evaporation rate, percolation, capillary rise, growth rate's of leaf, stem, root, storage organ.

Number of rate variables: > 75.

State variables: Leaf, stem, root, storage organ masses, moisture potential, water table depth.

Number of state variables: > 75.

Input data: Soil data, weather data, crop data, management data.

Output data: Plant organ masses per interval, water depth, salinity, soil moisture content.

Time interval of simulation: 1 day.

Basic spatial unit: 1 ha.

References general validation:

Driessen, P.M. & N.T. Konijn, 1992. Land-use systems analysis. Wageningen Agricultural University, The Netherlands. 230 pp.

Stand alone model: Yes, under MS-DOS.

Parentage: SUCROS*, BACROS* and WOFOST*.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Quick BASIC compiler, co-processor.

Programming language: Quick BASIC 40.

Other software required: MS-DOS.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: LEACHM

Title: Leaching Estimation and Chemistry Model.

Date first profile: January, 1995.

Date last profile: January, 1995.

Program type: Simulation model/module.

Purpose: Can be used as a research tool or management tool. It examines chemical movement through the root zone (up to 2-3 meters), plant uptake, degradation, transformation, sorption, etc.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Soil science: nutrient dynamics, pesticide fate, salinity.

Description: LEACHM is a simulation model used for management and/or research into chemical movement into and below the root zone. It also examines plant uptake of these chemicals. The model contains 5 submodules: a water flow module to estimate drainage (LEACHW), pesticide and tracer module (LEACHP), nitrogen dynamics module (LEACHN); micro-organisms (LEACHB); and a salinity module (LEACHC) (which includes Ca, Mg, Na, K, Cl, SO₄, CO₃⁻, HCO₂⁻). Keywords: chemical movement, root zone, leaching, plant uptake, GIS (Geographic Information System). Global change implications: LEACHM can be for studying various chemical leaching rates and how they might be affected by atmospheric and management changes. It is used widely and contains many standard leaching state equations. Some researchers (e.g. Steve DeGloria at Cornell University) have linked LEACHM to a GIS. LEACHM has been used to examine leaching of atrazine, cyanazine and pendimethalin in corn crops and soil and water quality impacts of waste application.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Degradation, transformation, sorption rates, hydraulic conductivity.

Number of rate variables: Depends on application and options chosen.

State variables: Soil water and chemical contents and distribution.

Input data: Soil parameters (physical property, bulk density, particle soil distribution, water retention), chemical contents, weather data (maximum and minimum temperature, precipitation, evapotranspiration), chemical transformation, management information, some information acquired from literature. Model input data source: Literature or field data.

Output data: Water content, drainage, potentials and fluxes; chemical residues and amounts leached, degraded and taken up by plants.

Time interval of simulation: Time step: < 1 day. Temporal scale: 1 day to several decades.

Basic spatial unit: Spatial scale: Point model.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Any computer running FORTRAN. It takes 3 minutes on a Pentium to run a year.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: \$ 500.

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GENERAL OVERVIEW

Name and version: LINTUL

Title: Light INterception and UtiLization simulator.

Date first profile: February 1996.

Date last profile: February 1996.

Update: February 1996.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science.

Aggregation level: Organ, and crop/herd.

Description: LINTUL is a simple general crop model, which simulates dry matter production as the result of light interception and utilization with a constant light use efficiency. Leaf area increase during the exponential phase is temperature-determined, and thereafter follows from dry matter allocation to leaves. Allocation functions depend on the temperature-sum. Leaf senescence also depends on the temperature-sum but is accelerated at overly high leaf area index. LINTUL simulates potential crop growth but extensions of the model dealing with drought, potato late blight and potato cyst nematodes have been developed already.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Development, leaf area growth and senescence, dry matter production and partitioning to leaves, stems, roots and storage organs.

Number of rate variables: 9.

State variables: Temperature sum, leaf area, dry matter of leaves, stems, roots and storage organs.

Number of state variables: 6.

Input data: 2 Crop husbandry parameters, 9 crop specific parameters, 3 dry matter partitioning functions, 2 weather time courses.

Output data: Any variable required.

Time interval of simulation: 1 day.

Basic spatial unit: Field.

References general validation:

Spitters, C.J.T. & A.H.C.M. Schapendonk, 1990. Evaluation of breeding strategies for drought tolerance in potato by means of crop growth simulation. *Plant and Soil* 123: 193-203

Stand alone model: Yes.

Parentage: None.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Any computer that runs CSMP* or similar language.

Programming language: CSMP* (but only few language-specific constructions).

Other software required: None.

Application reports:

Oijen, M. van, 1992. Evaluation of breeding strategies for resistance and tolerance to late blight in potato by means of simulation. *Netherland Journal of Plant Pathology* 98: 3-11

Oijen, M. van, F.J. de Ruijter & R.J.F. van Haren, 1995. Modelling the interaction between potato crops and cyst nematodes. In: Haverkort, A.J. & D.K.L. MacKerrow (Eds.). Potato ecology and modelling of crops under conditions limiting growth. Kluwer, Dordrecht. 185-196
Spitters, C.J.T. & A.H.C.M. Schapendonk, 1990. Evaluation of breeding strategies for drought tolerance in potato by means of crop growth simulation. Plant and Soil 123: 193-203

Source code available: Yes.

Executable available: No.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

COMMENTS: LINTUL is geared towards analyzing deviations of actual crop growth from potential growth. Its simplicity allows easy addition of user-defined modules simulating abiotic or biotic stress (see references under 'Application reports').

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GENERAL OVERVIEW

Name and version: LOWBAL 1.0

Title: Water balance for puddled lowland (rice) soils.

Date first profile: September, 1994.

Date last profile: September, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 2

New release expected: Yes, summer 1994.

Subject: Soil science.

Description: LOWBAL (LOWland Water BALance) is a simple water balance model for puddled lowland soil under rice production. The model keeps track of the amount of water in the puddled layer by book-keeping of the inputs (rainfall, irrigation) and outputs (evaporation, transpiration, seepage and percolation). The model can handle irrigated and rainfed conditions. In the irrigated situation, irrigation is treated as a dynamically simulated variable: a fixed amount of irrigation water is applied whenever the simulated depth of ponded water drops below a - user-defined - minimum level. When the soil dries out (rainfed situation), the puddled layer shrinks linearly with (decreasing) water content. Cracks can develop that penetrate the compacted layer in the bottom of the puddled layer at a certain minimum water content value. Water losses by seepage and percolation are then determined by the drainage rate of the subsoil below the puddled layer. Both shrinkage and cracking are irreversible. Roots of the rice crop are considered to be confined to the puddled layer only and no water extraction of the subsoil is simulated.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Seepage and percolation, irrigation, water storage in puddled layer.

Number of rate variables: 10.

State variables: Irrigation sum, water loss (seepage and percolation), ponded water depth, water storage in puddled layer, thickness puddled layer, soil water content, bund overflow.

Number of state variables: About 15.

Input data: Daily values of rainfall, evaporation and transpiration (either as simulated with a rice growth model or measured); physical and hydrologic soil properties; management information (e.g. bund height, depth of puddled layer, irrigation).

Number of input data: 15.

Output data: State and rate variables: ponded water depth, content and amount of water in puddled layer, irrigation requirement, water loss by seepage and percolation, thickness of the puddled layer.

Number of output data: 10.

Time interval of simulation: 1 day.

Basic spatial unit: Field.

References general validation:

Bouman, B.A.M., 1993. ORYZA_W, Rice growth model for irrigated and water-limited conditions. SARP report, March 1993. AB-DLO. 67 pp.

Bouman, B.A.M., M.C.S. Wopereis, M.J. Kropff, H.F.M. ten Berge & T.P. Tuong, 1994. Understanding the water use efficiency of flooded rice fields. II. Simulation and sensitivity analysis Agricultural Water Management. (In Press).

Stand alone model: As subroutine in ORYZA_W* model for rice; can also be run stand-alone.

Parentage: -

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, IBM compatible PC/AT >= 640 Kb RAM.

Programming language: Microsoft FORTRAN-77 (in FSE*).

Other software required: FORTRAN utility library and TTUTIL*.

User's guide available:

Bouman, B.A.M., 1993. ORYZA_W, Rice growth model for irrigated and water-limited conditions. SARP report, March 1993. AB-DLO. 67 pp.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: LOWBAL was mainly developed to support the crop growth model for irrigated and rainfed rice, ORYZA_W* but can also be used as stand-alone model.

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GENERAL OVERVIEW

Name and version: MACROS

Title: Modules of an Annual CROp Simulator.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: December, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 2

Subject: Crop science.

Aggregation level: Other: field.

Description: Processes of crop growth and water movement: Crop processes when there is adequate water and nutrients and no pest problems. Crop growth in optimal conditions and water-limited conditions for a range of crop types and weather variables. Water balance for well drained and partially saturated soils.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Growth, photosynthesis, water use.

Number of rate variables: About 10.

State variables: Biomass crop components (leaves, stems, roots, storage organs), soil water content: layers, development stage.

Input data: Weather data, soil, crop characteristics.

Number of input data: 25-50.

Output data: Production of biomass, water use efficiency.

Number of output data: 25-50.

Time interval of simulation: Day.

Basic spatial unit: Ha.

References general validation:

Bachelet, D., J. van Sickle & C.A. Gay, 1993. Impacts of climate change on rice yield: evaluation of the efficacy of different modeling approaches. In: Penning de Vries, F.W.T, P.S. Teng & K. Metselaar (eds). Systems Approaches for Agricultural Development. Kluwer Academic Publishers, Dordrecht, Netherlands. 145-174

Dingkuhn, M., F.W.T. Penning de Vries, S.K. DeDatta & H.H. van Laar, 1991. Concepts for a new plant type for direct seeded flooded tropical rice. In: Direct seeded flooded rice in the tropics. International Rice Research Institute, Los Banos, Philippines. 17-38

Timsina, J., D.P. Garrity, F.W.T. Penning de Vries & R.K. Pandey, 1993. Yield stability of cowpea cultivars in rice-based cropping systems: experimentation and simulation. Agricultural Systems 42: 383-405

Stand alone model: Yes.

Parentage: SUCROS*.

Check internal consistency or material balance present: Yes, C and H₂O.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Programming language: All models CSMP*, with Microsoft FORTRAN used in subroutines.

User's guide available:

Kraalingen, D.W.G. van & F.W.T. Penning de Vries, 1990. The FORTRAN version of CSMP MACROS. Simulation Report CABO-TT nr. 21. Centre for Agrobiological Research and Dept. of Theoretical Production Ecology. Wageningen. The Netherlands. 145 pp.

Penning de Vries, F.W.T., D.M. Jansen, H.F.M. ten Berge & A. Bakema, 1989. Simulation of ecophysiological processes of growth in several annual crops. Simulation Monographs 29.

Pudoc-DLO, Wageningen, The Netherlands. 308 pp. Also available in Chinese.

Source code available: Yes.

Executable available: No.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

COMMENTS: The modules provided a basis for many models and studies in the SARP-project.

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GENERAL OVERVIEW

Name and version: MAIZE

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 3

Subject: Crop science.

Aggregation level: Crop/herd.

Description: The MAIZE model is a mechanistic model that uses simplified functions to describe crop development and growth. Daily predictions of crop mass accumulation and water use are generated. The most complicated version includes the soil and crop nitrogen budget.

Number of rate variables: Approximately 8.

Number of state variables: Approximately 6.

Input data: Minimum and maximum temperature, solar radiation, precipitation.

Time interval of simulation: Daily.

Basic spatial unit: m².

References general validation:

Muchow et al., 1990. Agronomy Journal 82: 338-343

Muchow & Sinclair, 1991. Agronomy Journal 83: 1052-1059

Sinclair & Muchow, 1995. Agronomy Journal 87: 632-641

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: DOS.

Programming language: BASIC.

Source code available: Yes.

User contract mandatory: No.

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GENERAL OVERVIEW

Name and version: MANAGE-N 1.0

Title: Decision Support System for Nitrogen Management in Rice.

Date first profile: January 19th, 1996.

Date last profile: January 19th, 1996.

Update: January 19th, 1996.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Agricultural economics and optimization.

Aggregation level: Crop/herd.

Description: MANAGE-N: the user-friendly package for nitrogen management in rice.

MANAGE-N (Riethoven et al., 1995) is a decision support tool for researchers and extension workers. The main purpose of MANAGE-N is to provide a sound agronomic basis for designing optimum nitrogen (N) fertilizer management strategies, for specific combinations of cultivar, site, season and soil type. When supplied with the proper parameter values, MANAGE-N generates information on: a) the highest attainable yield (versus fertilizer level), b) the highest attainable additional income from applied N fertilizer (versus fertilizer level), c) the optimal time path for N application at each N input level, d) yield response to specific split N application schemes, e) a site-and-cultivar calibration factor expressing productivity of light and nitrogen and f) patterns of N uptake, biomass accumulation and other intermediary variables. The core of the MANAGE-N package is the explanatory (process-based) simulation model ORYZA_0* (Drenth et al., 1994), which is embedded in a custom-made user-interface to provide easy communication with the model. The procedure of selecting input files, editing input data and viewing outputs (tabular and graphical) is completely supported by MANAGE-N in a user-friendly way. Fully automated numerical optimization of nitrogen application patterns allows the user to maximise grain yield for several fertilizer N input levels in one go. The package includes a context-sensitive help function that provides ample information on each topic, both with respect to on-screen structures like input windows as to theoretical background of MANAGE-N, the ORYZA_0* model and required crop and soil characteristics.

Time interval of simulation: 1 Day.

References general validation:

Drenth, H., H.F.M. ten Berge & J.J.M. Riethoven (Eds.), 1994. ORYZA simulation modules for potential and nitrogen limited rice production. SARP Research Proceedings. AB-DLO/Wageningen, WAU-TPE/Wageningen, IRRI/Los Banos. 223 pp.

Riethoven, J.J.M., H.F.M. ten Berge & H. Drenth (Eds.), 1995. Software developments in the SARP project: a guide to applications and tools. SARP Research Proceedings. AB-DLO/Wageningen, WAU-TPE/Wageningen, IRRI/Los Banos: 301 pp.

Stand alone model: No.

Parentage: ORYZA_0*.

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC or true compatible, CPU 8088 or higher, FPU (co-processor) recommended, graphics CGA and up. 3 Mb of disk space total, including model and datafiles.

Programming language: Microsoft FORTRAN-77 / FSE* 2.0 for the model.

Other software required: PC/MS-DOS 3.30 or higher.

Source code available: Yes, for the model. No, for the user interface.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 150,=.

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GENERAL OVERVIEW

Name and version: MASQUE 1.0

Title: Mulch Application Simulation to Quench Unchecked Erosion.

Date first profile: January, 1995.

Date last profile: October, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Soil science, environmental science, and land use studies.

Aggregation level: Cropping system/animal husbandry system.

Description: The model simulates the effect of surface mulch on runoff, soil loss and crop yield. Crop growth simulation is based on SUCROS* and MAIZE*. The model is validated for maize and the mulch type of Cassia siamea prunings, in Madakos, Kenya, but if the necessary crop physiological properties and mulch decomposition rate are known, other species may be used.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Crop development, photosynthesis, growth, biomass, evaporation, transpiration, infiltration, percolation, water content, drainage, runoff.

Number of rate variables: 60.

State variables: Yield (leaves, stems, cobs, grain), infiltrated water, ponded water, drainage, runoff, soil loss, cumulated water, evaporated water.

Number of state variables: 60.

Input data: Mulch type, mulch rate, weather data, rainfall intensity, slope, altitude, latitude, crop physiological properties, soil properties.

Number of input data: 100.

Output data: Yield, soil loss, runoff and any other rate or state variable requested.

Number of output data: Optional.

Time interval of simulation: 1 day.

Basic spatial unit: Ha.

Stand alone model: Yes.

Parentage: SUCROS* and MAIZE*.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC/AT \geq 640 Kb RAM.

Programming language: FST*.

Other software required: FORTRAN-77, TTUTIL* and CABO/TPE Weather System*.

Source code available: No.

Executable available: No.

User contract mandatory: No.

Costs: No.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: MAX 0.34

Title: Farming for MAXimum efficiency.

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: Spring 1995.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 1

use of model for APPLICATIONS: 3

New release expected: Yes.

Subject: Farming systems.

Aggregation level: Cropping system/animal husbandry system.

Description: MAX is a program developed at Purdue University for Indiana's T by 2000 soil conservation education program to track and compare economic returns on crop production. MAX manages crop input data, generates cost worksheets and summary reports, and allows custom input costs to be used in all calculations. Various management options, such as tillage, pest control, and fertilizer strategies, can be compared to help assess which practices are both economically efficient and environmentally sound. Since 1991 MAX has been used to manage data for the nation-wide MAX program sponsored by 'Successful Farming' magazine and the Conservation Technology Information Center and is designed for use in the 48 contiguous U.S. states.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Seed, fertilizer, herbicides, field operations, other inputs, yield, moisture, cash rent (actual), crop residue levels, soil types.

Number of rate variables: 10.

State variables: Soil productivity rating, acceptable soil loss (at current productivity), standardized unit costs, rent value by soil types, crop price, handling price.

Number of state variables: 8.

Input data: General information, erosion controls, planting, fertilizers, herbicides, insecticides, operations, other inputs, and harvest.

Number of input data: 9.

Output data: Itemized worksheets; rankings by cost, yield or profit; bar and pie charts by cost; state participant maps; tabular summaries by cost, yield, or profit.

Number of output data: 10.

Time interval of simulation: Harvest to harvest.

Basic spatial unit: Acre (English units).

Stand alone model: Yes.

Parentage: Profit through Efficient Production Systems (PEPS).

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: Minimum requirements: IBM AT or compatible with 80286 or later processor, 450 Kb available memory, DOS 3.1 or later, hard drive with 2 Mb free space, high density 5 1/4" (1.2 Mb) or 3 1/2" (1.44 Mb) floppy drive.

Other software required: -

User's guide available:

Hess, P., December 1994. MAX Software User Guide. Purdue University, Agronomy Department.

Source code available: No.

User contract mandatory: Yes.

Costs: Free for non-commercial use.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: MGOPT_DAIRY

Title: Multiple Goal OPTimization model for DAIRY farming.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: August, 1995.

Program type: Optimization model.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Farming systems, environmental science, and agricultural economics.

Aggregation level: Farm, and region.

Description: Interactive multiple goal linear programming model for dairy farming on sandy soils in the Netherlands. Economic, environmental and landscape goals are considered in an integrated way. It is a static model, figures are expressed per hectare per year. It can be used to explore possible developments in dairy farming with respect to a varying set of goals and constraints. N flows and losses get much attention. Crops considered are: grass, maize and fodder beet. An input-output table is generated by using a Technical Coefficient Generator for those crops, of which GRASMOD* is an example.

SCIENTIFIC SPECIFICATIONS FOR OPTIMIZATION MODELS

Type of variables/activities: Crop variables including grassland, cattle variables, feeding variables, N flow variables, P flow variables, purchase and sale variables.

Number of variables/activities: About 2800.

Type of constraints: Feeding constraints, crop production constraints, N flow constraints, and P flow constraints.

Number of constraints: About 580.

Type of objective functions: Income, NO₃, NH₃, P-surplus, N surplus, landscape, labour.

Number of objective functions: 10.

Time horizon: 1 Year average.

Optimization interval: 1 Year.

Stand alone model: No.

Parentage: New.

TECHNICAL SPECIFICATIONS

Programming language: SCICONIC (Microsoft FORTRAN based).

Other software required: SCICONIC.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

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GENERAL OVERVIEW

Name and version: Microweather94

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: -

Subject: Crop science, and environmental science.

Description: With the observed weather at 2 or 10 m height as input, the crop canopy microclimate is simulated, including the soil. The energy balance, evapotranspiration and carbon exchange is calculated. In-canopy profiles of radiation and wind speed are calculated, with their effects on leaf temperatures. An in-canopy profile of air temperature and humidity is ignored, because the K-theory has been proven not to be valid. There is however, an offset with respect to the above-canopy temperature and humidity. The soil energy balance is included, down to 1 meter depth.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Fluxes of transpiration (latent heat loss), sensible heat loss, carbon dioxide assimilation, soil surface fluxes, in-soil fluxes of heat, radiation short-wave and long-wave transmitted and reflected.

Number of rate variables: About 100.

State variables: Soil energy contents. Leaf and air conditions are instantaneously calculated.

Number of state variables: About 30.

Input data: Above canopy climate, soil properties, vegetation properties.

Number of input data: About 100, many are default.

Output data: See state and rate variables.

Number of output data: About 100, many are default.

Time interval of simulation: 1 hour, or less.

Basic spatial unit: plot, 1 m².

References general validation:

Goudriaan, J., 1977. Crop micrometeorology: a simulation study. Dr. Landbouwwetenschappen: Dissertatie LH-683: Landbouwhogeschool Wageningen. Pudoc-DLO, Wageningen, The Netherlands. 249 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: MS-DOS or Macintosh.

Programming language: Microsoft FORTRAN.

Other software required: TTUTIL*.

Source code available: Yes, under some conditions.

Executable available: Yes.

User contract mandatory: No, but some conditions.

Costs: None.

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GENERAL OVERVIEW

Name and version: MIKE SHE 5.23

Title: Systeme Hydrologique Europeen.

Date first profile: June, 1996.

Date last profile: June, 1996.

Update: May, 1996.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, soil science, environmental science, and land use studies.

Aggregation level: Farm, and region.

Description: MIKE SHE is a dynamic fully distributed modelling tool for simulation of all major hydrological processes occurring in the land phase of the hydrological cycle. The basic MIKE SHE module is the Water Movement module describing the hydrological processes. The hydrological components included are interception-evapotranspiration, infiltration, snow melt, 1-dimensional flow in the unsaturated zone, 3-dimensional ground water flow, overland flow in 2-dimensions and 1-dimensional river flow, all of which are fully coupled. For studies of environmental and agricultural related topics different add-on modules are available: Irrigation, advection and dispersion of solutes, geochemical processes, crop growth and nitrogen dynamics in the root zone represented by a coupling to the Daisy* model and finally sorption, degradation and plant uptake of pesticides. The modelling system is well suited for analysis, planning and management of water resources and environmental problems related to surface water and ground water, in particular when the effect of human interference is investigated. Typical areas of application related to agricultural management assessment are: Irrigation and drainage, environmental impacts of farming practice (including use of agrochemicals and nitrogen fertilizers), soil and water management, effect of land use changes. MIKE SHE is applicable on spatial scales ranging from a single soil profile to large regions, which may include several river catchments. Keywords: catchment hydrology, nitrogen dynamics, pesticide behaviour.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Important rate variables in soil (arrays): Flux of water and solute in soil, river and at the soil surface, plant uptake of water and solutes.

Number of rate variables: > 100.

State variables: Important state variables in soil (arrays): water content, water pressure potential, depth of overland water, depth of water in river, temperature, solute concentrations.

Number of state variables: > 100.

Input data: Driving variables: Climatic data. Distributed data: topography, river and drainage networks, geology, soil profile distribution, vegetation. Model parameters: soil physical properties (retention curves, hydraulic conductivities, storage coefficients etc.), crop and solute specific data.

Number of input data: > 100.

Output data: Main state variables.

Number of output data: > 100.

Time interval of simulation: Flexible (minutes-months).

Basic spatial unit: Flexible (plot (m²) - catchments).

References general validation:

Abbott, M.B., J.C. Bathurst, J.A. Cunge, P.E. O'Connell & J. Rasmussen, 1986. An introduction to the European Hydrological System - Systeme Hydrologique Europeen "SHE" 1: History and philosophy of a physically based distributed modelling system. 2: Structure of a physically based distributed modelling system. Journal of Hydrology 87: 45-77

Jain, S.K., B. Storm, J.C. Bathurst, J.C. Refsgaard & R.D. Singh, 1992. Application of the SHE to catchments India. Part 2. Field experiments and simulation studies with the SHE on the Kolar subcatchment of the Narmada River. Journal of Hydrology 140: 25-47

Lohani, V.K., J.C. Refsgaard, T. Clausen, M. Erlich & B. Storm, 1993. Application of the SHE for irrigation command area studies in India. Journal of Irrigation and Drainage Engineering 119(1): 34-49

Refsgaard, J.C., S.M. Seth, J.C. Bathurst, M. Erlich, B. Storm, G.H. Joergensen & S. Chandra, 1992. Application of the SHE to catchments in India. Part 1. General results. Journal of Hydrology 140: 1-23

Refsgaard, J.C. & B. Storm, 1995. MIKE SHE. In: Singh, V.P. (Ed.). Computer Models of Watershed Hydrology. Water Resources Publication, 809-846

Stand alone model: Yes.

Parentage: The Crop and Nitrogen Model is a coupling to the Daisy* model.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: Workstation or PC (Pentium and Windows95).

Programming language: Microsoft FORTRAN 77 and C++.

Application reports:

Styczen, M. & B. Storm, 1993. Modelling of N-movement on catchment scale - a tool for analysis and model description. 1. Model description. Fertilizer Research 36: 1-6

Styczen, M. & B. Storm, 1993. Modelling of N-movement on catchment scale - a tool for analysis and model description. 1. A case study. Fertilizer Research 36: 7-17

Refsgaard, A., B. Nilsson & J. Flyvbjerg, 1995. Skrydstrup waste disposal site - a case study. WEFTEC conference, October 21-25, Miami.

Refsgaard, J.C., H.R. Soerensen & A. Refsgaard, 1996. Modelling the environmental impacts of the Gabcikovo hydropower scheme, Slovakia, by use of the MIKE SHE hydrological modelling system. 26. International Wasserbau-Symposium, January 1996, Aachen, Germany.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Water movement (basic): Price list available. Advection dispersion: - Geochemical reactions: - Daisy coupling: - Pesticide module: - Irrigation: -

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GENERAL OVERVIEW

Name and version: MILLETO

Title: Potential and water-limited MILLET grOwth in Niger.

Date first profile: September, 1994.

Date last profile: October, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: Yes.

Subject: Crop science.

Description: MILLETO is largely based on WOFOST* 4.1 and calculates millet canopy photosynthesis and crop growth and development for agro-ecological characterization. It uses crop physiological and ecological processes as a function of environmental (soil and climate) and plant conditions. Adaptations were made with respect to sowing date, the relation between sowing date and date of emergence and crop survival during intermediate periods of drought. MILLETO distinguishes between 2 production levels: (1) potential production (growth and development determined by radiation, temperature and crop characteristics) and (2) water-limited production (growth and development determined by radiation, temperature, water availability, crop evapotranspiration and millet crop characteristics).

Output data: Millet canopy photosynthesis and crop growth and development.

Time interval of simulation: 1 day.

Basic spatial unit: Typically 1 km².

Parentage: WOFOST* 4.1.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN.

Other software required: TTUTIL*.

Technical reference:

Diepen, C.A. van, C. Rappoldt, J. Wolf & H. van Keulen, 1988. Crop growth simulation model WOFOST, Documentation Version 4.1. Stichting Onderzoek Wereldvoedselvoorziening/Centre for World Food studies. Staff working paper SOW-88-01. 299 pp.

Application reports:

Bruin, H.A.R. de, B.O.M. Dirks & M.J.M. Saraber, 1992. Simulation of water-limited production and use of METEOSAT-derived precipitation for Niger. Internal report Wageningen Agricultural University, Dept. of Theoretical Production Ecology & Dept. of Meteorology no. 21. 79 pp.

Source code available: Yes.

Executable available: Yes.

COMMENTS: MILLETO is not yet available for external use.

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GENERAL OVERVIEW

Name and version: MOD-C-LECT 1.0

Title: Model Selecting Tool for Agricultural Nonpoint Source Water Quality Simulations.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: October, 1994.

Program type: Simulation tool.

Purpose: To assist the model user in (1) learning basic information about thirty-two nonpoint source water quality computer simulation models and (2) selecting the model(s) which fit(s) the needs of a specific situation.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

New release expected: Yes.

Description: Using the Knowledge Pro software (Knowledge Processor), developed by Knowledge Garden Inc., Nassau, New York, United States (Thompson and Thompson, 1987), an automated nonpoint source (NPS) water quality model selecting tool (MOD-C-LECT) was created. A knowledge base and object oriented programming (OOPS) interactively direct the user toward the model(s) that meet(s) his/her selection criteria through the use of windowing. In addition, hypertext (help files built to be accessed by mouse clicking on highlighted words) helps to describe the models and define technical terms associated with water quality. Almost 200 issues (criteria) can be addressed for each of the 32 models included in the decision matrix. These criteria are organized into 14 sections and each section has several specific headings under it to create an outline or tiered organizational structure. A windowing approach is used to access the tiered data structure. The data is stored as either a yes or no in answer to the generic question: 'Does this model address this issue?'. A backwards chaining process is used to deduce which models do address the selected criteria. In addition to the decision matrix, each of the 32 models has a brief text section organized into ten topical sections. Technical terms are defined by the use of hypertext throughout these information sections. In an attempt to present the models in objective fashion, many basic terms are also defined by hypertext in order to clarify how the terms are used in MOD-C-LECT. Keywords: decision support, water quality, simulation, model, and nonpoint source pollution.

Input data: Almost 200 issues (criteria) can be addressed for each of the 32 models included in the decision matrix (see below under 1). These criteria are organized into 14 sections (see below under 2) and each section has several specific headings under it to create an outline or tiered organizational structure (see below under 3). A windowing approach is used to access the tiered data structure. In addition to the decision matrix, each of the 32 models has a brief text section organized into ten topical sections (see below under 4). Technical terms are defined by the use of hypertext throughout these information sections. 1. Models included in MOD-C-LECT (version 1.0): AGMAN, AGNPS, ALMANAC*, ANSWERS, CHEMRANK, CMLS, CREAMS, DRAINMOD, DRASTIC, EGEM, EPIC*, EXAMS, GAMES, GLEAMS, GWLF, HEC-5Q, HSPF, LEACHM*, MODFLOWP*, NLEAP, NPURG, PLANETOR, PRE-AP*, PRZM2, RUSTIC, SWAT, SPUR, SWRRBWQ, TR-55, VS2DT, WASP4, and WEPP*. 2. Sections of data in the MOD-C-LECT decision matrix: platform, resolution, hydrologic processes, routing, impoundments, erosion processes, crop growth, management, structures, nutrients, pesticides, other pollutants, economics, input/output. 3. MOD-C-LECT decision matrix data structure: platform section: hardware, operating system, programming language, other. 4. Text information sections for models in MOD-C-LECT: title (name, acronym, version number, and version release date), description (brief overview), developer/supporter (name, organization, address, telephone

and telefax numbers), water quality applications (examples, studies, other versions or modifications of the original model), limitations, resource requirements (hardware, software, memory, resident programs), inputs (numbers, required versus optional), output (type, form, flexibility), future model developments (plans, dreams), and references (complete bibliography of publications used to develop the model as well as applications/validations using the model).

Output data: A list of models which meet some specific criteria.

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

User's guide available:

Campbell, C.A., H.R. Davidson & F.G. Warder, 1977. Effects of Fertilizer N and Soil Moisture on Yield, Yield Components, Protein Content, and N Accumulation in the Aboveground Parts of Spring Wheat. *Canadian Journal of Soil Science* 57: 311-327

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: MODFLOWP 2.3

Title: MODFLOW - Parameter Estimation version.

Date first profile: October 11th, 1995.

Date last profile: October 11th, 1995.

Update: September 27th, 1995.

Program type: Simulation model/module, and optimization model.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science, and land use studies.

Aggregation level: Cropping system/animal husbandry system.

Description: The computer program MODFLOWP allows least-squares nonlinear regression to be used to estimate parameters of steady-state or transient, three-dimensional, ground water flow systems simulated using the U.S. Geological Survey modular finite-difference model (MODFLOW). Observations which may be used in the regression include measured flows and hydraulic heads or changes in hydraulic heads over time. Prior estimates on parameter values also may be included. Parameters may be defined to represent most physical quantities of interest, including horizontal and vertical hydraulic conductivity, vertical or horizontal anisotropy, storage terms, conductances of head-dependent boundaries, maximum evapotranspiration, the hydraulic head along constant-head boundaries, and the flow rate of defined flows. Spatially distributed quantities such as hydraulic conductivity can be represented using zones of constant value or can be interpolated using, for example, kriging. MODFLOWP works like MODFLOW when the Parameter-Estimation Package is inactive.

State variables: Hydraulic head.

Number of state variables: 1.

Input data: Hydraulic conductivity and specific yield of unconfined and convertible layers; transmissivity and specific storage of confined layers; vertical anisotropy of model layers; vertical leakance of intervening confining beds; conductance and define head of head-dependent boundaries; fluxes at flow boundaries; pumpage rates; maximum evapotranspiration and extinction depth; definition of parameters to be estimated; definition of observations, or targets, used in the regression; variables used to execute the regression.

Number of input data: > 100.

Output data: Hydraulic heads, flows to and from surface-water bodies such as lakes and streams, actual evapotranspiration, flows between finite-difference cells, parameter values which optimize the match between observations and simulated values, residuals (observed minus estimated values) and weighted residuals, sensitivities or scaled sensitivities, parameter correlation coefficients, parameter standard deviations and coefficients of variation.

Number of output data: > 100.

Time interval of simulation: All input needs to be consistent; usually second or days.

Basic spatial unit: All input needs to be consistent; usually meters or feet.

Stand alone model: Yes.

Parentage: Developed from MODFLOW.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

Type of objective functions: Weighted least squares.

Number of objective functions: 1.

Basic spatial unit: Same as in 'B. Scientific specifications of simulation models.'

Time horizon: Steady state or Steady state/transient.

Optimization interval: All observations matched simultaneously.

Stand alone model: Yes.

Parentage: Developed from MODFLOW.

TECHNICAL SPECIFICATIONS

Hardware: 486 or better.

Programming language: Microsoft FORTRAN.

Other software required: Extended memory - 4 Mb; 8 Mb RAM.

User's guide available:

Hill, M.C., 1992. A computer program (MODFLOWP) for estimating parameters of a transient, three-dimensional, ground-water flow model using nonlinear regression. U.S. Geological Survey Open-File Report 91-484. 358 pp.

Hill, M.C., 1994. Five computer programs for testing weighted residuals and calculating linear confidence and predictions intervals on results from the ground-water parameter-estimation computer program MODFLOWP. U.S. Geological Survey Open-File Report 93-381. 81 pp.

Hill, M.C., 1990. Preconditioned conjugate-gradient 2 (PCG2), a computer program for solving ground-water flow equations. U.S. Geological Survey Water-Resources Investigations Report 90-4048. 43 pp.

McDonald, M.G. & A.W. Harbaugh, 1988. A modular, three-dimensional finite-difference ground-water flow model. U.S. Geological Survey Techniques of Water-Resources Investigations, Book 6, Chapter A1. 548 pp.

McDonald, M.G., A.W. Harbaugh, B.R. Orr & D.J. Ackerman, 1991. A method of converting no-flow cells to variable-head cells for the U.S. Geological Survey modular finite-difference ground-water flow model. U.S. Geological Survey Open-File Report 91-536. 99 pp.

Prudic, D.E., 1989. Documentation of a computer program to simulate stream-aquifer relations using a modular, finite-difference, ground-water flow model. U.S. Geological Survey Open-File Report 88-729. 113 pp.

Technical reference:

Cooley, R.L. & R.L. Naff, 1990. Regression modeling of ground-water flow. U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter B4. 232 pp.

Application reports:

Anderman, E.R., M.C. Hill & E.P. Poeter, 1994. Two-dimensional advective transport in nonlinear regression - Sensitivities and uncertainty of plume-front observations. In: Warner, J. et al. (ed.), 1994. Ground Water Conference, Fort Collins, CO, Proceedings. 55-62

Anderman, E.R., M.C. Hill & E.P. Poeter, 1995. Two-dimensional advective transport in ground-water flow parameter estimation. Ground Water (In Press).

Giacinto, J.F., 1994. An application of MODFLOWP to a Superfund case study. In: Warner, J. et al. (ed.), 1994. Ground Water Conference, Fort Collins, CO, Proceedings. 103-110

Poeter, E.P. & S.A. McKenna, 1994. Geostatistical simulation and inverse flow modeling to reduce uncertainty associated with flow and transport predictions. In: Warner, J. et al. (ed.), 1994. Ground Water Conference, Fort Collins, CO, Proceedings. 47-54

Starn, J.J., 1994. Field application of nonlinear regression to estimate the parameters of a two-dimensional ground-water flow model, Calvert City, Kentucky. In: Warner, J. et al. (ed.), 1994. Ground Water Conference, Fort Collins, CO, Proceedings. 575-582

Yager, R.M., 1993. Simulated three-dimensional ground-water flow in the Lockport Group, a fractured dolomite aquifer near Niagara Falls, New York. U.S. Geological Survey Water-Resources Investigations Report 91-4189. 43 pp.

Source code available: Yes.

Executable available: No.

User contract mandatory: No.

Costs: Program free through internet; documentation about US \$ 100.

COMMENTS: Order MODFLOW and MODFLOWP by fax: +1.703.648 5295. Diskettes and documentation will be sent for \$ 80 plus overseas postage. Order documentation only from:

Books and Opn-File Reports, U.S. Geological Survey, P.O.Box 25425, Denver, CO 80215,

United States. To ftp MODFLOWP: From the directory on your machine where you want

MODFLOWP to be located: type: ftp brrcrftp.cr.usgs.gov <return> at login prompt type:

anonymous <return> at password prompt type: XX <return> at ftp prompt type: cd

pub/mchill/Modflowp <return> at ftp prompt type: prompt <return> at ftp prompt type: mget *

<return> at ftp prompt type: quit <return> Professor Richard Winston of Louisiana State

University, United States, has put a DOS compiled executable of MODFLOWP on his homepage of the World Wide Web (WWW): <http://scribe.geol.lsu.edu/rbwinston.html>

CONTACT(S):

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GENERAL OVERVIEW

Name and version: MODGRID 1.00

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: August, 1995.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science, and land use studies.

Aggregation level: Region, and supra region.

Description: Developed by DELFT HYDRAULICS. MODGRID is a dataprocessor for the groundwater model MODFLOW. Input can be generated easily, both input and output of a simulation can be visualized. Calibration on heads occurs semi-automatic. Through MODGRID, the MODFLOW input and output can be coupled to a Geographic Information System (ARCINFO) and the interpolation program SURFER. Furthermore MODGRID provides a robust coupling to the DELFT HYDRAULICS transport model STYX. MODGRID calculates the water balance for randomly chosen areas within the modelled area.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Fluxes, flows.

Number of rate variables: 6.

State variables: Heads, volumes (water balances).

Number of state variables: 2.

Input data: Recharge, evaporation, withdrawals, boundary conditions, initial heads, vertical and horizontal permeability, thickness of layers, cell dimensions, surface storage.

Number of input data: 11.

Output data: Fluxes, drawdowns, velocities.

Number of output data: 13.

Basic spatial unit: From \leq m to \geq km per cell.

References general validation:

May 1994. Delft Hydraulics Report T 1155.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: 486 or Pentium.

Programming language: Microsoft FORTRAN.

Other software required: Haloprof.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Dfl. 5 000,-.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: MOMASS: SUCROS* Assimilation interactively

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

Subject: Crop science.

Description: Crop assimilation is calculated, either as an instantaneous rate, or as a daily total. A default input list can be changed interactively.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: CO₂ assimilation rate.

Number of rate variables: -

State variables: None, leaf area index is an input.

Number of state variables: 1.

Input data: Latitude, maximum assimilation rate, light use efficiency, light extinction coefficient, leaf area index, wind speed, crop height, leaf width, day number, hour, global radiation, CO₂ concentration, SO₂ concentration.

Number of input data: 13.

Output data: Canopy assimilation rate, instantaneous or daily total.

Number of output data: 4.

Time interval of simulation: 1 day.

Basic spatial unit: 1 m².

References general validation:

Laar, H.H. van, J. Goudriaan & H. van Keulen (editors), 1992. Simulation of crop growth for potential and water-limited production situations, as applied to spring wheat. Simulation Reports 27. 72 pp.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC or Macintosh.

Programming language: Microsoft FORTRAN.

Other software required: TTUTIL*.

Source code available: Yes, under some conditions.

Executable available: Yes.

User contract mandatory: No, but some conditions.

Costs: None.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: MOSOM

Title: MOdelling Soil Organic Matter.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: 1991.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: Yes.

Subject: Soil science.

Aggregation level: Farm.

Description: MOSOM is a mathematical model that was developed to describe carbon (C) and nitrogen (N) cycling in different types of soil, e.g. clay and sandy soils. Transformation rates were described by first-order kinetics. Soil organic matter is divided into four fractions (including microbial biomass pool) and three fractions of residues. The fraction of active soil organic matter was assumed to be affected by the extent of physical protection within the soil, so was the soil microbial biomass. The extent of protection influenced the steady state level of the model, and, hence, the mineralization rates. The mineralization rate in fine-textured soils is lower than in coarse-textured soils; in fine-textured soils a larger proportion of the soil organic matter may be physically protected. The availability of organic materials as a substrate for micro-organisms is not only determined by their chemical composition, but also by their spatial distribution in the soil. In future research, attention will be paid to the effects of soil structure and soil texture and to the spatial distribution of organic materials and their decomposers.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: (Substrate) decomposition, respiration, nitrogen release, growth of microbial biomass, net mineralization, (daily) residue input, rate of change in the amount of carbon in microbial biomass (nonprotected, protected, stabilized soil organic matter), microbial biomass formed.

State variables: Decomposable material (carbohydrates, proteins), structural material (cellulose, hemicellulose), resistant material (lignified structural material), microbial biomass (protected and nonprotected), protected soil organic matter, nonprotected soil organic matter, stabilized soil organic matter.

Input data: Moisture and oxygen status, carbon dioxide pressure, aeration, pH, temperature, soil type, organic material, agricultural practices, C/N ratio, fraction of decomposable, structural and resistant material, microbial biomass.

Number of input data: -

Output data: (Daily) net mineralization of different soils.

Number of output data: -

Time interval of simulation: 1 day.

Basic spatial unit: Field.

Stand alone model: Yes.

Parentage: The models of Van Veen: Veen, J.A. van & E.A. Paul, 1981. Organic carbon dynamics in grassland soils. 1. Background information and computer simulation. Canadian Journal of Soil Science 61: 185-201 Veen, J.A. van, J.N. Ladd & M.J. Frissel, 1984. Modelling C and N turnover through the microbial biomass in soil. Plant and Soil 76: 257-274 Veen, J.A. van, J.N. Ladd & M. Amato, 1985. Turnover of carbon and nitrogen through the microbial biomass in a sandy loam and a clay soil incubated with [¹⁴C(4)] glucose and [¹⁵N](NH₄)SO₄ under

different moisture regimes. Soil Biology and Biochemistry 17: 747-756

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: 80*86 machine, co-processor.

Programming language: Microsoft FORTRAN.

Other software required: -

Technical reference:

Verberne, E.L.J., J. Hassink, P. de Willigen, J.J.R. Groot & J.A. van Veen, 1990. Modelling organic matter dynamics in different soils. Netherlands Journal of Agricultural Science 38: 221-238

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: MOTOR

Title: Modular description of Organic matter TurnOver.

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation tool, and other.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 2

New release expected: Soil science.

Aggregation level: Other: soil.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: User specified.

Number of rate variables: User specified but typically.

State variables: Residues microbial biomass, non-protected organic matter, protected organic matter.

Number of state variables: User specified but typically.

Input data: Decomposition of: residues, microbial biomass and non-protected organic matter, rates of desorption and adsorption of organic matter.

Number of input data: Initial sizes of state variables.

Output data: Rate constant, clay content.

Time interval of simulation: Any.

Parentage: Bradbury et. al., Jenkinson and Rayner model.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: Microsoft FORTRAN.

Source code available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Floppy disk.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: MOTOTN 1.2

Title: -

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, soil science, farming systems, and land use studies.

Aggregation level: Crop/herd.

Description: The model comprises four submodels. The first of these is a vegetative grass growth model with responses to light, temperature and nitrogen based on Johnsson & Thornley (1985), the second concerns a soil moisture submodel (Van Keulen & Seligman, 1987), the third is involved with soil organic matter dynamics (Verberne et al., 1990) and the fourth submodel is related to inorganic nitrogen.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Pasture model: Photosynthesis, growth and partitioning, potential nitrogen uptake rate, respiration, fluxes between the age categories, senescing and recycling of carbon and nitrogen. Soil moisture submodel: Infiltration, evaporation, and transpiration. Soil organic matter dynamics submodel: nitrogen and carbon input. Soil inorganic nitrogen submodel: fertilization and atmospheric deposition, nitrogen transport, nitrogen uptake rate.

Number of rate variables: About 30.

State variables: Pasture model: structural and substrate dry matter content, carbon and nitrogen concentration, leaf area index, nitrogen demand, dry matter, dry weight. Soil moisture submodel: volumetric water content in soil layer. Soil organic matter dynamics submodel: decomposable material, structural material. Soil inorganic nitrogen submodel: soil mineral nitrogen.

Number of state variables: About 30.

Input data: Daily weather data (radiation, irradiation, evaporation, minimum and maximum temperature, early morning vapour pressure, mean wind speed, precipitation), nitrogen demand, leaf area index, root length density, nitrogen fertilization, net mineralization rate, latitude, transpiration, N uptake, water uptake, C/N ratio.

Number of input data: > 60.

Output data: Gross assimilation, carbon yield, total N uptake, nitrogen yield, N mineralization.

Number of output data: > 40.

Time interval of simulation: Day.

Basic spatial unit: Ha.

References general validation:

Verberne, E., 1992. Simulation of the nitrogen and water balance in a system of grassland and soil. DLO-Instituut voor Bodemvruchtbaarheid Nota 258. 56 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: None.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: Multinary gas diffusion program (STEMAX)

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: -

Subject: Physics.

Description: The dynamic simulation model describes diffusion of gases in multinary gas mixtures to calculate the interdiffusion of gases in complex systems where respiration and denitrification take place. The model is based on the Stefan-Maxwell equations for concentration diffusion of isothermal, isobaric, ideal-gas mixtures and applies to an one phase system in one dimension.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Dynamics of the rate variables mentioned in 'State variables'.

Number of rate variables: 8, excluding the spatial subdivision of these rate variables.

State variables: Gases in a mixture (e.g. oxygen, carbon dioxide, nitrous oxide, molecular nitrogen).

Number of state variables: 8, excluding the spatial subdivision of these state variables.

Input data: Initial gas pressures, gas data to calculate binary diffusion coefficients.

Number of input data: About 30.

Output data: Concentration and pressure distributions of the gases in the gas layer are output of the program.

Number of output data: -

Time interval of simulation: The maximum time step amounts to 100 seconds, but is strongly dependent on the spatial resolution and the non-linearity of the problem (for 100 seconds maximum time step the spatial co-ordinate is 2.5 millimetre).

Basic spatial unit: A gas layer at the bottom of which gas production and consumption takes place is simulated.

References general validation:

Leffelaar, P.A., 1987. Dynamic simulation of multinary diffusion problems related to soil. Soil Science 143: 79-91

Stand alone model: Yes.

Parentage: Program developed by P.A. Leffelaar.

Check internal consistency or material balance present: Yes.

Input check in model: Some checks are performed.

TECHNICAL SPECIFICATIONS

Hardware: VAX, PC

Programming language: CSMP* 2% / (standard) Microsoft FORTRAN 98%.

Other software required: CSMP* (VAX) and FORTRAN plus the IMSL library.

Source code available: Yes, under some conditions.

Executable available: Source code should be compiled on your machine.

User contract mandatory: -

Costs: -

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: MUST 2.4

Title: Model for Unsaturated flow above a Shallow water-Table.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

Subject: Soil science.

Description: MUST is a Model for Unsaturated flow above a Shallow water-Table. The solution technique for vertical transport of soil moisture is based on a pseudo steady-state approach. The soil profile is schematized into a root zone and a subsoil. Transient flow in the subsoil is simulated by a succession of steady-state situations. The solution is obtained by combining the steady flow situations with the water balance for the root zone and the subsoil for given boundary flux conditions. The upper boundary flux is found from the given rate of rainfall and potential evapotranspiration, or may be computed by the evaporation module for standard meteorological data. The lower boundary flux may be found from a given water-table elevation, a relation between a flux and the water-table elevation, or a module that describes the drainage system.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Potential and actual evapotranspiration, open water evaporation, fluxes in the soil at various levels, fluxes to the different drainage systems.

Number of rate variables: > 10.

State variables: Water-table depths, saturation deficits, matric pressure in the root zone, crop height, soil cover, crop coefficients.

Number of state variables: > 10.

Input data: Standard meteorological data, soil physical data, data on drainage system, crop specific physiological data, water management data.

Number of input data: > 10.

Output data: Actual and potential evapotranspiration, water-table depth, drain outflows, various fluxes in the soil, matric pressure in the root zone.

Number of output data: > 10.

Time interval of simulation: Preferable 1 day.

Basic spatial unit: m² to field level.

References general validation:

Dam, O. van & C.M.A. Hendriks, 1994. Gebruik van MUST bij het berekenen van de evapotranspiration van bos. (The use of must for calculating the evapotranspiration of forest.) DLO-Staring Centrum, Wageningen. Rapport 353. 77 pp.

Laat, P.J.M. de, 1980. Model for unsaturated flow above a shallow water-table. Agricultural Research Report 895. Pudoc-DLO, Wageningen, The Netherlands.

Stand alone model: Yes.

Check internal consistency or material balance present: Partly.

Input check in model: Partly.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC (AT or more).

Programming language: Microsoft FORTRAN-77.

User's guide available:

Laat, P.J.M. de, 1985. MUST: a simulation model for unsaturated flow. Delft. International Institute for Hydraulic and Environmental Engineering. Report no. 16. 91 pp.

Application reports:

Laat, P.J.M. de, 1995. Design and operation of a subsurface irrigation scheme with MUST. In: Pereira, L.S., B.J. v.d. Broek & P. Kabat (Eds.). Crop-Water-Simulation Models in Practice: selected papers of the 2nd workshop on the International Commission on Irrigation and Drainage (ICID), the Hague, the Netherlands in 1993. Wageningen Press. 123-140

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: Dfl. 100,=

CONTACT(S):

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GENERAL OVERVIEW

Name and version: NCSOIL

Title: Nitrogen-Carbon Transformations in Soil.

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: December, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Soil science.

Aggregation level: Organ.

Description: C and N transformations in soil: mineralization, immobilization, nitrification, denitrification. Total and tracer C and N flows are computed.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Decay rates of soil organic pools; transformation rate of inorganic pools.

Number of rate variables: More than 60.

State variables: Decay rate constants, microbial efficiency, stabilization efficiency, C/N ratios.

Number of state variables: Variable number depending on purpose.

Input data: Initial levels of organic-inorganic, pools tracer constant.

Number of input data: Variable number depending on purpose.

Time interval of simulation: 1 Day or less.

Basic spatial unit: Mixed, sieved and in one soil horizon.

References general validation:

Nicolardot, B. & J.A.E. Molina, 1994. Soil Biology and Biochemistry 26: 235-243

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN.

User's guide available:

Haskett, J.D., J.A.E. Molina & C.E. Clapp, 1986. Soil Series 122. Dept. of Soil Science, University of Minnesota, St. Paul, MN 55108-6028

Application reports:

Molina J.A.E. et al., 1990. Soil Biology and Biochemistry 22: 349-353

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: N-DICEA

Title: Nitrogen Dynamics In Crop rotations in Ecological Agriculture.

Date first profile: August 22nd, 1994.

Date last profile: August 22nd, 1994.

Update: January 13th, 1994.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Soil science, and environmental science.

Description: This nitrogen dynamics model is designed to calculate the availability of nitrogen in a crop rotation. It includes a simple water balance to estimate soil moisture content and water leaching. Mineralization of initial soil organic matter, and of the consecutive additions of crop residues and organic manure to the soil, are calculated using Janssen's one parameter formula for the decomposition of organic matter with a correction for soil moisture and temperature. Crop uptake is based on actual yield data and derived amounts of crop residues and roots. Fixation by legume crops is estimated. A nitrogen balance is made including mineralization, deposition, fixation, uptake and (leaching) loss.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water, evapotranspiration, water percolation per layer, nitrogen mineralization for every addition, nitrogen uptake per layer, nitrogen leaching per layer.

Number of rate variables: > 8.

State variables: Soil water content per layer, amount of organic C and amount of organic N for every addition, amount of mineral N per layer.

Number of state variables: > 6.

Input data: Weather data (Penman evapotranspiration, soil temperature), soil data (thickness of layers, pF curves, organic matter content, N content), crop data (sowing and harvest data, potential N-uptake, N fixation), organic matter (date of application, amount, organic carbon and nitrogen content, apparent initial age).

Number of input data: > 19.

Output data: Water uptake, water leaching, water content, N-uptake, N-leaching, mineral N content, remaining organic matter, remaining organic nitrogen.

Number of output data: > 8.

Time interval of simulation: 10 days.

Basic spatial unit: Ha.

References general validation:

Habets, A.S.J. & G.J.M. Oomen, 1993. Modelling van de stikstofdynamiek binnen gewasrotaties in de biologische landbouw: N-DICEA. Wageningen, Department of Ecological Agriculture, Wageningen Agricultural University. 45 pp.

Stand alone model: No.

Parentage: -

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC >= 2 Mb RAM.

Programming language: Quattro Pro.

Other software required: Quattro Pro for MS-DOS, Borland.

Source code available: Yes.

Executable available: No.

User contract mandatory: -

Costs: -

COMMENTS: The model is applied on 12 year data from a 7-crop rotation on an experimental field of the Department of Ecological Agriculture. According to the model enough N was released to supply the crops, and measured mineral N (0-25 cm) in 1992 coincided well with results in 6 of 7 plots.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: NGROW.RICE

Title: Simple growth model for rice under N-limited conditions.

Date first profile: September, 1994.

Date last profile: January, 1995.

Update: June, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: To simulate N limited production of irrigated rice. Basis equations quantify: - light interception as function of total leaf-N, - crop CO₂ exchange as function of intercepted radiation, and - daily crop growth rate. Environmental effects other than radiation and crop specific factors need to be expressed by a site specific scaling factor.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: N uptake rate, crop growth rate, crop assimilation rate, daily global radiation.

Number of rate variables: 4.

State variables: Total dry mass crop, N uptake, grain yield.

Number of state variables: 3.

Input data: Daily global radiation, N uptake in through time.

Number of input data: 2.

Output data: Crop production, yield.

Number of output data: 2.

Time interval of simulation: 1 day.

Basic spatial unit: -

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: PCSMP* or FSE*.

Other software required: No.

Source code available: In preparation.

Executable available: -

User contract mandatory: -

Costs: -

COMMENTS: -

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GENERAL OVERVIEW

Name and version: NITCROS

Title: NITrogen balance and CROp production Simulation.

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: 1984.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

Subject: Crop science, soil science, and environmental science.

Aggregation level: Crop/herd: crop production at field level.

Description: The objective of the model is at field scale to simulate: - Nitrogen limited production. - Water balance in the winter time. - Soil mineral N balance. In the model a crop comprises a root and a shoot (including storage organs). The root is characterized by its dry matter content, N-content, and its rooting depth. The shoot is characterized by its dry matter content, N-content, and its leaf area index. The soil water model is of the tipping bucket type. The mineralization model considers only one organic pool. Only mineral fertilizers are considered.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Infiltration, percolation out of the rooting zone, transpiration, evaporation (from soil and intercepted water), daily gross photosynthesis, respiration (maintenance and growth) and dry matter production, N-mineralization, denitrification, leaching, and N-uptake by plants.

State variables: Soil water content (in a number of reservoirs), soil mineral N content, accumulated dry matter content (shoot and root), crop N content, development stage, leaf area index, and rooting depth.

Input data: Driving variables: global radiation, air temperature, precipitation, and irrigation (daily values). Soil and crop parameters.

Output data: Evapotranspiration, percolation, denitrification, leaching, soil water and mineral N storage, dry matter content (shoot and root), crop N-content, leaf area index and rooting depth.

Time interval of simulation: Daily time step.

Basic spatial unit: Field.

References general validation:

Aslyng, H.C. & S. Hansen, 1985. Radiation, water and nitrogen balance in crop production. Field experiments and simulation models WATCROS and NITCROS. Hydrotechnical Laboratory. The Royal Veterinary and Agricultural University, Copenhagen. 146 pp.

Hansen, S. & H.C. Aslyng, 1984. Nitrogen balance in crop production. Simulation model NITCROS. Hydrotechnical Laboratory. The Royal Veterinary and Agricultural University, Copenhagen. 113 pp.

Stand alone model: An extension to the model WATCROS*.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: Microsoft FORTRAN IV.

Source code available: Yes.

Executable available: No.

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GENERAL OVERVIEW

Name and version: NTARG and NTEXT

Title: Simple N balance model.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Soil science.

Aggregation level: Crop/herd.

Description: A simple nitrogen balance model to calculate long-term changes in soil organic nitrogen, nitrogen uptake by the crop and recovery of applied nitrogen. It functions with time intervals of one year or one growing season. A special version (NTARG) can be applied to establish fertilizer recommendations for a certain target nitrogen uptake by the crop.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Base N uptake rate, total N uptake rate, change in labile organic N and stable organic N, rate of N losses.

Number of rate variables: 5.

State variables: See output data (except for fertilizer-N required).

Number of state variables: 6.

Input data: N in labile and stable organic pools, in fertilizer and rainfall; N partitioning factors.

Number of input data: 20.

Output data: Labile organic N, stable organic N, total organic N, fertilizer-N required.

Number of output data: 7.

Time interval of simulation: 1 Year or 1 growing season.

Basic spatial unit: Ha.

References general validation:

Wolf, J., C.T. de Wit & H. van Keulen, 1989. Modelling long-term crop response to fertilizer and soil nitrogen. I. Model description and application. II. Comparison with field results. Plant and Soil 120: 11-22/23-38

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: Microsoft FORTRAN.

Other software required: FORTRAN compiler.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: No.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: Nwheat 1.0

Title: Nitrogen Winter Wheat.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: 1991.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop science, and soil science.

Aggregation level: Crop/herd, and other: field.

Description: Simulation of nitrogen balance in a system of winter wheat and soil. Daily total gross assimilation calculated with SUCROS* model (Spitters, 1989), modified for effects of N on maximum rate of photosynthesis and maintenance respiration. Nitrogen uptake based on N-deficiency in crop. Water balance: infiltration piston flow model, Penmann transpiration/evaporation approach. Soil nitrogen model: 2 pool mineralization/immobilization model, nitrogen transport according to Burns (1974), zero-sink nitrogen uptake as function of root length distribution.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Death rates organs (leaves, stems, roots), gross/net assimilation rates, maintenance rates different organs, water flow rates between soil compartments, growth rates different organs (grains, stems, reserves, roots, leaves), maintenance rates organs, soil organic matter decomposition rates, rates of nitrogen uptake, rates of nitrogen translocation from different organs, transpiration rates.

Number of rate variables: > 25.

State variables: Organ weights, amounts of nitrogen in different organs, soil organic matter pools, amounts of nitrogen in different soil layers, amounts of water in different soil layers.

Number of state variables: > 25.

Input data: Soil: soil type, soil moisture retention curves, rooting depth, initial moisture contents, organic matter inputs and pool sizes, relative soil organic decomposition rates, nitrogen applications, initial N contents. Crop: relative maintenance respiration rates, conversion efficiencies, residual nitrogen contents, photosynthesis-temperature table, dry matter partitioning tables, specific leaf area, maximum N-contents as function development stage, potential N-accumulation rates as function of temperature.

Number of input data: > 25.

Output data: See 'State variables'.

Number of output data: > 25.

Time interval of simulation: 1 Day.

Basic spatial unit: Ha.

References general validation:

Groot, J.J.R. & P. de Willigen, 1991. Simulation of the nitrogen balance in the soil and a winter wheat crop. *Fertilizer Research* 27: 261-272

Stand alone model: Yes.

Parentage: Keulen, H. van & N.G. Seligman, 1987. Simulation of water use, nitrogen nutrition and growth of a spring wheat crop. *Simulation Monographs*. Pudoc-DLO, Wageningen, The

Netherlands. 308 pp.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: 80286 or more.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Technical reference:

Groot, J.J.R., 1987. Simulation of nitrogen balance in a system of winter wheat and soil. Simulation Report CABO-TT no. 13. Centre for Agrobiological Research and Dept. of Theoretical Production Ecology. Wageningen. The Netherlands. 69 pp.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: OILCROP-SUN 4.1

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: March, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: Simulation of sunflower (*Helianthus annuus* L.) crop growth, development and yield in response to climate and water and nitrogen supply. The model has similar water and nitrogen balances as Ceres-Maize v2. Crop growth is based on radiation interception and a leaf area index-dependent Radiation Use Efficiency. Dry matter partitioning is based on priority relationships for the different organs and the ratios potential growth/total increment in dry matter. Yield determination depends on the number of seeds per plant and on seed growth rates. Phenological development depends on temperature and photoperiod. The different sunflower varieties are described using five genetic coefficients: Thermal time for the juvenile period, Sensitivity to photoperiod, Thermal time from first anthesis to physiological maturity, Maximum seed number per plant and maximum seed growth rate.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Above ground: phenological development, crop growth, growth of plant organs, evaporation, transpiration (and others). Below-ground: percolation rate, water content, irrigation, root growth (mass and length).

Number of rate variables: > 100.

State variables: Above ground: biomass (total, and per crop organ e.g. leaf, stem, root, head), leaf area index, number of flowers and seeds, seed mass. Below-ground: soil water content (per layer), root length, nitrate content, ammonium content (all per layer).

Number of state variables: > 20.

Input data: Geographical latitude and longitude, weather data (daily radiation, minimum and maximum temperature), rainfall, five genotype specific parameters physical and hydrological soil properties, crop and soil management information.

Output data: Crop rate and state variables (e.g. leaf area index), soil rate and state variables (e.g. evapotranspiration).

Time interval of simulation: 1 Day.

Basic spatial unit: m² - ha.

References general validation:

Villalobos, F.J., A.J. Hall & J.T. Ritchie., 1990. Oilcrop-Sun: A crop growth and development simulation model of the sunflower. Phenology model calibration and validation. Inaugural Congress European Society of Agronomy. Pars, 5-7 Diciembre de 1990.

Villalobos, F.J., A.J. Hall & J.T. Ritchie, 1992. Oilcrop-Sun: A crop growth and development simulation model of the sunflower (*Helianthus annuus* L.). Proceedings 13th International Sunflower Conference. Pisa, Italia. 8-10 Septiembre, 1992. International Sunflower Association. 453-458

Stand alone model: Yes.

Parentage: Ceres-Maize.

Check internal consistency or material balance present: No.

Input check in model: Partial check.

TECHNICAL SPECIFICATIONS

Hardware: PC-Compatibles under DOS.

Programming language: Microsoft FORTRAN.

Other software required: None.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: OMIS 6.0

Title: Operational Management for Irrigation Systems.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: August, 1995.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

Subject: Crop science, soil science, farming systems, and environmental science.

Aggregation level: Crop/herd, cropping systems/animal husbandry system, farm, and region.

Description: OMIS supports various aspects of irrigation system management at the pre-season crop planning, the in-season scheduling of water to command areas, the post-season irrigation performance evaluation. OMIS consists of a database, a large number of analysis modules, geographical information system for map processing.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

Number of rate variables: -

State variables: Flows in canals, storage of water in soil.

Number of state variables: -

Input data: Physical and operational characteristics of irrigation system, crops, soil, etc.

Number of input data: -

Output data: Crop plan, water allocation schedules, etc.

Number of output data: -

Time interval of simulation: Week, 2-week, 10 days.

Basic spatial unit: Irrigation system of sub-system.

References general validation:

Waterloopkundig Laboratorium, 1991. W & M kwaliteitshandboek. Deel: Waterbeheer en Milieu. Oktober 1991.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes, from map or irrigation scheme.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC 486 or higher.

Programming language: Microsoft FORTRAN, Visual Basic, C.

Other software required: MS Windows.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Depends on consultancy input; if more than 1 month than free else about Dfl. 15.000,-.

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GENERAL OVERVIEW

Name and version: On systems analysis and simulation of ecological processes with examples in CSMP* and FORTRAN

Title: Kluwer Academic Publishers, ISBN 0-7923-2435-8 (paperback).

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: -

Program type: Other.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 1

New release expected: -

Subject: General introduction to systems analyzes and simulation, see 'description'.

Description: This book presents a method for the analysis of ecological systems using numerical models. It describes the development of these models by means of relational diagrams and rate equations. The calculation of the dynamic behaviour of the models is studied through small computer programs. The approach is illustrated by treating examples ranging from simple exponential growth to the development of an insect population and transport phenomena in soils. About a hundred worked examples clarify the theoretical concepts presented and give the book a tutorial nature. The examples often illustrate the process from defining the problem to the development of a computer program. Examples include models about yeasts, prey-predator interactions, pollutant and organic matter dynamics and heat flow in soil. A simulation language is used to develop the programs, so that the need to learn technical programming details is minimized and attention can be focussed on the ecological problem. Use of this language is described in the text. The book concludes with the presentation of a simulation environment in FORTRAN, assuring a high model portability. Those interested in applying systems analysis and simulation in the study of ecological processes, like biologists, agriculturalists and soil scientists, will find this book a valuable introduction. After studying the book readers will be able to develop their own models and to critically follow the literature on more complex ecosystem models.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

Number of rate variables: -

State variables: -

Number of state variables: -

Input data: -

Number of input data: -

Output data: -

Number of output data: -

Time interval of simulation: -

Basic spatial unit: -

References general validation:

Leffelaar, P.A. (Ed.), 1993. On systems analysis and simulation of ecological processes with examples in CSMP and FORTRAN. Kluwer Academic Publishers, Dordrecht/Boston/London. 308 pp.

Stand alone model: -

Parentage: Based on work of the members of TPE-WAU.

Check internal consistency or material balance present: How this type of balance is set up .

Input check in model: -

TECHNICAL SPECIFICATIONS

Hardware: VAX, PC

Programming language: CSMP* / Microsoft FORTRAN.

Other software required: CSMP* (VAX) or PCSMP*, and FORTRAN plus TTUTIL*.

Source code available: Yes, all programs available on floppy disk.

Executable available: -

User contract mandatory: -

Costs: -

COMMENTS: -

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GENERAL OVERVIEW

Name and version: ONTO-WW 1

Title: Ontogenesis model winter wheat.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: April 15th, 1993.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, crop protection, and farming systems.

Aggregation level: Crop/herd.

Description: ONTO-WW is a dynamic model describing ontogenesis (development) and vernalization of winter wheat plants. The plant development is characterized by codes with respect to scales of development stages like germination, emergence, shooting, flowering and maturity of grain. The rates of the state variables of the model depend essentially on the air temperature, but also on soil temperature, relative air humidity, soil moisture, and photoperiod (day length). The computed variables allow to predict phenological events and their durations. Keywords: development, ontogenesis, winter wheat plant, vernalization.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Development, vernalization, water content.

Number of rate variables: 3.

State variables: Development, vernalization, water content, six state functions.

Number of state variables: 9.

Input data: Air temperature, day length, air and soil moisture, model parameters.

Number of input data: 30.

Output data: Rating scale D, transformed rating scale DC (Decimal Code).

Number of output data: 2.

Time interval of simulation: Vegetation period, day.

Basic spatial unit: M2, ha.

Stand alone model: Yes.

Parentage: AFRC-Model (Weir et al., 1984).

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Personal Computer.

Programming language: Borland Pascal.

Application reports:

Wernecke, P. & S. Claus, 1992. Extension and improvement of descriptive models for the ontogenesis of wheat plants. Modeling of geobiosphere processes 1: 131-144

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

Costs: Unknown.

COMMENTS: See model documentation in: Lenz et al., 1994. An Information System of

Ecological Models. GSF-Bericht 27/94. GSF-Forschungszentrum fuer Umwelt und Gesundheit, GmbH, Germany. Internet: ufis@gsf.de

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GENERAL OVERVIEW

Name and version: OPTIMA 1.0

Title: Whole farm planning with dynamic linear programming.

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: June, 1995.

Program type: Optimization model: dynamic linear programming.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Farming systems, and agricultural economics.

Aggregation level: Farm, and cropping system/animal husbandry system.

Description: This dynamic linear programming model for whole farm planning can evaluate the influence of agricultural policy on a micro level. The model can also be used for farm planning in any area where the main enterprises is grain, livestock and pastures. The model can accommodate 35 crop rotation activities and 10 livestock enterprises and the planning period is 6 years. The model is divided into four main components: (1) Evaluation of the present situation and a six year yearly cash flow, (2) calculation of alternative optimal six year plans, (3) presentation of the answer with graphs and tables, and (4) evaluation of the alternative plans to decide on the best alternative. The model is very user-friendly in the sense that the user don't need to be an expert on dynamic linear programming to operate the system. The budget information with technical coefficients is in a Quattro Pro spreadsheet and coupled to the linear programming matrices. The program is menu driven.

SCIENTIFIC SPECIFICATIONS FOR OPTIMIZATION MODELS

Type of variables/activities: Livestock enterprises, pastures/grain crop rotation activities, feed transfer activities (quarterly), labour transfer (quarterly), household expenses, overhead expenses, short term loans, and interest on savings.

Number of variables/activities: 14800.

Type of constraints: Five land use types, labour (fixed and hired) hours, tractor hours (big, medium, small), total digestible feed, crude protein, total dry matter, feed transfer constraints, loans, household expenses, overhead costs, operating capital, minimum and maximum value of activities.

Number of constraints: 4600.

Type of objective functions: Maximize.

Number of objective functions: 1.

Basic spatial unit: Ha, tons, livestock units.

Time horizon: Six years.

Stand alone model: Yes.

Parentage: The model was developed and improved over time. There are no other similar models in South Africa.

TECHNICAL SPECIFICATIONS

Hardware: The minimum computer requirement is a 486 computer with 8 Meg RAM. A mathematical co-processor and 240 Meg hard disk.

Programming language: Quattro Pro macros.

Other software required: Quattro Pro for MS-DOS, Borland. Xa professional, Sunset software

Word Perfect or WS2000.

Source code available: No.

Executable available: No.

User contract mandatory: No.

Costs: Not yet commercially available, maybe in 1996.

COMMENTS: This model is a concept model and other models will follow if this model prove to be a useful management tool. At this stage I believe that there is no other DLP whole farm planning model with the same capacity available in the world. If anybody knows of a model in existence please let me know. I will really appreciate it if people with the same interests invite me to visit them during a study tour.

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GENERAL OVERVIEW

Name and version: OPUS1 & 2

Title: Oil Palm sUmmary Simulator.

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: Yes, end 1994.

Subject: Crop science.

Description: The model simulates oil palm growth and production under potential or water limited production circumstances. The photosynthesis routines of SUCROS*87 are the backbones of the potential productivity model. Dry Sahel (DRSAHE) water balance is used to model water limitation. Dry matter partitioning is based on Corley's overflow hypothesis of yield.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Daily canopy photosynthesis, maintenance and growth respiration are based on SUCROS*. A long term assimilate pool is kept to avoid negative growth rates.

Number of rate variables: 15.

Number of state variables: 12.

Number of input data: 50.

Output data: All state and rate variables plus intermediate values.

Number of output data: 40.

Time interval of simulation: Up to 25 years.

Basic spatial unit: Ha.

Stand alone model: Yes.

Parentage: Based on SUCROS*87.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: Mainframe, mini, or PC.

Programming language: Microsoft FORTRAN and FSE*.

Other software required: TTUTIL* and CABO/TPE Weather System*.

Source code available: Yes.

Executable available: Yes.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: ORYZA_0

Date first profile: September, 1994.

Date last profile: October, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

Subject: Crop science.

Description: The model ORYZA_0 simulates biomass accumulation in rice as limited by nitrogen (N) uptake and daily total global radiation. It is based on a very limited set of relations expressing soil and crop processes. The equations used in describing both the soil and the crop component of the model are stripped down to the bare basics. ORYZA_0 can, therefore, be regarded as a real summary model of N limited rice growth. The complexity found in the more detailed crop growth and development models, such as ORYZA1* and ORYZA_N*, is avoided here; explicit formulations of phenological development, leaf area development, light interception, assimilation, respiration, conversion of glucose into dry matter, partitioning of dry matter, remobilization of carbohydrates, and the formation of sink size are all omitted. The net results of all these processes are expressed in a few coefficients. Contrary to the other ORYZA models, however, ORYZA_0 includes a soil component to describe, albeit in empirical form, N uptake. Attention is also given to crop N demand as a factor that might limit N uptake. The model can also be used with leaf N as observed forcing function and then omits all uptake and allocation processes. Most of the parameters used in the model can be easily obtained from field studies. A user-friendly interface (MANAGE-N*) exists to optimize N application schemes based on ORYZA_0.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Crop growth, N allocation to leaves, N uptake, N application, N translocation, soil N supply.

Number of rate variables: 6.

State variables: Amount of N in the leaf canopy, total N uptake, total biomass, total N applied.

Number of state variables: 4.

Input data: Fraction of N allocated to the leaves, N fraction in panicles, maximum leaf nitrogen pool, global radiation use efficiency, leaf N use efficiency, soil N supply, recovery of applied fertilizer-N, date of planting, date of flowering, harvest date.

Number of input data: 5-20: depending whether N uptake is simulated or forced as observed time series.

Output data: Biomass accumulation.

Number of output data: 5-10: depending whether N uptake is simulated or forced as observed time series.

Time interval of simulation: Day.

Basic spatial unit: m² and ha.

References general validation:

Berge, H.F.M. ten, M.C.S. Wopereis, J.J.M. Riethoven, T.M. Thiyagarajan & R. Sivasamy, 1994. The ORYZA_0 model applied to optimize nitrogen use in rice. In: Proceedings of the 'International Workshop on Nitrogen Management and Modelling in Irrigated Rice', held at the Crop Experiment Station, Rural Development Administration, Suweon, Korea, 1-10 November

1993. DLO-CABO, Wageningen. WAU-TPE, Wageningen. IRRI, Los Banos. 235-253
Drenth, H., H.F.M. ten Berge & J.J.M. Riethoven (Eds.), 1994. ORYZA simulation modules for potential and nitrogen limited rice production. SARP Research Proceedings. AB-DLO/Wageningen, WAU-TPE/Wageningen, IRRI/Los Banos. 223 pp.
Thiyagarajan, T.M., H.F.M. ten Berge & M.C.S. Wopereis (Ed.), May 1995. Nitrogen management studies in irrigated rice: proceedings of the SARP Applications Workshop held at the International Rice Research Institute (IRRI), Los Banos, Philippines, 18 April - 6 May, 1994. Wageningen, DLO-Research Institute for Agrobiolology and Soil Fertility. Wageningen, WAU-Department of Theoretical Production Ecology. Los Banos, International Rice Research Institute. SARP Research Proceedings. 109 pp.

Stand alone model: Yes.

Parentage: None.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN, FSE*, and FST*.

Other software required: FST* and FORTRAN compiler.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 350,=.

COMMENTS: ORYZA_0 is the simplest form of N-limited rice production model used in SARP project. The interface MANAGE-N* optimizes the cumulative N application curve, a generalized logistic, that should be followed to achieve maximum attainable total biomass. Optimization is by a 'global random search' numerical procedure.

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GENERAL OVERVIEW

Name and version: ORYZA_N 1.0

Title: Model for Potential and Nitrogen limited rice production.

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: August, 1993.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: Yes.

Subject: Crop science, and soil science.

Description: ORYZA_N simulates the growth of transplanted rice under potential and N limited conditions. N uptake is entered as a forcing function; or calculated for potential conditions. It is a starting point to further development into a structure which connects submodels of varying levels of detail, each submodel describing particular components of the crop-soil system. The main use is in evaluation and interpretation of experimental data, and development and testing of submodels. For this purpose, a requirement is that the user can easily make choices between submodels of different complexity levels, according to particular interests. Similarly, submodels can be replaced by measured time series, thus reducing the simulated system to a smaller core section. This user-model interaction is via switches that can be set according to the user's preference. The main difference between ORYZA1* and the current ORYZA_N version is that the latter includes nitrogen uptake and allocation to crop organs, via a number of subroutines.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Growth of crop and organs, development, photosynthesis, respiration, N demand at organ level, N uptake at organ level, N allocation and removal at organ level, N translocation at organ level.

Number of rate variables: 24.

State variables: Temperature sum plant and leaves, development stage, weights of crop and organs, tiller and grain number, N uptake, N amount in crop and organs.

Number of state variables: 24.

Input data: Latitude, elevation, maximum and minimum temperature, measured global radiation, sampling days, N application days, initial weights and N contents, initial phenological development stage, N application and sampling days, partitioning, harvest day, measured weights of crop and organs, amounts of N in crop and organs, leaf area, switches (to (in-)activate subroutines), transplanting date.

Number of input data: 46.

Output data: Weights of crop and organs, amounts of N in crop and organs.

Number of output data: 30.

Time interval of simulation: Day.

Basic spatial unit: Ha.

References general validation:

Drenth, H. & H.F.M. ten Berge, 1993. Documentation of test runs with ORYZA_N reference model for Potential and Nitrogen limited rice production. Simulation Report CABO-TT. Centre for Agrobiological Research and Dept. of Theoretical Production Ecology. Wageningen. The Netherlands. 25 pp.

Drenth, H., H.F.M. ten Berge & J.J.M. Riethoven (Eds.), 1994. ORYZA simulation modules for potential and nitrogen limited rice production. SARP Research Proceedings. AB-DLO/Wageningen, WAU-TPE/Wageningen, IRRI/Los Banos. 223 pp.

Stand alone model: Yes.

Parentage: MACROS*-L1D and SUCROS*.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Programming language: CSMP* and FSE*.

Other software required: TTUTIL*, CABO/TPE Weather System* and FSU* libraries.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: ORYZA_N is a subset of the ORYZA simulation modules for rice production. A set of simplified modules is named ORYZA_0*.

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GENERAL OVERVIEW

Name and version: ORYZA_W 2.1

Title: Rice model for irrigated and water-limited conditions.

Date first profile: September, 1994.

Date last profile: October, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: -

Subject: Crop science.

Description: The model simulates growth and development of rice in irrigated and rainfed lowland and in rainfed upland conditions, with ample supply of nutrient and with no pests, diseases or weeds. The above-ground part of the model is based on ORYZA1*, extended with the effects of drought stress on crop growth and development. Daily dry matter increase is simulated based on underlying physical and physiological processes (e.g. light interception, leaf and canopy photosynthesis, maintenance respiration (e.g. light interception, leaf and canopy photosynthesis, maintenance respiration, conversion). Leaf photosynthesis is a function of irradiation and leaf nitrogen content. Soil evaporation and crop transpiration are calculated on the basis on the Penman equations. Drought stress effects include leaf rolling, delay in phenological development, inhibited leaf growth and reduced photosynthesis. Switches are used to control the production environment. In lowland, the above-ground module is combined with the water balance model LOWBAL*, and in upland with SAHEL. In irrigated lowland, irrigation is treated as dynamically simulated variable. ORYZA_W can be used for experimental studies (leaf area index as forcing function; comparison with measurements) and for extrapolation purposes (e.g. agro-ecological zonation, scenario studies).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Above ground: phenological development, leaf and canopy photosynthesis (gross, net), maintenance and growth respiration, crop growth, growth of plant organs, evaporation, transpiration (and others); Below-ground: seepage and percolation rate, water content, irrigation.

Number of rate variables: > 75.

State variables: Above ground: biomass (total, and per crop organ e.g. leaf, stem, root, ear), leaf area index, intercepted light (and others); Below-ground: ponded water depth, content and amount of water in puddled layer.

Number of state variables: > 75.

Input data: Geographical latitude and longitude, weather data (daily radiation, minimum and maximum temperature), wind speed, rainfall, vapour pressure), crop specific physiological and morphological properties, physical and hydrological soil properties, crop and soil management information.

Number of input data: 75.

Output data: Crop rate and state variable (e.g. leaf area index, soil cover, biomass), soil rate and state variables (e.g. ponded water depth, irrigation water).

Number of output data: 25.

Time interval of simulation: 1 day.

Basic spatial unit: m² - ha.

References general validation:

Bouman, B.A.M., 1993. ORYZA_W, Rice growth model for irrigated and water-limited conditions. SARP report, March 1993. AB-DLO. 67 pp.

Bouman, B.A.M., 1994. ORYZA_W rice growth model. SARP Internal paper, April 1994. (45 pp.) [Formal description to appear in 1994]

Stand alone model: Yes, but can also be run under FSU*.

Parentage: ORYZA_W* (1.0), ORYZA1*, SUCROS*, MACROS*, and INTERCOM*.

TECHNICAL SPECIFICATIONS

Hardware: VAX computers, IBM compatible PC/AT >= 640 Kb RAM.

Programming language: Microsoft FORTRAN-77 (in FSE*).

Other software required: FORTRAN utility library, TTUTIL* and CABO/TPE Weather System*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: ORYZA1 1.3

Title: An ecophysiological model for irrigated rice production.

Date first profile: September, 1994.

Date last profile: October, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: -

Subject: Crop science.

Description: ORYZA1 is an ecophysiological model for irrigated rice production. The main structure and basic routines are from the Wageningen models for potential production (INTERCOM* - Kropff & van Laar, 1993; SUCROS* - Spitters et al., 1989; van Laar et al., 1992; MACROS* module L1D - Penning de Vries et al., 1989). An important advantage of the current model is that it can be used to simulate realistic yields and to assess the impact of planting date, weather, latitude at measured leaf N contents. This is in contrast to models for potential production, that have a fixed pattern of leaf photosynthesis in time. The model follows the daily calculation scheme for the rates of dry matter production of the plant organs, and the rate of phenological development. By integrating these rates over time, dry matter production of the crop is simulated throughout the growing season. The model ORYZA1 can be used as a tool in rice research for different types of studies: 1. Detailed physiological analysis of field experiments. It enables interpretation of treatment differences in yield in terms of leaf area index development, leaf N content, weather conditions and varietal characteristics determining physiological and morphological processes. For this purpose, detailed measurements are required on leaf area index and leaf N content, preferably throughout the growing season, although a single measurement at flowering can be seen as a minimum dataset. 2. Extrapolation of experimental findings to other environments. Given the N content of the leaves throughout the growing season and the varietal characteristics, attainable yields can be estimated for other environments (planting date, irradiation, temperature). 3. Estimation of yield potential for a given environment (planting date, latitude, radiation, temperature, variety as input) based on the leaf N content of the highest yielding experiments. The leaf N contents measured in the recent IRRI experiments used for model development can be used as a starting point. 4. Estimation of the effect of climate change on yield potential.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Phenological development of the crop, daily dry matter production, maintenance and growth respiration, dry matter partitioning, leaf area development, daily gross CO₂ assimilation of the canopy, daily growth rate from CO₂ assimilation.

Number of rate variables: 20-30.

State variables: Development stage, CO₂ assimilation canopy, leaf area, maintenance respiration, growth respiration, weights leaves/stems/panicles/roots, carbon balance check.

Number of state variables: 10-15.

Input data: Geographical latitude, daily weather data (radiation, minimum and maximum temperature), plant density, date of crop emergence and transplanting, morpho-physiological characteristics of the plant species.

Number of input data: 50-60

Output data: Accumulated carbon in the crop, carbon fluxes, total area index, leaf area index, N

fractions in the leaves, temperature sum for phenological/leaf area development, transplanting shock for phenological development, above-ground dry matter, dry weights of dead/green leaves/storage organs/stems.

Number of output data: Maximum 55.

Time interval of simulation: 1 day.

Basic spatial unit: 1 m².

References general validation:

Kropff, M.J., H.H. van Laar & R.B. Matthews (Eds.), 1994. ORYZA1 rice production: an ecophysiological model for irrigated rice production. SARP Research Proceedings, IRRI, TPE-WAU, AB-DLO. 110 pp.

Parentage: SUCROS* and MACROS*-L1D.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: FST* and Microsoft FORTRAN.

Other software required: TTUTIL*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: OZCOT

Title: A simulation model for cotton crop management.

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module: Empirical mainly top down process model for management applications.

Purpose: Management and economic decision making for cotton production at strategic and tactical levels; regional climatic analysis. Tactical use includes pest management, therefore fruiting is simulated in sufficient detail interface with insect feeding models.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science, and crop protection.

Aggregation level: Farm, and region.

Description: A simple temperature driven model of the fruiting dynamics (Hearn & Da Rosa, 1985) was linked to the widely used Ritchie (1972) soil water balance model. The function describing the processes in the fruiting model were made sensitive to solar radiation, water and nitrogen stress and water logging, and a leaf area generator, a boll growth model and an elementary nitrogen model were included. The model can be used for dryland and irrigated crops, and for specific historical crops with given sowing and irrigation dates, or the model can simulate the sowing and irrigation date decisions. Output at the end of the season consists of yield and yield components, nitrogen uptake, seasonal evapotranspiration and the number of irrigations and amount of irrigation water. Within season, either daily or at selected intervals, output consists of numbers of squares, bolls and open bolls, leaf area index and soil water content. OZCOT is applied throughout cotton growing areas in Australia. OZCOT assumes that the soil is one of the vertisols on which cotton is usually grown in Australia, and that there is negligible deep drainage, so that any rainfall or irrigation in excess of that needed to restore the soil to the upper limit runs off. Soil water balance is too simplistic in respect to drainage and run off. The soil nitrogen model is rudimentary and not process based. The ability of OZCOT to differentiate between varieties is limited. The model does not simulate fibre quality and can only partially simulate skip-row planting configurations. Target use/user group: On-farm, consultants, extension workers, planning, research, water allocation policy.

Input data: Weather data: rainfall, maximum and minimum temperature, solar radiation, optionally wet and dry bulb. Agronomic data: variety, plant population and row spacing, sowing date or sowing window, irrigation dates or parameters for irrigation, expected seasonal uptake of non-fertilizer N (previous crop or soil test), date and amount of N fertilizer. Soil data: plant available soil water capacity and initial content by layers.

References general validation:

Sharpley, A.N., & J.R. Williams (Eds.), 1990. EPIC - Erosion/Productivity Impact Calculator. 1. Model Documentation. U.S. Department of Agriculture Technical Bulletin No. 1768. 235 pp.

Aslyng, H.C. & S. Hansen, 1985. Radiation, water and nitrogen balance in crop production. Field experiments and simulation models WATCROS and NITCROS. Hydrotechnical Laboratory. The Royal Veterinary and Agricultural University, Copenhagen. 146 pp.

Hansen, S., H.E. Jensen, N.E. Nielsen & H. Svendsen, 1991. Simulation of nitrogen dynamics and biomass production in winter wheat using the Danish simulation model Daisy. Fertilizer Research 27: 245-259

TECHNICAL SPECIFICATIONS

Technical reference:

Hearn, A.B. & G.D. da Roza, 1985. A simple model for crop management applications for cotton (*Gossypium hirsutum* L.). *Field Crops Research* 12: 49-69

Hearn, A.B., 1994. OZCOT: A simulation model for cotton crop management. *Agricultural Systems* 44: 257-299

Talpaz, H., G.D. da Roza & A.B. Hearn, 1987. Parameter estimation and calibration of simulation models as a non-linear optimization problem. *Agricultural Systems* 23: 107-116

Application reports:

Bryant, M. et al., 1989. A study of reliability of water supply for irrigated cotton in the Namoi Valley. Centre for Water Policy Research.

Cox, P.G. & A.B. Hearn, 1990. A simple spreadsheet model of the area of irrigated cotton to plant. Fifth Australian Cotton Conference, Broadbeach, 8-9 August, 1990. ACGRA, Wee Waa. 123-127

Dudley, N.J. & A.B. Hearn, 1993. El Nino effects hurt Namoi cotton growers, but they can do little to ease the pain. *Agricultural Systems* 42: 103-126

Dudley, N.J. & A.B. Hearn, 1993. Systems modelling to integrate river valley water supply and irrigation decision making under uncertainty. *Agricultural Systems* 42: 3-23

Hearn, A.B., 1988. Water use - an update on strategies. *The Australian Cotton Grower* 9: 4-7

Hearn, A.B., 1990. Climatic risk in Australian cotton production. Models and management in the semi-arid tropics and subtropics. In: Muchow, R.C. & J.A. Bellamy (Ed.). *Poster papers from the International Symposium, Brisbane, 2-6 July, 1990. CSIRO Division of Tropical Crops and Pastures, Brisbane.* 48-49

Hearn, A.B., 1990. Prospects for rain-fed cotton. Fifth Australian Cotton Conference, Broadbeach, 8-9 August, 1990. ACGRA, Wee Waa. 135-144

Hearn, A.B., 1992. Risk and reduced water allocations. *The Australian Cotton Grower* 13(5): 50-55

Hearn, A.B., 1995. High prices and low rainfall: calculating the risk. *The Australian Cotton Grower* 16(5): 20-28

Routley, S.A. & C.A. Constable, 1994. Sensitivity of Australian raingrown cotton yield to soil and climate. In: Gonstable, G.A. & N.W. Forrester (Ed.). *World Cotton Research Conference - 1: Challenging the future. Brisbane, Australia 14-17 February 1994. CSIRO, Melbourne.*

User contract mandatory: See 'Comments'.

COMMENTS: Available for use for research purposes subject to a research agreement and appropriate acknowledgement. Will be available configured for pest management in the next release of entomoLOGIC.

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GENERAL OVERVIEW

Name and version: (P)CSMP

Title: Continuous Systems Modelling Program for PC.

Date first profile: September, 1994.

Date last profile: October, 1995.

Update: -

Program type: Simulation tool: simulation language.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 3

New release expected: No.

Description: PCSMP is a simulation language for user friendly programming. It is based on CSMP III, that was released in 1975 by IBM for mainframes. Many of the early models were written in CSMP, and many textbooks made use of it. This package is no longer available for distribution. It is replaced by FST* as a system oriented program language. The models in FST* are almost identical to those in CSMP.

TECHNICAL SPECIFICATIONS

Hardware: MS-DOS based PC's, AT and up.

Programming language: Based on Microsoft FORTRAN.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

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GENERAL OVERVIEW

Name and version: PESTLA 2.3

Title: PESTicide Leaching and Accumulation.

Date first profile: September, 1994.

Date last profile: October, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: Yes.

Subject: Environmental science.

Description: The PESTLA model consists of submodels for water and heat flow and for pesticide behaviour. The submodels for water and heat flow are based on Darcy's law and Fourier's law. The submodel for water flow is SWACROP* which implies that a range of upper and lower boundary conditions can be specified. The submodel for heat flow assumes that the surface temperature of the soil is equal to the air temperature. The relationship between heat conductivity and moisture content is fixed. The submodel for pesticide behaviour is based on the convection/dispersion equation for transport in the liquid phase. Transport in the gas phase is ignored. Sorption is described via a Freundlich isotherm and is proportional to organic matter. Transformation proceeds with first-order kinetics and depends on temperature, moisture content and soil depth. Plant uptake of pesticide is passive. Pesticide can be applied to the soil surface or incorporated to a specified depth. The model is used in the Dutch pesticide registration procedure as a first screening tool.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water uptake, water flux, heat flux, pesticide transport flux, pesticide uptake, pesticide transformation.

Number of rate variables: 6.

State variables: Volume fraction of liquid, soil temperature, pesticide concentration in soil, pesticide concentration in liquid phase.

Number of state variables: 4.

Input data: Weather (rainfall, potential evapotranspiration, minimum and maximum temperature), soil hydraulic properties, rooting depth, soil cover, pesticide sorption and transformation data.

Number of input data: About 20.

Output data: See 'State variables' plus cumulative values of rate variables.

Number of output data: About 50.

Time interval of simulation: 1 day.

Basic spatial unit: 1 m² to 1 ha.

References general validation:

Boesten, J.J.T.I., L.J.T. van der Pas & J.H. Smelt, 1993. Field test of the PESTLA model for ethoprophos on a sandy soil. In: H.J.P. Eijsackers & T. Hamers (eds.), Integrated soil and sediment research: A basis for proper protection, 241-245. 1993 Kluwer Academic Publishers, Dordrecht. 763 pp.

Boesten, J.J.T.I., 1994. Simulation of bentazon leaching in sandy loam soil from Mellby (Sweden) with the PESTLA model Journal of Environmental Science and Health A29: 1231-1253

Bosch, H. van den & J.J.T.I. Boesten, 1994. Validation of the PESTLA model: field test for leaching of two pesticides in a humic sandy soil in Vredepeel (The Netherlands). Report 82.

DLO Winand Staring Centre, Wageningen, Netherlands. 59 pp.

Stand alone model: Yes.

Parentage: None.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC.

Programming language: Microsoft FORTRAN.

Other software required: -

User's guide available:

Boesten, J.J.T.I., 1993. User's manual for version 2.3 of PESTLA. Internal Communication 275, SC-DLO.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes.

Costs: 275 ECU.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: PGWA 1.0

Title: Perennial grasses for West Africa conditions.

Date first profile: September, 1994.

Date last profile: December, 1995.

Update: December, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop science, and soil science.

Aggregation level: Crop/herd.

Description: PGWA is a model for water and nitrogen limited growth conditions. It simulates phenological development and growth, storage and recirculation of non-structural carbohydrates, water use and forage exploitation of a perennial grass crop in tropical areas with a well-pronounced dry season, such as the Sahel and Sudan zones of West Africa. Development and parameterization of the model is based on *Andropogon gayanus*, a tall, tufted grass that forms part of the vegetation of many savannah areas throughout Africa south of the Sahara. Nutrient and organic matter balances were not considered in this version.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Dry matter production/partitioning, senescence, root depth, water uptake, reserves use and accumulation.

Number of rate variables: > 25.

Number of state variables: > 25.

Input data: Geographical and weather data, initial biomass and water availability, shoot nitrogen content, root depth, soil water characteristics.

Number of output data: About 25.

Time interval of simulation: 1 day.

Basic spatial unit: 1 ha.

Stand alone model: Yes.

Parentage: No.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC/AT >= 640 Kb RAM.

Programming language: Microsoft FORTRAN-77 (FSE*).

Other software required: FORTRAN utility library, TTUTIL* and CABO/TPE Weather System*.

User's guide available:

Bonachela Castano, S., 1995. A model of a perennial grass (*Andropogon gayanus*) for West Africa (PGWA): description and user's guide. Rapport du projet Production Soudano-Sahelienne (PSS) No. 2. (gewijzigde versie). IER, Bamako / AB-DLO, Wageningen / & Haren / DAN-AUW, Wageningen. 25 pp. + 14 pp. app.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: A short version of this model is in preparation.

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GENERAL OVERVIEW

Name and version: PLAXIS 5.0

Title: PLane strain and AXI Symetric.

Date first profile: November 25th, 1995.

Date last profile: November 25th, 1995.

Update: 1993.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 3

New release expected: Yes.

Subject: Soil science.

Description: Finite element code for soil and rock plasticity.

Input data: Loads, displacements, mesh.

Output data: Stresses, strains, at mesh nodes.

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC 386 with Intel 80387.

User's guide available:

PLAXIS Balkema, Rotterdam

Executable available: Yes.

User contract mandatory: Yes.

Costs: US \$ 4000.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: POPDYN

Title: POPulation DYNAmics of greenhouse whitefly and the parasitoid *Encarsia formosa*.

Date first profile: December, 1994.

Date last profile: November 25th, 1995.

Update: December 1st, 1994.

Program type: Simulation model/module: State-variable and individual-based model.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop protection.

Aggregation level: Plant/animal: animal production.

Description: The model simulates the population dynamics of the pest insect, greenhouse whitefly, and its natural enemy, the parasitoid *Encarsia formosa*. Demographic parameters, as a function of host plant and temperature of both insect species are input. The most important part is the interaction between the natural enemy and the pest insect: the searching and foraging behaviour of the natural enemy is simulated in detail. Spatial distribution of both species in the canopy is simulated as well.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: The total model consists of 10 important subroutines, each of which use many rate and state variables.

Time interval of simulation: Two time steps: slow processes: 0.05 day, fast process (foraging behaviour of parasitoid): 0.00005 day.

Basic spatial unit: Number / day.

Stand alone model: Yes.

Parentage: Model based on BOXCAR-subroutine.

Check internal consistency or material balance present: Yes.

Input check in model: No, (sometimes).

TECHNICAL SPECIFICATIONS

Hardware: VAX computer.

Programming language: Microsoft FORTRAN-77 (in FSE*).

Other software required: TTUTIL*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: -

Costs: -

COMMENTS: -

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GENERAL OVERVIEW

Name and version: POTPLANT

Title: -

Date first profile: October 16th, 1995.

Date last profile: October 16th, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Crop science (horticulture) and soil science.

Description: The model simulates water and nutrient dynamics in a potted plant. For specified plant water and nutrient uptake the model simulates spatial distribution of water and nutrients as affected by fertigation schedule (sub-irrigation) and physical and chemical characteristics of the potting medium.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Actual evapotranspiration, transpiration, nutrient uptake, water flow, fertigation rate, plant growth data.

State variables: Water and nutrient content, physical and chemical characteristics of peat, chemical equilibria constants.

Input data: Evapotranspiration data, physical and chemical characteristics.

Output data: Water and solute content, chemical equilibria in relation to depth, water balance.

Time interval of simulation: Variable (input dependent), usually 1 day.

Basic spatial unit: m².

References general validation:

Otten, W., 1994. Dynamics of water and nutrients for potted plants induced by flooded bench fertigation: experiments and simulation. Thesis Wageningen. 115 pp.

Stand alone model: Yes.

Parentage: SWATRE and CHEM.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX.

Programming language: Microsoft FORTRAN.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: PRE-AP 2.0

Title: PRE-Application/Pesticide Registration and Environment Assessment Program.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: August, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop protection, and environmental science.

Aggregation level: Cropping system/animal husbandry system, and other: multiple ecosystems.

Description: PRE-AP is a shell, database and assessment tool built around the GLEAMS model.

It is a simulation assessments at an early stage of research and development. The database currently carries 10 major crops, 15 years of climate data and three levels of tillage or management. The ecosystems are based on United States conditions but can be replaced with other soils and climate data. Multiple ecosystems and years are compared to assess the potential environmental exposure risks.

Input data: Crop, tillage methods, pesticide name, application rate and method.

Number of input data: 35.

Output data: Pesticide losses from multiple sites and years as a function of site specific data such as organic matter.

Number of output data: 30.

Time interval of simulation: 1 Day time period for 15 years.

Basic spatial unit: 40 Hectare homogeneous fields.

References general validation:

Griggs, R.H. & J.K. Estes, 1995. PREAP: Pesticide Registration and Environmental Assessment Program - An Early Research Screening Model for Experimental Agricultural Pesticides. In: Leng, M.L., E.M.K. Leovey & P.L. Zubkoff. Agrochemical Environmental Fate Studies: State of the Art. Lewis Publishers, Washington, D.C.

Stand alone model: Yes.

Parentage: GLEAMS - Ground water Loading Effects of Agricultural Management Systems.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC DOS math co-processor, 8 megs RAM, 40 meg hard drive.

Programming language: Microsoft FORTRAN and C.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: New Windows version with additional crops, sites and 30 years of climate to be released in early 1996.

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GENERAL OVERVIEW

Name and version: Principles of theoretical production ecology

Date first profile: September, 1994.

Date last profile: October, 1995.

Update: -

Program type: Other.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for TEACHING: 1

New release expected: Yes, 1997; to be published in the Kluwer Series: 'Current issues in production ecology'.

Subject: Crop science, soil science, and crop protection.

Description: Textbook on quantitative aspects of crop production, as introduction to crop simulation modelling, with specific reference to SUCROS* and WOFOST* and the associated courseware 'CMN crop ecology'. The approach is based upon integrating basic meteorological, physical, chemical and plant physiological processes that determine crop growth. In order of decreasing production level, distinction is made between: 1. Defining growth factors, determining potential production: radiation, temperature and crop characteristics, in relation to CO₂ assimilation, respiration, development and dry matter distribution; 2. Limiting growth factors, determining attainable production: water, focusing on function of water, water demand, energy balance, stomatal behaviour, water balance, soil water relations, transpiration-assimilation relations and water use efficiency; 3. Nutrients, with emphasis on function of minerals, application, uptake and crop response relations, and nutrient cycling; 4. Reducing growth factors, determining actual production: weeds, pests, diseases and pollutants.

TECHNICAL SPECIFICATIONS

User's guide available:

Lovenstein, H., E.A. Lantinga, R. Rabbinge & H. van Keulen, 1993. Principles of Theoretical Production Ecology. WAU-TPE and CABO-DLO. Text for course F300-001. Wageningen, December 1995.

Costs: Dfl. 15,75

COMMENTS: -

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GENERAL OVERVIEW

Name and version: PTARG, RC and RECPF

Title: Simple P balance model.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: -

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Soil science.

Aggregation level: Crop/herd.

Description: A simple phosphorus balance model to calculate long-term changes in available soil phosphorus, phosphorus uptake by the crop and recovery of applied phosphorus. It functions with time intervals of one year or one growing season. A special version (PTARG) can be applied to establish fertilizer recommendations for a certain target phosphorus uptake by the crop.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Base P uptake rate, total P uptake rate, change in labile P and stable organic P.

Number of rate variables: 4.

State variables: See output data (except for fertilizer-P required).

Number of state variables: 5.

Input data: Time constants of dissolution/precipitation, P mineralization, fertilizer-P applied, P partitioning factors.

Number of input data: 7.

Output data: Labile P pool, stable P pool, base P uptake, total P uptake, fertilizer-P required, recovery of fertilizer-P.

Number of output data: 6.

Time interval of simulation: 1 Year or 1 growing season.

Basic spatial unit: Ha.

References general validation:

Wolf, J., C.T. de Wit, B.H. Janssen & D.J. Lathwell, 1987. Modeling long-term crop response to fertilizer phosphorus. I. The model. II Comparison with field results. *Agronomy Journal* 79: 445-451 and 452-458

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: Microsoft FORTRAN.

Other software required: FORTRAN compiler.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: QUASI

Title: QUantitative Analysis of (agro-eco-) Systems at higher Integration levels.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: 1995.

Program type: Other: book.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for TEACHING: 1

New release expected: Yes, 1997.

Subject: Land use studies.

Description: QUASI is an advanced course for students able to contribute to interdisciplinary studies. The objectives of the course are: - to get acquainted with and learn to apply quantitative methods to explore and design future land use options for agro-ecosystems at higher integration levels; - to learn obtaining secondary data from literature or simulation models about lower integration levels and applying this in interdisciplinary studies; - to learn working in interdisciplinary working groups. During the course quantitative methods to analyze complex agro-ecosystems at higher integration levels will be presented. Higher integration levels may be regions, countries or continents, contrary to lower integration levels like plot, parcel and farm. These methods may be valuable for the exploration of future land use options, taking into account conflicting economical, social or environmental objectives. Quantified knowledge on agricultural production is confronted with conflicting objective functions distilled from the various policy views in an Interactive Multiple Goal Linear Programming model. With this interactive method land use scenarios can be generated for different policy views, showing the trade offs between the various objectives. These explorative studies for future land use may help policy makers in explicitizing the consequences of different aims for land use. The course is interdisciplinary and each student contributes from his own background. Experience and knowledge on the lower integration levels, obtained in other courses, applied for the analysis of higher integration levels. In QUASI students will get acquainted with the methods during 24 day-parts of 4 hours each, making use of two case-studies with optimization programmes running on PC. One case-study addresses the temperate climate (Four perspectives for the rural areas in the EC) and one the tropical climates (Competing for limited resources in the 5th region of Mali). The following subjects are treated, either in introductions or in exercises/practical training: 1. Introduction to agro-ecosystems and their hierarchy and to land use studies. 2. Why explorative land use studies ? 3. Introduction to mathematical programming techniques: linear programming and multiple criteria analysis. 4. Introduction to the case studies (Mali and EC) 5. Methodology for explorative land use studies. 6. Quantifying input and output relations. 7. Sensitivity analysis. 8. Exercises with the case study models. 9. Explorative land use studies in the context of land use planning. The case-studies are described on separate forms.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: -

State variables: Not applicable.

Number of state variables: -

Input data: Not applicable.

Number of input data: -

Output data: Not applicable.

Number of output data: -

Time interval of simulation: Not applicable.

Basic spatial unit: Not applicable.

References general validation:

Ittersum, M.K. van & N. de Ridder, 1995. Quantitative analysis of (agro-eco-)systems at higher integration levels (QUASI). Wageningen Agricultural University. Department of Agronomy & department of Theoretical Production Ecology.

Stand alone model: Not applicable.

Parentage: Not applicable.

Check internal consistency or material balance present: Not applicable.

Input check in model: Not applicable.

TECHNICAL SPECIFICATIONS

Hardware: Not applicable.

Programming language: Not applicable.

Other software required: Not applicable.

COMMENTS: The LP software package OMP is hardware bound.

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GENERAL OVERVIEW

Name and version: RANGETEK

Date first profile: November 30th, 1995.

Date last profile: November 30th, 1995.

Program type: Simulation model/module.

Purpose: To improve the ease of data input and interpretation of output data.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Soil science: hydrology, range science.

Aggregation level: Other: rangeland site (homogeneous soil and vegetation).

Description: RANGETEK is a deterministic simulation model with expert system technology.

This is a slightly modified and improved version of the ERHYM-II* model. It includes expert system technology to improve the ease of data input and interpretation of output data. The model provides simulation of a daily water balance and calculation of annual yield indices based on the ration of actual to potential transpiration. The model runs on a daily time step with daily inputs of maximum and minimum air temperatures and solar radiation. Water added to the soil profile is the difference between precipitation and runoff. The SCS curve number procedure as described in CREAMS is used to estimate runoff. When the profile is full, surplus water becomes drainage. Potential evapotranspiration is calculated by a modified Penman equation as described in SPUR. Actual soil and plant evaporation are based on potential evapotranspiration, soil water content, average site leaf area index and a relative growth curve.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evaporation, transpiration, soil water dynamics, plant growth.

Number of rate variables: < 20.

State variables: Soil textural composition, water content, bulk density, leaf area index.

Number of state variables: < 40.

Input data: Daily precipitation, maximum and minimum air temperatures and solar radiation, field capacity and permanent wilting water contents for each soil layer, initial soil water content, average site herbage yield at peak standing crop, and dates for start of growing season, peak standing crop, and end of growing season. Model input data source: Various weather records, SCS soil and range surveys, and field-measured values.

Number of input data: < 40.

Output data: Calculated daily values of potential and actual soil and plant evaporation from each soil layer, daily soil water contents, cumulative actual and potential transpiration, and graphic display of these values.

Number of output data: < 20.

Time interval of simulation: Day.

Basic spatial unit: Spatial scale: Range site specific.

Stand alone model: Yes.

Parentage: ERHYM-II*.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: 640 K of memory, a colour monitor, and DOS 3.0 or better operating system.

Programming language: BASIC and C++.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: RECAFS 1.0

Title: Modelling resource competition and cycling in agroforestry systems.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: December, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science, soil science, and forestry.

Aggregation level: Cropping system/animal husbandry system.

Description: Basically, the model simulates the absorption of light, water and nitrogen by each species, the dry matter production as a function of the absorbed resources and the effect of resource depletion by both species upon the availability of light, water and nitrogen. The tree population, as described in the model, consists of a number of trees planted in a rectangular planting pattern. The area per tree has been subdivided into 3 subareas and the herbaceous development of each subarea is simulated separately. Light interception by the trees and remaining light availability at ground level for each subarea is simulated and the production of both species is calculated by using the LUE approach. The potential soil evaporation and the potential herb transpiration per subarea are calculated with the Penman-Monteith equation. For simulating the potential tree transpiration, the WUE approach has been applied. Actual water uptake is modelled as a function of soil water status and root length distribution of both species. A simple soil water balance (storage overflow concept) with a number of horizontal layers has been incorporated separately for each subarea. Lateral soil water movement is thus not modelled. Uptake of nitrogen has been related to availability in the soil, root length distribution and the demand for nitrogen of living plant biomass. Net nitrogen mineralization is calculated in dependence of carbon-nitrogen ratios in the soil organic matter. Growth of several plant parts is simulated by partitioning the biomass production of each species among its plant parts. Death of plant parts has also been modelled providing carbon and nitrogen input for the soil organic matter. Modelling objectives are: 1. to predict the herbage growth underneath and outside the tree crown. 2. to simulate the effects of a tree population on water and nutrient availability of the agro-ecosystem. 3. to calculate the production possibilities of a mixed culture of trees and herbs.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Light absorption, water uptake, nutrient uptake/partitioning, dry matter production/partitioning, leaf area growth, rooted depth extension, senescence, soil organic matter input (C & N), organic matter decomposition, net nitrogen mineralization, infiltration and redistribution of soil water, soil nutrient flow.

Number of rate variables: > 25.

State variables: Dry weight, N content of leaves, stems, roots and generative organs of the herbaceous species for each subarea (3), dry weight, N content of leaves, stems, branches, roots and generative organs of the tree species, leaf area of both species, root length distribution, water and mineral N content per soil layer, C and N content of the soil organic matter.

Number of state variables: > 25.

Input data: Geographical latitude, daily weather data, plant and tree density, tree crown size and form, nutrient input rates, morpho-physiological characteristics of tree and herb species,

volumetric soil water content at air-dry, wilting point and field capacity, initial amount of C and N in soil organic matter, decomposition constants, critical N/C ratios.

Number of input data: > 50 per species.

Output data: Values of all state and rate variables and their cumulative values

Number of output data: > 25.

Time interval of simulation: 1 day.

Basic spatial unit: 1 ha.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, IBM compatible PC/AT \geq 640 Kb RAM; ROM

Programming language: Microsoft FORTRAN.

Other software required: TTUTIL* and CABO/TPE Weather System*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: The model has been developed to assess the effect of trees on the nutrient use efficiency in producing fodder in the semi-arid region of the Sahel-Sudan zone in West-Africa.

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GENERAL OVERVIEW

Name and version: RENLEM 2

Title: REgional Nitrate LEaching Model.

Date first profile: December, 1994.

Date last profile: December, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Soil science, and environmental science.

Aggregation level: Region.

Description: RENLEM is a deterministic steady-state nitrate leaching model, which includes relatively simple concepts for processes like mineralization, volatilization, nitrification and denitrification. The model considers two periods of calculation: summer (growing season) and winter (leaching period). For these two seasons the nitrate concentration of the water leaching to the ground water is calculated. The model is developed for calculating the long-term regional effects of various nitrate management scenarios for an average hydrological year.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Nitrification, denitrification, mineralization, volatilization.

Number of rate variables: Approximately 75.

State variables: Amounts of N: in manure, in fertilizer, in crop, in soil, leached etc.

Number of state variables: Approximately 70.

Input data: Soil data (pH, bulk density, organic matter content), fertilizer and animal manure application data, manure type (cattle slurry, pig slurry, poultry slurry or poultry manure), grazing management, crop data (uptake, rooting depth, etc.), N-deposition and average hydrological data (moisture content, precipitation surplus).

Number of input data: Approximately 100 (depending on chosen options).

Output data: Balance terms for the N-balance per season and per soil layer (inputs and outputs) and average concentrations in the soil water.

Number of output data: Approximately 70.

Time interval of simulation: Half year (summer-winter).

Basic spatial unit: Ha.

References general validation:

Kragt, J.F. & W. de Vries, 1988. Onderzoek naar de effecten van mestbeperking op de nitraatuitspoeling in waterwingebieden in Overijssel. 2. Gevoeligheidsanalyse en toetsing van het model RENLEM. Wageningen. Stichting voor Bodemkartering. Rapport 2073.

Kragt, J.F., W. de Vries & A. Breeuwsma, 1990. Modelling nitrate leaching on a regional scale. In: Merckx, R., H. Vereecken & K. Vlassak (eds.), 1990. Fertilization and the environment. Leuven University Press. 340-347

Kragt, J.F., W. de Vries & R. Visschers, 1990. Onderzoek naar de effecten van mestbeperking op de nitraatuitspoeling in grondwaterbeschermingsgebieden in Overijssel. 3. Toepassing van RENLEM op zeven kwetsbaar geachte grondwaterbeschermingsgebieden. Wageningen, Staring Centrum. Rapport 38.

Kragt, J.F. & M.J.D. Hack-ten Broeke, 1991. Brief description of RENLEM. In: CEC, 1991. Nitrate in Soils, Soil and Groundwater Research Report II, EUR 13501 EN. 253-255

Kragt, J.F. & M.J.D. Hack-ten Broeke, 1991. Performance of the model RENLEM. In: CEC, 1991. Nitrate in Soils, Soil and Groundwater Research Report II, EUR 13501 EN. 281-287

Stand alone model: Yes.

Parentage: RENLEM 1.

Check internal consistency or material balance present: Yes.

Input check in model: Some.

TECHNICAL SPECIFICATIONS

Hardware: VAX, PC - MS-DOS.

Programming language: Microsoft FORTRAN-77.

Other software required: No.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes.

Costs: None.

COMMENTS: - It is difficult to distinguish rate and state variables in a steady-state model. It would be plausible to call all variables state variables in the model. - The model has been distributed among only few research colleagues and is not very user-friendly. It is a rather simple model and therefore not much help is needed to get started.

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GENERAL OVERVIEW

Name and version: ReSAM 1.0

Title: Regional Soil Acidification Model.

Date first profile: September, 1995.

Date last profile: September, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Environmental science.

Aggregation level: Region.

Description: ReSAM is a process-oriented, dynamic simulation model, that describes changes in soil chemistry both in the solid and in the liquid phase for given rates of atmospheric deposition.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Weathering rates, mineralization rates, nitrification rates, litter fall, root decay, denitrification, folio exudation, growth rate.

Number of rate variables: About 35.

State variables: Absorbed amount of cations, concentration, AL-hydroxide content, amount of leaves, roots, stems, litter, branches, total element content in the soil, element content biomass.

Number of state variables: About 50.

Input data: Deposition, water fluxes, rates of (bio)chemical processes, initial element content in biomass and soil (total, exchange complex).

Number of input data: > 150 (depending on number of soil horizons).

Output data: Concentration soil solution, element content solid phase and biomass, amount of biomass, element fluxes of considered processes.

Number of output data: > 150 (depending on number of soil horizons).

Time interval of simulation: Days (internal) -> output -> year.

Basic spatial unit: Ha.

References general validation:

Vries, W. de, J. Kros & C. van der Salm, 1995. Modelling the impact of acid deposition and nutrient cycling on forest soils. *Ecological Modelling* 79: 231-245

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes, partial.

TECHNICAL SPECIFICATIONS

Hardware: PC, VAX, Alpha.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes.

Costs: None.

COMMENTS: The model is available as soon as the documentation is finished (expected before June 1996).

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GENERAL OVERVIEW

Name and version: Ribasim 6.0

Title: River Basin Simulation model.

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: October, 1995.

Program type: Simulation tool: Simulation model package.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes, 1996.

Subject: River basin management and planning.

Aggregation level: Region, and other: national, basin, sub-basin.

Description: Ribasim is a generic model package for the simulation of the behaviour of complex river basins over time. It is a tool for generating and evaluating the hydrologic performance of alternative water resources development schemes comprising different types of measures: technical, operational, institutional.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Irrigation demands, public water demand, minimum flow requirement, etc.

Number of rate variables: -

State variables: Storage of water in reservoirs and ground water, flows at various locations.

Number of state variables: -

Input data: Physical characteristics of basin, operational parameters.

Number of input data: -

Output data: Water allocation, power production.

Number of output data: -

Time interval of simulation: Monthly, half-monthly, decade, or daily.

Basic spatial unit: National, regional, river basin, sub-basin.

References general validation:

Waterloopkundig Laboratorium, 1991. W & M kwaliteitshandboek. Deel: Waterbeheer en Milieu. Oktober 1991.

Stand alone model: Yes.

Parentage: MITSIM (MIT Cambridge, United States).

Check internal consistency or material balance present: Yes.

Input check in model: Yes, graphical from map of study area interactively.

TECHNICAL SPECIFICATIONS

Hardware: PC 486 or higher.

Programming language: Microsoft FORTRAN, Visual Basic, C.

Other software required: MS Windows.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Depends on consultancy input (about Dfl. 15 000,-).

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GENERAL OVERVIEW

Name and version: RIGAUS 1.0

Title: Random Input Generator for the Analysis of Uncertainty in Simulation.

Date first profile: May, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

Description: RIGAUS generates random parameter values from uniform, beta and normal statistical distributions and from actual measurement series. The generated parameter values are randomly combined in parameter sets for reruns with simulation models. The generated parameter sets can be used for Monte Carlo simulation for the analysis of uncertainty and/or (spatial, temporal, genetic) variation with crop growth and water balance models under the FORTRAN Simulation Environment (FSE*). However, the generated parameter values can also be used with other simulation programs as well. RIGAUS has special provisions for the generation of random parameter values for the soil water balance model SAHEL that take correlation between soil moisture characteristics into account.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: Not applicable.

State variables: Not applicable.

Number of state variables: Not applicable.

Input data: Names of parameters to be generated, type of statistical distributions, upper/lower limits, statistical parameters, number of values to be generated.

Number of input data: User defined.

Output data: Names of generated parameters, parameter values.

Number of output data: User defined.

Time interval of simulation: Not applicable.

Basic spatial unit: Not applicable.

Stand alone model: Yes, but also incorporated in FSU*.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Extensively.

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, IBM compatible PC/AT \geq 640 Kb RAM.

Programming language: Microsoft FORTRAN-77.

Other software required: FORTRAN utility library and TTUTIL*.

User's guide available:

Bouman, B.A.M. & M.J.W. Jansen, 1993. RIGAUS, Random Input Generator for the Analysis of Uncertainty in Simulation. Simulation Report CABO-TT no. 34. AB-DLO. 26 pp + appendices.

Application reports:

Bouman, B.A.M., 1994. A framework to deal with uncertainty in soil and management parameters in crop yield simulation: a case study for rice. *Agricultural Systems* 46: 1-17

Bouman, B.A.M., M.C.S. Wopereis & J.J. Riethoven, 1994. Crop growth modelling in agro-ecological zonation of rice. Simulation and System Analysis for Rice Production (SARP). AB-

DLO. 135 pp.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 230,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: ROTHC-26.3

Title: A model for the turnover of carbon in soil.

Date first profile: May, 1995.

Date last profile: May, 1995.

Update: May, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 3

New release expected: Yes.

Subject: Soil science, forestry, farming systems, and land use systems.

Description: ROTHC-26.3 is a model of the turnover of organic carbon in non-waterlogged soils that allows for the effects of soil type, temperature, moisture content and plant cover on the turnover process. ROTHC-26.3 was originally developed and parameterized to model the turnover of organic carbon in arable soils under a range of soil and climatic conditions. It has been extended to model turnover in temperate grassland and forest sites. It should be used cautiously outside this range.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Decomposition.

State variables: Partitioning.

Input data: Monthly rainfall, monthly open pan evaporation, average monthly air temperature, clay content of the soil, decomposability estimate, soil cover, monthly input of plant residues, monthly input of farm yard manure.

Number of input data: 8.

Output data: Total organic carbon, microbial biomass carbon, delta14C, radiocarbon age of the soil.

Number of output data: 4.

Time interval of simulation: Month.

Basic spatial unit: Ha.

References general validation:

Coleman, K. & D.S. Jenkinson, 1995. ROTHC-26.3. A model for the turnover of carbon in soil. IACR Rothamsted, Harpenden, Herts, AL5 2JQ. 16 pp.

Stand alone model: Yes.

Parentage: Jenkinson and Rayner, 1977 and Hart, 1984.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM or IBM compatible 286 PC or higher.

Programming language: Microsoft FORTRAN-77.

Other software required: None.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: RUSLE

Title: Revised Universal Soil Loss Equation.

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

Subject: Soil science.

Description: RUSLE is an empirical model for predicting erosion in the form of annual soil loss. This in turn can be used to assist in making field-management decisions that affect soil loss. Can be incorporated in more comprehensive models, such as EPIC* and AGNPS to permit more complete problem resolutions involving surface water quality. Model solves the equation $A = RKLSCP$ where A is the computed annual soil loss; R is the rainfall-runoff erosivity factor, K is a soil erodibility factor; LS is a topographic factor combining slope length (L) and slope steepness (S); C is a cover-management factor; and P is a supporting practices factor. RUSLE computes values for each of these factors based on input data describing the field, climate, and management conditions. Keywords: soil loss, erosion, water. Global change implications: RUSLE could potentially have a large impact on knowledge of soil erosion rates for various locations around the world. EPIC*, for example, has been used widely in over 20 different countries; one component in EPIC* is the USLE. The USLE was very sensitive to the C factor used for each cell; in many cases this value was estimated. It is hoped that modifications to determining the C factor may improve estimates of soil erosion.

Input data: Existing model data files include the: (1) city database (the city database contains climate parameter and variable values for hundreds of United States cities), (2) crop database (the crop database contains plant data representing above-ground and below-ground characteristics), and (3) operation database (the operations database contains farming and soil-disturbing factors). The crop and operations databases contain information describing a variety of agronomic crops and a wide range of field operations. Model input data source: User-defined data files may be used to supplement and modify existing model databases (city, crop, and operations).

Output data: Annual soil loss, and values for the five model parameters (R, K, LS, C, and P).

Time interval of simulation: Temporal scale: Average annual soil loss, but simulation done on twice-monthly basis.

Basic spatial unit: Spatial scale: Hill slopes on a per-unit-width basis.

Stand alone model: Yes.

Parentage: RUSLE is a modified version of the USLE model.

TECHNICAL SPECIFICATIONS

Hardware: IBM 386 PC or compatible with hard disk and math co-processor.

Programming language: C.

Technical reference:

Renard, K.G., G.R. Foster, G.A. Weesies & J.P. Porter, 1991. RUSLE: Revised Universal Soil Loss Equation. *Journal of Soil Water Conservation* 46: 30-33

Renard, K.G. & V.A. Ferreira, 1993. RUSLE, Model Description and Database Sensitivity. *Journal of Environmental Quality* 22: 458-466

Renard, K.G., G.R. Foster, D.C. Yoder & D.K. McCool, 1994. RUSLE revisited: Status, questions, answers and the future. *Journal of Soil and Water Conservation* 49(3): 213-220

Renard, K.G. & J.R. Freimund, 1994. Using Monthly Precipitation Data to Estimate the R-Factor in the Revised USLE. *Journal of Hydrology* 157: 287-306

Executable available: Yes, RUSLE is available from the Soil and Water Conservation Society, Iowa, United States.

Costs: \$ 295 for software and User's manual.

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GENERAL OVERVIEW

Name and version: RZWQM

Title: Root Zone Water Quality Model.

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Purpose: To simulate water, chemical and biological processes in and on top of the root zone, as well as solute movement from the bottom of the root zone to the water table.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

Subject: Soil science (hydrology), and farming systems.

Aggregation level: Cropping system/animal husbandry system.

Description: The RZWQM is a process-oriented simulation model. The purpose of the model is to simulate water, chemical and biological processes in and on top of the root zone. The model also examines solute movement from the bottom of the root zone to the water table (DeCoursey et al., 1992). The model includes components for management practices, pesticide degradation dynamics, nutrient cycling and hydrologic dynamics. Site description and initial profile state are established. With a daily time step, management practices are implemented, pesticides are degraded, nutrient chemistry is updated, solution chemistry is updated, plant growth takes place. With an hourly time step infiltration and macropore flow are simulated; evapotranspiration, water redistribution, heat flux, energy balance, water and nutrient uptake are processed. The pesticide model RZWQM allows for three options: 1. instantaneous equilibrium 2. partial instantaneous approach to equilibrium 3. kinetic approach throughout using the 2-sequential-i equilibrium model. RZWQM also allows for a slower 'binding' step that mimics the often-observed increasingly less-desorbable behaviour of pesticides in soils after weeks to months of residence time. Keywords: hydrology, root zone. Global change implications: This model can be used for global change research to examine the interactions of pesticides, soils and hydrologic factors in the root zone. It is also important because it includes many different components: biological, physical and social (e.g. management). It is currently undergoing beta-testing at six sites.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Pesticide degradation, nutrient cycling, plant growth.

Number of rate variables: Many.

State variables: Water, temperature, aqueous chemistry, nutrient carbon pool profiles; plant growth, snow pack.

Number of state variables: Many.

Input data: Daily meteorology, breakpoint rainfall information, output report specifications, and initial state of the soil profile are needed. Main parameterization data file contains information on soil profile description, soil chemistry, pesticides, plant growth, nutrients, and management. Daily meteorology can be obtained from NWS (National Weather Service) monitoring stations. Break point rainfall data is obtained from strip charts. Initial soil state is from soil cores. Main parameterization information is obtained from published reports, field observations, and intuitive knowledge.

Number of input data: Many.

Output data: Hundreds of items are available from the model. They can be presented to the user in tabular form, high resolution graphics (both 2-D and 3-D). Detailed output on nitrogen fate, pesticide fate, plant growth, water and solute transport, management effects on simulations.

Number of output data: Hundreds.

Time interval of simulation: Daily and hourly.
Basic spatial unit: Unit area.
Stand alone model: Yes.
Parentage: None, original work.
Check internal consistency or material balance present: Yes.
Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: The simulation model will run on an IBM compatible 386 or better PC. Successfully operated on DEC-VMS, UNIX, HP-UNIX, SUN-OS, IBM-VM, and DEC Ultrix. Run time on a 486 class is 10 minutes per simulation year. Reportwriter requires PC.

Programming language: The simulation model is written in ANSI standard Microsoft FORTRAN-77. Output report generators are written in C.

Technical reference:

DeCoursey, D., L. Ahuja, J. Hanson, M. Shaffer, R. Nash, C. Hebson & K. Rojas, 1992. Root Zone Water Quality Model: version 1.0: technical documentation. USDA-ARS, GPSR Technical Report No. 2. Great Plains Systems Research Unit, Fort Collins, Colorado.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: SAWAH 2.0

Title: Simulation Algorithm for Water flow in Agucic Habitats.

Date first profile: September, 1994.

Date last profile: October, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Soil science.

Description: The soil water balance model SAWAH simulates one-dimensional vertical movement of water in soil based on the Darcy equation and mass conservation. The model handles both saturated and unsaturated flow, including perched water tables. It was designed to model water flow in rice fields.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Fluxes between compartments, changes of water content per layer, change of ponded water depth, overall water balance terms rainfall, capillary rise etc.

Number of rate variables: 20.

State variables: Water content per layer, depth of ponded water, cumulative water balance terms.

Number of state variables: 20.

Input data: Soil characteristics, ground water daily values.

Number of input data: 20.

Output data: All states and rates variables.

Number of output data: 50.

Time interval of simulation: Variable: seconds-minutes for flux calculations; days for interacting with higher level models (crops).

Basic spatial unit: m².

References general validation:

Berge, H.F.M. ten, D.M. Jansen, K. Rappoldt & W. Stol, 1992. The soil water balance module SAWAH: description and users guide. Simulation Report CABO-TT no. 22. Centre for Agrobiological Research and Dept. of Theoretical Production Ecology. Wageningen. The Netherlands. 78 pp. and 4 appendices.

Berge, H.F.M. ten, K. Metselaar, M.J.W. Jansen, E.M. de San Agustin & T. Woodhead, 1995 / 1996 ?. The SAWAH riceland hydrology model. Accepted for publication in Water Resources Researches.

Stand alone model: No.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN-77.

Other software required: TTUTIL*.

Source code available: Yes.

Executable available: Yes

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: The model is written in the form of a subroutine with underlying routines. It used two levels of time steps for integration of rate variables, and performs an extra (dummy) loop to calculate and integrate daily average rates.

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GENERAL OVERVIEW

Name and version: SBFLEVO

Title: Growth model to simulate crop growth, optical reflectance and radar backscatter of sugar beet.

Date first profile: May, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

Subject: Crop science.

Description: The model simulates daily growth of a sugar beet crop on the basis of underlying physiological and physical processes (e.g. light interception, photosynthesis, respiration), and its optical reflectance and radar backscatter on the basis of physical interaction processes. The crop model part is SUCROS*87 for potential crop growth (i.e. ample supply of water and nutrients, no pests, weeds and diseases). The rate of dry matter accumulation is a function of irradiation, temperature and crop characteristics. The optimal reflectance model is EXTRAD: optical reflectance is simulated in the green, red and infrared bands from soil and crop optical properties, leaf area index, canopy architecture and illumination conditions. The vegetation indices NDVI, WDVI and IR/R-ratio are calculated. The radar backscatter model is CLOUD: radar backscatter (gamma) is simulated from the amount of water in the soil and in the canopy and from soil and canopy backscatter characteristics for several angles of incidence, VV and HH polarization and in Ku1, Ku2, X, C, S and L-bands. All submodels have been parameterized and validated on data collected during several remote sensing campaigns in (South-)Flevoland, The Netherlands, between 1980-1988 (ground based ROVE, Agriscatt).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Phenological development, leaf and canopy photosynthesis (gross, net), maintenance and growth respiration, crop growth, growth of plant organs.

Number of rate variables: > 50.

State variables: Biomass (total, and per crop organ e.g. leaf, stem, root, tuber), leaf area index, soil cover, intercepted light. Auxiliary variables: reflected solar radiation, vegetation indices, radar backscatter.

Number of state variables: > 50.

Input data: Geographical latitude and longitude, weather data (daily radiation, minimum and maximum temperature), top soil moisture content, crop specific physiological and morphological properties, canopy reflection characteristics, canopy and soil radar backscatter characteristics, crop management information.

Number of input data: 75.

Output data: Crop rate and state variables (e.g. leaf area index, soil cover, biomass), optical canopy reflection, vegetation indices (NDVI, WDVI, IR/Gr ratio), radar backscatter (multi-incidence angle, VV and HH polarization, multi-frequency).

Number of output data: 15.

Time interval of simulation: 1 day.

Basic spatial unit: Field level (some m²).

References general validation:

Bouman, B.A.M., 1992. SBFLEVO and WWFLEVO, Growth models to simulate crop growth, optical reflectance and radar backscatter of sugar beet and winter wheat, calibrated for

Flevoland. CABO-DLO report 163. CABO-DLO Wageningen, The Netherlands. 116 pp.

Stand alone model: Yes.

Parentage: SUCROS*87 and EXTRAD.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, IBM compatible PC/AT \geq 640 Kb RAM.

Programming language: Microsoft FORTRAN-77.

Other software required: FORTRAN utility library.

Application reports:

Bouman, B.A.M., 1992. Linking physical remote sensing models with crop growth simulation models, applied to sugar beet. International Journal of Remote Sensing vol 13 no. 14: 2565-2581

Clevers, J.G.P.W., C. Buker, H.J.C. van Leeuwen & B.A.M. Bouman, 1994. A framework for Monitoring crop growth by combining directional and spectral remote sensing information.

Accepted for publication in Remote Sensing of Environment 1994.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: SBFLEVO_OPT

Title: Program to calibrate crop growth model SBFLEVO* for sugar beet in Flevoland on optical reflectance and/or radar backscatter data.

Date first profile: May, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 1

Subject: Crop science.

Description: This model parameterizes the combined 'remote sensing - crop model' SBFLEVO* for sugar beet on measured time series of optical reflectance (vegetation indices) and/or radar backscatter. The values of the crop parameters sow date, relative growth rate, light use efficiency and maximum leaf area are optimized in such a way that the difference between simulated and measured time courses of the remote sensing signals is minimal. [The optimization procedure can also be applied using measured values of crop parameters (e.g. leaf area index, biomass)]. The optimized values of the crop growth and final yield of the sugar beet crop from which the remote sensing observations have been taken.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Phenological development, leaf and canopy photosynthesis (gross, net), maintenance and growth respiration, crop growth, growth of plant organs.

Number of rate variables: > 50.

State variables: Biomass (total, and per crop organ leaf, stem, root, tuber), leaf area index, soil cover, intercepted light. Auxiliary variables: reflected solar radiation, vegetation indices, radar backscatter.

Number of state variables: > 50.

Input data: Geographical latitude and longitude, weather data (daily radiation, minimum and maximum temperature), top soil moisture content, crop specific physiological and morphological properties, canopy reflection characteristics, canopy and soil radar backscatter; crop management information.

Number of input data: 75 model parameters; user-defined number of observations.

Output data: Optimized values for the model parameters sow date, relative growth rate, light use efficiency, maximum leaf area. These data can be used in the model SBFLEVO* to simulate crop growth, yield, optical reflection and radar backscatter.

Number of output data: 4.

Time interval of simulation: 1 day.

Basic spatial unit: Field level (some m²).

References general validation:

Bouman, B.A.M., 1992. SBFLEVO_OPT, A program to calibrate the crop growth model SBFLEVO for sugar beet in Flevoland on optical reflectance and/or radar backscatter data. CABO-DLO report 164. CABO-DLO Wageningen, The Netherlands. 104 pp.

Stand alone model: Yes.

Parentage: SBFLEVO* and FSEOPT*.

Check internal consistency or material balance present: -

Input check in model: -

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, IBM compatible PC/AT \geq 640 Kb RAM.

Programming language: Microsoft FORTRAN-77.

Other software required: FORTRAN utility library.

Application reports:

Bouman, B.A.M., 1992. Linking physical remote sensing models with crop growth simulation models, applied to sugar beet. International Journal of Remote Sensing vol 13 no. 14: 2565-2581

Clevers, J.G.P.W., C. Buker, H.J.C. van Leeuwen & B.A.M. Bouman, 1994. A framework for Monitoring crop growth by combining directional and spectral remote sensing information.

Accepted for publication in Remote Sensing of Environment 1994.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: SBORER 2

Title: Model for the crop-pathosystem rice - stem borer.

Date first profile: May, 1994.

Date last profile: October, 1995.

Update: July 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop protection.

Description: The SBORER model simulates the effects on damage of a stem borer infestation in a rice crop at any moment during the growing season. It includes a tiller module which accounts for the dynamics of healthy tillers, dead hearts and white heads. The model is detailed with respect to growth and loss rates and weights of plant organs (leaves, structural stem material, stem reserves, roots, storage organs) of the three tiller classes. The stem borer infestation rate has to be defined as input, and is used in the tiller module to determine the number of healthy tillers, dead hearts and white heads, and to calculate kernel density. Kernel density and grain filling rate determine sink capacity. The stem borer infestation is also used to calculate weights of various plant organs of all tiller classes, which leads to determination of green area index and source capacity. Sink and source capacity are compared, and the growth rate of storage organs is computed. The basis structure of the model is similar to ORYZA1*.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Crop growth and senescence, tiller formation and death, stem borer infestation rate, crop development.

Number of rate variables: > 25.

State variables: Plant organ weights, tiller density, tiller weights, leaf area.

Number of state variables: > 25.

Input data: Stem borer infestation rate, leaf area, development rate, relative growth rate.

Number of input data: > 25.

Output data: Plant organ weights, tiller density and weight.

Number of output data: As desired, > 25.

Time interval of simulation: 1 day.

Basic spatial unit: 1 ha.

Stand alone model: Yes.

Parentage: ORYZA1* and L1DSTB.

Check internal consistency or material balance present: Yes.

Input check in model: No, the inputs are not checked in the program, however if the inputs are not available, the model terminates.

TECHNICAL SPECIFICATIONS

Hardware: \geq 640 Kb RAM.

Programming language: Microsoft FORTRAN-77.

Other software required: FORTRAN and MS-DOS.

User's guide available:

Elings, A. & E.G. Rubia, 1994. Models for the crop-pathosystems rice - bacterial leaf blight,

sheath blight and stem borer. AB-DLO, TPE-WAU, Wageningen, IRRI, Los Banos. 102 pp.

Technical reference:

Elings, A. & E.G. Rubia, 1994. SBORER: a model for the crop-pathosystem rice - stem borer. In: Elings, A. & E.G. Rubia (Editors). Analysis of damage mechanisms by pests and diseases and their effects on rice yield. SARP Research Proceedings. AB-DLO, TPE-WAU, Wageningen. IRRI, Los Banos. 83-101

Application reports:

Elings, A., 1993. Damage by bacterial leaf blight and sheath blight in rice: a quantitative simulation model. In: Rossing, W.A.H., E.G. Rubia, K.L. Heong, M. Keerati-Kasikorn & P.R. Reddy (Editors). Mechanisms of damage by stem borer, bacterial leaf blight and sheath blight, and their effects on rice yield. SARP Research Proceedings. Proceedings of workshops in Khon Kaen, Thailand, 3-5 August 1992, and Cuttack, India, 3-5 March 1993. DLO-Centre for Agrobiological Research, Wageningen. Dept. of Theoretical Production Ecology, Wageningen. IRRI, Los Banos. 79-109

Rubia, E.G., 1994. Calibration of the SBORER model for cultivars IR64 and Binato. In: Elings, A. & E.G. Rubia (Editors). Analysis of damage mechanisms by pests and diseases and their effects on rice yield. SARP Research Proceedings. AB-DLO, TPE-WAU, Wageningen. IRRI, Los Banos. 102-110

Rubia, E.G. & Xu Zhihong, 1994. Simulation of the effect of stem borer injury on grain yield of rice. SARP internal publication.

Zhihong Xu, E.G. Rubia & A. Elings, 1994. Application of the SBORER model to analyze combined stem borer and leaf folder infestation. In: Elings, A. & E.G. Rubia (Editors). Analysis of damage mechanisms by pests and diseases and their effects on rice yield. SARP Research Proceedings. AB-DLO, TPE-WAU, Wageningen. IRRI, Los Banos. 117-129

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: Advise/request: E.G. Rubia (to be contacted through SARP/International Rice Research Institute (IRRI): e.rubia@cgnnet.com / stelosa@cgnnet.com) may be aware of more application reports. I would appreciate if you could contact her.

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GENERAL OVERVIEW

Name and version: SCUAF

Title: Soil Changes Under AgroForestry.

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: Yes.

Subject: Forestry, and land use system (tree and crop components).

Description: SCUAF is a nutrient-cycling model, designed to be employed by any user. Its purpose is to predict changes in soil properties under specified agroforestry systems within given environments, and for comparison with agriculture and forestry. It can be used in the design of experiments, to extrapolate experimental data (in time or to other treatments), to indicate what data are needed for prediction, and in training. Version 2 covers erosion, soil organic matter, and nitrogen cycling (Young and Muraya, 1990). Version 3 adds phosphorus cycling. It also has a more flexible specification of agroforestry systems; an improved feedback based on nutrient requirements and availability; graphical representation of internal and external nutrient cycling; and added agroforestry-specific elements. Features of SCUAF are: (1) It is a general-purpose model, applicable to all agroforestry systems (Young, 1994). A key basis is percentage areas under trees and crops. (2) The process simulation is relatively simple, and visible to the user. (3) Added agroforestry-specific features in version 3 include separate prediction of changes to soil-under-trees and soil-under-crops; litter/prunings transfer from trees to crops; and effects of tree root growth under crops (all under control of the model user). (4) It is usable: newcomers rapidly learn to use interactively (see Warner, 1991). Some 80% of version 3 was finished in 1992, but, regrettably opportunity has not been found for its completion.

Time interval of simulation: Year.

Basic spatial unit: Ha.

TECHNICAL SPECIFICATIONS

Hardware: MS-DOS.

User's guide available:

Young, A. & P. Muraya, 1990. SCUAF: Soil Changes Under Agroforestry. ICRAF, Nairobi, 124 pp. plus diskette

Application reports:

Young, A., 1990. Modelling changes in soil properties. In: Greenland, D.J. & I. Szabolcs (Ed.). Soil Resilience and Sustainable Land Use. CAB International, Wallingford, UK. 423-447

Source code available: No.

User contract mandatory: Yes.

Costs: 50 Eng. pounds sterling.

COMMENTS: Current version is interim.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SHAW 2.0

Title: Simultaneous Heat and Water model.

Date first profile: November 11th, 1995.

Date last profile: November 11th, 1995.

Update: August, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 2

Subject: Soil science (hydrology), farming systems, and environmental science.

Description: The model simulates a one-dimensional profile which may include a plant canopy, snow, plant residue, and soil. Weather conditions are used to define heat and water flux at the upper boundary of the system, and the interrelated heat, water, and solute fluxes are computed through the profile using an implicit finite difference scheme. Unique features of the model include: simultaneous solution of heat, water, and solute fluxes; detailed provisions for soil freezing and thawing, and a sophisticated approach to computing vapour flow through a multi-species plant canopy which computes plant transpiration and soil evaporation separately.

Keywords: water balance, energy balance, soil freezing, evapotranspiration. **Global change implications:** This model has many components valuable to global change research, especially those that examine the interaction between soil properties and climate.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evaporation, transpiration, runoff, percolation, soil water flux, surface energy fluxes (solar radiation, long-wave radiation, sensible and latent heat).

Number of rate variables: 15.

State variables: Soil temperature, water and ice content, soil water potential, solute concentrations, snow depth, density and temperature, thaw and frost depth, canopy temperature, residue temperature.

Number of state variables: 18.

Input data: Initial conditions of soil temperature and water profiles; site description data including vegetation, residue and soil properties; and weather data including temperature, wind speed, humidity, solar radiation and precipitation.

Number of input data: 45.

Output data: Hourly or daily predictions of evapotranspiration, transpiration, soil frost depth, snow depth, runoff, surface energy balance, and soil profiles of temperature, water, ice, and solutes.

Number of output data: 35.

Time interval of simulation: Hourly or daily time steps.

Basic spatial unit: One-dimensional point model.

References general validation:

Flerchinger, G.N. & Hanson, 1989. Transactions of the A.S.A.E. / American Society of Agricultural Engineers 32(5): 1551-1554

Flerchinger, G.N. & K.E. Saxton, 1989. Transactions of the A.S.A.E. / American Society of Agricultural Engineers 32(2): 573-578

Flerchinger, G.N., 1991. Transactions of the A.S.A.E. / American Society of Agricultural Engineers 34(6): 2381-2389

Flerchinger, G.N. et al., 1994. Hydrological Sciences Journal 39(5): 507-520

Hayhoe, 1994. Canadian Agricultural Engineering 36(4): 279-285

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Operational on 386 PC or any platform with FORTRAN compiler.

Programming language: Microsoft FORTRAN-77.

Other software required: None.

Technical reference:

Flerchinger, G.N. & K.E. Saxton, 1989. Simultaneous heat and water model of a freezing snow-residue-soil system. I. Theory and development. Transactions of ASAE 32(2): 565-571

Flerchinger, G.N. & F.B. Pierson, 1991. Modeling plant canopy effects on variability of soil temperature and water. Agricultural and Forest Meteorology 56: 227-246

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: Public domain.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SHIELD 1.0

Title: Simulation of Hedgerows Intervention against Erosion and Land Degradation.

Date first profile: November 11st, 1994.

Date last profile: November 23rd, 1995.

Update: November 30th, 1994.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Soil science, and environmental science.

Description: SHIELD calculates the effect of hedgerows on runoff, soil loss and maize yield. Crop growth simulation is based on SUCROS* and MAIZE*, but the water balance has been changed extensively. The amount of excess water runs off. Infiltration depends on management and is calculated with a set of algorithms that will be published shortly. Loss of soil is calculated through the calculation of the sediment concentration in runoff. Climatic data are read from the CABO/TPE Weather System* files, with inclusion of rainfall intensity data.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Crop specific variables (development, photosynthesis, maintenance, growth, evaporation, transpiration) and soil specific variables (infiltration, hydraulic conductivity, etc.).

Number of rate variables: 81.

State variables: Crop variables (grain weight, cob weight, biomass) and soil variables (water content, amount of water in the soil, drainage, runoff).

Number of state variables: 81.

Input data: Slope, latitude, climatic data, crop species specific data (physiological and morphological) and soil data (infiltration, texture, soil organic matter content).

Number of input data: 140 + climatic data.

Output data: Maize yield, total runoff, total soil loss and any other rate or state variable desired.

Number of output data: Optional.

Time interval of simulation: 1 day.

Basic spatial unit: m² - ha.

Stand alone model: Yes.

Parentage: SUCROS*, MAIZE* and MASQUE*.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC/AT >= 640 Kb RAM.

Programming language: FST*.

Other software required: FORTRAN-77, TTUTIL* and CABO/TPE Weather System*.

Application reports:

Kiepe, P., 1995. No runoff, no soil loss: soil and water conservation in hedgerow barrier systems. Tropical Resource Management Papers 10, Wageningen. 156 pp.

Source code available: No.

Executable available: No.

User contract mandatory: -

Costs: Not yet available.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: SIBIL

Title: Simulare BILant (Balance Simulation - in Romanian).

Date first profile: November 1st, 1995.

Date last profile: November 1st, 1995.

Update: 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science, and soil science.

Aggregation level: Crop/herd: crop population.

Description: The model describes dynamics of soil water and the crop yield formation. The production system is defined by crop species, soil type, hydrologic conditions and weather during the growing season. The SIBIL model is designated for calculating the effect of soil water balance and soil mechanical resistance on agricultural production potential for selected crop-soil-climate combinations. The model allows to evaluate the relative importance of principal soil physical properties to crop production. The dynamics of the root system is related to soil water content and soil resistance to penetration, the model having the ability to estimate the root density profile in soils with compact layers. The biomass production algorithm uses the water use efficiency. The simulation model SIBIL has 8 subsystems (blocks) which simulate the main processes involved in soil water dynamics and crop yield formation. Each subsystem is characterized by a number of processes which describe time- (and eventually space-) dependence of corresponding state variables. As optional tools are included a weather daily data generator (using monthly averages of air temperature and precipitation) and an algorithm for the evaluation of the pedotransfer functions using soil data obtained in simple soil survey studies (texture, bulk density, organic carbon).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Potential / actual evaporation and transpiration, actual infiltration rate, runoff, water fluxes between soil layers, soil water root sink rate, drainage.

Number of rate variables: < 10.

State variables: Air temperature, soil water matric potential, soil resistance, dry matter (total and per plant organ), water use efficiency, cumulated transpiration deficit, root front depth.

Number of state variables: < 25.

Input data: Soil physical properties per layer, standard meteorological variables, initial soil water content, crop type and cultivar, sowing date and depth.

Number of input data: < 25.

Output data: Soil water profile dynamics, biomass per plant organs, crop yield, root system development, water balance elements (evaporation, transpiration, drainage, runoff).

Number of output data: < 20.

Time interval of simulation: 1 Day for plant processes, 0.1 day for soil water balance calculation.

Basic spatial unit: Ha.

References general validation:

Simota, C. & A. Canarache, 1988. Effects of induced compaction in soil water balance and crop yields estimated with a deterministic simulation model. Proceedings XI ISTRO Conference,

Edinburgh. 391-396

Simota, C., 1992. SIBIL - a simulation model for soil water dynamics and crop yield formation. RISSA internal report. 55 pp.

Stand alone model: Yes.

Parentage: SIBIL uses algorithms developed in SWATRE and ARIDCROP models.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM-PC compatible with a 286 processor or better, math co-processor is highly recommended.

Programming language: QuickBasic.

Other software required: MS-DOS. The output files are compatible with standard spreadsheet managers (QuattroPro, Excel).

Technical reference:

Simota, C., 1992. SIBIL - a simulation model for soil water dynamics and crop yield formation. RISSA internal report. 55 pp.

Application reports:

Simota, C. & A. Canarache, 1988. Effects of induced compaction in soil water balance and crop yields estimated with a deterministic simulation model. Proceedings XI ISTRO Conference, Edinburgh. 391-396

Simota, C., J. Lipiec & S. Tarkiewicz, 1989. Validation of the simulation model SIBIL for soil water dynamics and crop yield formation in an experiment concerning induced soil compaction. Proceedings International Conference "Soil Compaction as a Factor Determining Plant Productivity", Lublin, Poland. 140-141

Source code available: Yes.

Executable available: Yes

User contract mandatory: No.

Costs: No.

COMMENTS: SIBIL was validated for various soil and climate conditions specific for Romania and Poland for the following crops: winter wheat, barley, maize, soybeans, and sunflower.

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GENERAL OVERVIEW

Name and version: SIBQUICK

Title: Simulation Balance QUICK.

Date first profile: November 1st, 1995.

Date last profile: November 1st, 1995.

Update: 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science, soil science, and land use studies.

Aggregation level: Crop/herd: crop population.

Description: The model describes dynamics of the crop available soil water and the crop yield formation. The production system is defined by crop species, soil type, hydrologic conditions and weather during the growing season. The SIBQUICK model is designated for calculating the effect of soil water balance and soil mechanical resistance on agricultural production potential for selected crop-soil-climate combinations. The model allows to evaluate the relative importance of principal soil physical properties to crop production. The dynamics of the root system is related to soil water content and soil resistance to penetration. The crop available soil water is estimated on a daily base using a general balance algorithm for the root zone. The root zone is considered as one vessel having soil water retention properties given by a weighted average over the soil layers included in this zone. The biomass production algorithm uses the water use efficiency. As optional tools are included a weather daily data generator (using monthly averages of air temperature and precipitation), an algorithm for the evaluation of the pedotransfer functions using soil data obtained in simple soil survey studies (texture, bulk density, organic carbon).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Potential / actual evaporation and transpiration, actual infiltration rate, runoff, drainage.

Number of rate variables: < 10.

State variables: Air temperature, crop available soil water, soil resistance, dry matter (total and per plant organ), water use efficiency, cumulated transpiration deficit, root front depth.

Number of state variables: < 25.

Input data: Soil physical properties per layer, standard meteorological variables, qualitative index for the initial soil water content, crop type and cultivar, sowing date and depth.

Number of input data: < 25.

Output data: Crop available water dynamics, biomass per plant organs, crop yield, root system development, water balance elements (evaporation, transpiration, drainage, runoff).

Number of output data: < 20.

Time interval of simulation: 1 Day.

Basic spatial unit: Ha.

References general validation:

Simota, C., 1994. SIBQUICK - a fast simulation model for crop yield formation as affected by soil water availability. RISSA internal report. 40 pp.

Stand alone model: Yes.

Parentage: SIBQUICK uses algorithms developed in ARIDCROP model.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM-PC compatible with a 286 processor or better, math co-processor is highly recommended.

Programming language: QuickBasic.

Other software required: MS-DOS. The output files are compatible with standard spreadsheet managers (QuattroPro, Excel).

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: SIBQUICK model was validated in four different soil and climate conditions specific to Romania, for winter wheat, maize, sunflower and soybeans. SIBQUICK is used now at a national level for the forecast of the potential yields (limited by water, temperature and radiation) of the main crops (winter wheat, maize) in Romania, using the weather forecasts at various times during the crop development period, given by the National Institute for Meteorology and Hydrology. The model is applied in a 16 km grid network all over the country.

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GENERAL OVERVIEW

Name and version: Sigma +

Date first profile: November 1st, 1995.

Date last profile: November 1st, 1995.

Program type: Simulation model/module.

Purpose: To provide management information to cotton growers.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

Subject: Crop science.

Aggregation level: Field.

Description: Sigma + is process-mechanistic, cotton growth simulation model that simulates plant growth, soil phenomenon, photosynthesis, uptake, evapotranspiration for the purposes of examining potential effects of climate change and providing management information to cotton farmers. The model uses 2DSOIL, a two-dimensional soils model developed at the ARS Salinity Laboratory. This model is part of a larger effort to develop new crop models and to develop graphical user interfaces (GUI) for existing crop growth models (e.g. GLYCIM) for the purposes of interfacing them with soils models. The models can be used for the purposes of management of agricultural chemicals and examining the possible effects of climate change on plant growth. Keywords: crop, cotton growth, plant-soil-atmospheric interactions, management, cotton, model, simulation, expert system. Global change implications: This model is potentially valuable to the climate change research because it interfaces known crop growth models with a soils dynamics model. In addition, the model is designed to examine the effects of chemical inputs on water pollution.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Temperature, radiation, humidity, wind, irrigation, fertilization.

Number of rate variables: 10 continuously over the season.

State variables: Soil properties, cotton varietal parameters.

Number of state variables: About 100.

Input data: Variety data, weather data, soil parameters, irrigation schedule, fertilization schedule.

Number of input data: About 75.

Output data: Approximately 300 plots showing the growth of the cotton plants and the evolution of a large number of organs and variables.

Number of output data: About 300 plots.

Time interval of simulation: Temporal scale: From emergence to harvest, in one hour increments.

Basic spatial unit: Spatial scale: A cotton field.

Parentage: The model uses 2DSOIL, a two-dimensional root-soils model developed at the ARS Salinity Laboratory.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Model requires 4 minutes to simulate one season on a Sun SparcStation; 5 minutes on a Pentium 90.

Programming language: C++ for all but the soils models. Microsoft FORTRAN for the soils models. The model is written in C++.

Other software required: -

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: SIMGRO 2.1

Title: Simulation of ground water flow and surface water levels.

Date first profile: November 3rd, 1995.

Date last profile: November 3rd, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Soil science.

Aggregation level: Region.

Description: The ground water model SIMGRO simulates regional ground water flow and water levels in the surface waters. It includes also aspects such as the retention of water in the unsaturated zone, sprinkling, evapotranspiration, water supply and subsurface irrigation. The unsaturated zone is modelled per land use and per subregion, characterized as different agricultural crops, built-up areas, forests and nature reserves. Subregions in this respect represent more or less homogeneous hydrological conditions and one soil type. The surface water system is considered as a single reservoir per subregion. Water is extracted from it for sprinkling and water level control is possible.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evapotranspiration, capillary rise, percolation, ground water level, drainage, infiltration, seepage, leakage, sprinkling, surface water level, water supply.

Number of rate variables: About 40.

State variables: Moisture contents, storage coefficient, rooting depth, target levels surface water.

Number of state variables: About 20.

Input data: Meteorological data, land use, soil properties unsaturated and saturated zone, characteristics surface water, ground level, drainage bases, drainage resistances, groundwater extractions, boundary fluxes/heads.

Number of input data: Variable.

Output data: All terms of the water balances of unsaturated zone, saturated zone and the surface water, groundwater levels, surface water levels.

Number of output data: Variable (> 1000).

Time interval of simulation: 0.5 - 10 Days.

Basic spatial unit: 1 M2.

References general validation:

Querner, E.P., 1988. Description of a regional groundwater flow model SIMGRO and some applications. *Agricultural Water Management* 14: 209-218

Querner, E.P. & P.J.T. van Bakel, 1989. Description of the regional groundwater flow model SIMGRO. DLO Winand Staring Centre, Wageningen. Report 7. 44 pp.

Querner, E.P., 1993. Aquatic weed control within an integrated water management framework.

Doctoral thesis. Wageningen Agricultural University. Also published as Report 67, DLO Winand Staring Centre (SC-DLO). 204 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX, IBM compatible with co-processor.

Programming language: Microsoft FORTRAN-77.

Other software required: -

User's guide available:

Querner, E.P., 1987. User's manual for groundwater model SIMGRO. Nota 1745. ICW, Wageningen, The Netherlands. (draft report - SC-DLO). 63 pp.

Querner, E.P., 1988. Data management program for groundwater and surface water models. Nota 1903. ICW, Wageningen, The Netherlands. 55 pp.

Technical reference:

Querner, E.P., 1988. Program manual for groundwater model SIMGRO. Nota 1902. ICW, Wageningen, The Netherlands. 31 pp.

Application reports:

D'Urso, G., E.P. Querner & J.A. Morabito, 1992. Integration of hydrological simulation models with remotely sensed data: an application to irrigation management. Proceedings International Conference Adv. in Planning, Design and Management of Irrigation Systems as related to Sustainable Land Use. Center for Irrigation Engineering, Leuven. 463-472

Morabito, J.A. & E.P. Querner, 1993. Regional hydrological modelling of irrigation and drainage systems: case study in Argentina. 15th International Congress of ICID, The Hague. Workshop on Surface Drainage Simulation Models. 309-320

Querner, E.P., W.H.B. Aarnink & C.C.P. van Mourik, 1994. Scenario studie naar de veranderingen van grondwateraanvulling en grondwaterstanden tussen de jaren vijftig en tachtig. Wageningen. DLO Staring Centrum. Rapport 308. 154 pp.

Querner, E.P., 1994. The combined surface and groundwater flow model MOGROW applied to the Hupselse Beek drainage basin. FRIEND: Flow Regimes from International Experimental and Network Data, 2nd International Conference, Braunschweig, Germany. Oct 1993. IAHS Publication No. 22: 381-389

Source code available: No (for research contact DLO Winand Staring Centre).

Executable available: Yes.

User contract mandatory: Yes.

Costs: Dfl. 1500.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: SIMPOTATO 1.52

Title: The SIMPOTATO growth simulation model.

Date first profile: February, 1995.

Date last profile: October, 1995.

Update: September 30th, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, and soil science.

Aggregation level: Plant/animal.

Description: SIMPOTATO is a potato growth simulation model. It is intended for a wide range of application such as 1) at the farm level: irrigation and fertilizer scheduling on individual fields or subfields, predicting yield response to irrigation and fertilization regimes, estimating movement of water and nitrogen below the root zone in response to various levels of applied water and nitrogen, estimating economic benefit of supplemental applied water and nitrogen, estimating distribution of nitrogen in the soil during the growing season and after crop maturity; 2) at the regional level: estimating yield potential for the regional climate and soil types, estimating regional irrigation and nitrogen requirements for various yield levels, estimating potential nitrogen loading to ground water; and 3) as a research tool: testing hypotheses as to how environmental factors (light, temperature, water, nitrogen) interact with plant physiological processes to determine growth, development, and yield.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Plant growth and development processes, soil processes affecting soil water, soil mineral and organic nitrogen.

Number of rate variables: > 50.

State variables: Plant organ dry weights and nitrogen content, tuber fresh weight (all in g/plant), leaf area (cm²/plant), for each soil layer (up to 20 layers): volumetric water content; mineral NO₃⁻, NH₄⁺, Urea, N in humus, N in crop residue; residue dry weight (3 pools), humus dry weight (2 pools) - all in kg/ha.

Number of state variables: > 50.

Input data: Initial soil status, planting information, water and nitrogen applications, daily solar radiation, maximum and minimum temperatures, rainfall.

Number of input data: 50-200 depending on number of soil layers.

Output data: User selectable, 1-10 files, final growth/yield summary, 15 growth variables, 15 potential evaporation/soil water values, 15 plant/soil nitrogen values, 10 leaching/stress values at daily or any less frequent interval.

Number of output data: 10-200, user selectable.

Time interval of simulation: Daily.

Basic spatial unit: Any reasonably uniform soil area (1-100 ha); or large region with representative soil and climate data.

References general validation:

Hodges, T., 1992. A modular structure for crop simulation models: implemented in the SIMPOTATO model. *Agron.J.* 84: 911-915

Stand alone model: Yes.

Parentage: IBSNAT models such as CERES-Maize.

Check internal consistency or material balance present: Yes, somewhat.

Input check in model: Yes, some.

TECHNICAL SPECIFICATIONS

Hardware: Intel compatible CPU based microcomputer. If graphics library is removed, any computer supporting FORTRAN compiler.

Programming language: Microsoft FORTRAN-77 (and 8086 Assembler in graphics library).

Other software required: To change and recompile: Microsoft FORTRAN compiler.

Application reports:

Abstracts and papers in progress.

Han, S., R.G. Evans, T. Hodges, S.L. Rawlins, accepted 2-'95. Linking a GIS with a potato simulation model for site-specific crop management. Journal of environmental quality.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: The program structure is highly modular so that it is relatively easy to modify or add components to the model. The model is written in standard FORTRAN-77 except for clearly identified (and easily removable) portions that call assembler subroutines, so it can easily be transported to platforms other than IBM compatible PC's. Because of the modular structure, it is relatively easy to remove the plant growth and development modules and attach them to other soil process models. SIMPOTATO has been attached to the RZWQM* and 2DSOIL soil models with relatively little effort. The SIMPOTATO package is available from the author on floppy disks and at two ftp sites: ftp.tricity.wsu.edu ftp://ftp.hrz.uni-kassel.de/pub/ecosys/models/simpotato The SIMPOTATO package consists of executables, model source code, the GRAFPAC graphics library for FORTRAN simulation models, FORTRAN and 8086 Assembler source code for GRAFPAC, MS Assembler object files for the Assembler source files, data files to run the model on many experimental and commercial fields of potatoes in the US, Europe, and Australia, a User/Programmers Manual (ASCII file), Manual for Input/Output files (ASCII file), ReadMe.1st file, QuattroPro spreadsheet for creating input files.

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GENERAL OVERVIEW

Name and version: SIRATAC (obsolete, been superseded by entomoLOGIC)

Date first profile: October 25th, 1995.

Date last profile: October 25th, 1995.

Program type: Simulation model/module: Empirical mainly top down process models for management applications.

Purpose: SIRATAC is a tactical pest management decision support system for cotton production at a farm scale.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

New release expected: No.

Subject: Crop science, and crop protection.

Aggregation level: Farm.

Description: A simple temperature driven model of the fruiting dynamics is linked by a pest feeding model to simple pest development models. The SIRATAC system includes a crop model, several pest simulation models and a decision model. The crop model is FRUIT which simulates the dynamics of fruiting in sufficient detail to interface with insect feeding models. Yield, harvest date and fruiting dynamics are accurately simulated when water and nitrogen are not limiting (the model is limited to crops where water and nitrogen are not limiting). SIRATAC advises whether or not of pest control is needed, and saves up to 40% of number and cost of insecticide sprays. The cost ratio for the research has been estimated as 1:3:4 (a return \$3.4 for every \$1 spent on R&D) with an internal rate of return of 16.2% (Brian Johnston et al., 1992, Rural Research - the pay off. Occasional Paper No. 7. CSIRO, Canberra). The crop soil is grown on one of the vertisols on which cotton is usually grown in Australia, and water and nitrogen are not limiting. SIRATAC is applied throughout cotton growing areas in Australia. Target use/user group: On-farm use by farmers, consultants and extension workers.

Input data: Weather data: maximum and minimum temperature; Agronomic data: variety, plant population and row spacing, sowing date; Weekly fruit counts; Counts of insects every 3 or 4 days.

Output data: Output consists of pest populations expected to infest the crop each day over the next few days (i.e. until the crop is monitored again), whether the crop needs to be sprayed or not, and if so, the recommended insecticide, using the softest (most environmentally friendly) that will control the population adequately. Output also reports how many of the fruit currently on the crop will contribute to yield, how many more will be produced, what the yield and harvest date will be and the yield loss that will be inflicted by pests currently infesting the crop if they are not controlled.

TECHNICAL SPECIFICATIONS

Technical reference:

Brook, K.D. & A.B. Hearn, 1990. The 'SIRATAC' pest management computer program:

program content (July 1988). Technical Paper CSIRO Division of Plant Industry, Canberra.

Hearn, A.B. & G.D. da Roza, 1985. A simple model for crop management applications for cotton (*Gossypium hirsutum* L.). Field Crops Research 12: 49-69

Application reports:

Brock, R.D., K.R. Christian & A.B. Hearn, 1984. Computer management in agriculture. CSIRO Division of Plant Industry, Australia. Report 1984-84. 5-11

Brook, K.D. & A.B. Hearn, 1983. Development and implementation of SIRATAC: a computer-based cotton management system. In: Bennett, D. (Ed.). Computers in agriculture. Proceedings

1st National Conference, University of Western Australia, Nedlands. 220-240

Brook, K.D. & A.B. Hearn, 1984. A comparison of different SIRATAC systems of pest management - initial results. Australian Cotton Growers Research Conference 1984, Toowoomba. ACGRA, Wee Waa. 167-177

Brook, K.D., B.G. Stafford & A.B. Hearn, 1986. Early season damage - holes in your bolls or your bank balance ? Australian Cotton Conference, Surfers Paradise 20-21 August 1986. ACGRA, Wee Waa. 223-238

Brook, K.D., A.B. Hearn & C.F. Kelly, 1992. Response of cotton (*Gossypium hirsutum* L.) to damage by insect pests in Australia: pest management trials. *Journal of Economic Entomology* 85: 1356-1367

Brook, K.D., A.B. Hearn & C.F. Kelly, 1992. Response of cotton (*Gossypium hirsutum* L.) to damage by insect pests in Australia: manual simulation of damage. *Journal of Economic Entomology* 85: 1368-1377

Brook, K.D., A.B. Hearn & C.F. Kelly, 1992. Response of cotton (*Gossypium hirsutum* L.) to damage by insect pests in Australia: compensation for early season damage. *Journal of Economic Entomology* 85: 1378-1386

Cox, P.G., S.G. Marsden, K.D. Brook, H. Talpaz & A.B. Hearn, 1990. Economic optimisation of *Heliothis* thresholds on cotton using the SIRATAC pest management model. *Agricultural Systems* 35: 157-171

Hearn, A.B., P.M. Ives, P.M. Room, N.J. Thomson & L.T. Wilson, 1981. Computer-based cotton pest management in Australia. *Field Crops Research* 4: 321-332

Hearn, A.B. & K.D. Brook, 1983. SIRATAC a case study in pest management of cotton. In: Blyth, D.E., M.A. Foale, V.E. Mungomery & E.S. Wallis (Ed.). Refresher Training Course Notes on 'New technology in field crop production'. Australian Institute Agricultural Science, Queensland Branch, Brisbane. 199-211

Source code available: No longer available as it has been superseded by the release of entomoLOGIC.

Executable available: No longer available as it has been superseded by the release of entomoLOGIC.

User contract mandatory: See 'Comments'.

Costs: See 'Comments'.

COMMENTS: SIRATAC Ltd., a company set up by cotton growers, marketed SIRATAC for commercial use by cotton growers between 1981 and 1994 under license from CSIRO Division of Plant Industry, Program T. Up to 25% of the Australian cotton growers used the system, and a further 50% were influenced by it, until the system was superseded by entomoLOGIC.

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GENERAL OVERVIEW

Name and version: SMARAGD

Date first profile: February 1996.

Date last profile: February 1996.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

Subject: Environmental science.

Aggregation level: Other: lake or segment.

Description: The model predicts submerged macrophyte abundance based on depth and extinction characteristics of water bodies. Depth profile of basin or lake or river needed as input. 2-Dimensional abundancy map as output (multi segment model).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: None.

Number of rate variables: 0.

State variables: Biomass, macrophyte biomass extinction, depth, irradiance (average columns), 12 depth related irradiance.

Number of state variables: About 4.

Input data: Depth, irradiance (total) extinction coefficient.

Number of input data: About 3.

Output data: Macrophyte biomass per segment.

Number of output data: 1.

Time interval of simulation: Irrelevant.

Basic spatial unit: m².

Stand alone model: Yes.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Programming language: Microsoft FORTRAN-77.

Other software required: None.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: Consult author.

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GENERAL OVERVIEW

Name and version: SNAPS 1.0

Title: Simulation Network Atmosphere-Plant-Soil.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 3

New release expected: Yes, 1996.

Subject: Crop science, soil science, and environmental science.

Description: Exposure assessment model of organic chemicals in the soil-plant-atmosphere environment of agricultural systems. The dynamics of chemical leaching in soil and the chemical uptake with transpiration stream are calculated on a daily basis in the course of a vegetation period. The model calculates the soil water dynamic using a one-dimensional Richards' equation. Chemical transport in soil is calculated via a convection-dispersion equation. A chemical specific transpiration-stream-concentration factor (TSCF) is used to calculate the chemical uptake in plants using a depth dependent root water uptake. The TSCF is assumed to be correlated to the octanol/water distribution coefficient. The transport of the chemical within the plant is calculated as mass flux in xylem and phloem streams between the compartments stem, leaves and fruits. A local equilibrium distribution between water and lipid fraction is assumed within each compartment. The transport to/from atmosphere is calculated via a network of stomata, cuticula, and atmospheric resistance. Degradation processes and sorption processes are included too in soil and plant. Keywords: soil water transport, heat transport, material transport, transport of chemicals, metabolites, unsaturated soil zone, soil water dynamics, plant, plant uptake, chemical transport in plant, volatilization.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water and chemical flow rates through soil profile, plant uptake rate, flow rates in xylem and phloem between plant compartments stem, leaves and fruits, and flow rate leave to/from atmosphere.

Number of rate variables: > 100.

State variables: Water matrix potential, temperature, chemical concentration.

Number of state variables: > 100.

Input data: Water matrix potential, temperature, and chemical concentration as initial conditions; crop development data and climate data.

Number of input data: > 100.

Output data: Flow rates and state variables.

Number of output data: > 100.

Time interval of simulation: Day.

Basic spatial unit: M2 to field level.

References general validation:

Behrendt, H. & R. Brueggemann, 1993. Modelling the fate of organic chemicals in the soil plant environment: model study of root uptake of pesticides. Chemosphere 27: 2325-2332

Behrendt, H., R. Brueggemann & M. Morgenstern, 1995. Numerical and analytical model of pesticide root uptake model comparison and sensitivities. Chemosphere 30: 1905-1920

Gayler, S., S. Trapp, M. Matthies, R. Schroll & H. Behrendt, 1995. Uptake of terbuthylazin and

its medium polar metabolites into maize plants. Environmental Science and Pollution Research 2: 98-103

Trapp, S., J.C. Mc Farlane & M. Matthies, 1994. Model for uptake of xenobiotics into plants: validation with bromacil experiments. Environmental Toxicology and Chemistry 13: 413-422

Stand alone model: Yes.

Parentage: Plant module, PLANTX (Trapp, 1994).

Check internal consistency or material balance present: Yes, check of chemical mass balance.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: SUN Workstation, OS 4.x, OS Solaris 2.4 (in 1996); IBM PC, OS LINUX, OS WINDOWS NT/95 (in 1996).

Programming language: Microsoft FORTRAN-77.

Other software required: Optional GNUPLOT.

Source code available: No.

Executable available: Depending on contract.

User contract mandatory: Yes.

Costs: To be determined at a later date.

COMMENTS: The SNAPS model is currently tested and only available to researchers closely affiliated with co-operating institutes. <http://www.gsf.de/> has information on GSF

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GENERAL OVERVIEW

Name and version: SOIL DATA

Title: Estimation of the waterholding-capacity of soils in Europe. The compilation of a soil dataset.

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Simulation tool: database.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

Subject: Soil science, and environmental science.

Description: As a contribution to an agroclimate study, a simple method was set up to estimate the available waterholding-capacity (AWC) of soils in Europe. Soil data taken from maps were stored on the basis of a 1/2 x 1/2 degree grid. For each grid cell three dominant soil types were recorded, with information on topsoil texture, stoniness and slope. The dataset covers the European territory up to the 44th degree of longitude. The method for estimating AWC is based on texture available reserve relations, given in the literature. For five texture classes mean values of available reserve (cm/cm soil) were summarized in a conversion table. The crop rooting depth determines the thickness of the soil layer contribution to the AWC. The rooting depth was derived from the soil type. A reduction factor was proposed for stony soils. For each grid cell a mean AWC figure can be determined by taking into account the relative proportions of the soil types concerned. An example was worked out for the cells covering The Netherlands.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

Number of rate variables: -

State variables: -

Number of state variables: -

Input data: -

Number of input data: 18.

Output data: -

Number of output data: -

Time interval of simulation: -

Stand alone model: Database.

TECHNICAL SPECIFICATIONS

Hardware: -

Programming language: -

Other software required: -

User's guide available:

Groenendijk, H., 1989. Estimation of the waterholding-capacity of soils in Europe. The compilation of a soil dataset. Simulation Report CABO-TT nr. 19. A joint publication of Centre for Agrobiological Research, Dept. of Theoretical Production Ecology (Agricultural University) and International Soil Reference and Information Centre (ISRIC). Wageningen. The Netherlands. 18 pp.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SOIL 7.51

Date first profile: December, 1994.

Date last profile: December, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Soil science, and forestry.

Aggregation level: Region.

Description: The model simulates soil water and heat processes in many type of soils; bare soils or soils covered by vegetation. The basic structure of the model is a depth profile of the soil. Processes such as snow-melt, interception of precipitation and evapotranspiration are examples of important interfaces between soil and atmosphere. Two coupled differential equations for water and heat flow represent the central part of the model. These equations are solved with an explicit numerical method. The basic assumptions behind these equations are very simple: (i) The law of conservation of mass and energy and (ii) flows occur as a result of gradients in water potential (Darcy's Law) or temperature (Fourier's law). The calculations of water and heat flows are based on soil properties such as: the water retention curve, functions for unsaturated and saturated hydraulic conductivity, the heat capacity including the latent heat at thawing/melting and functions for the thermal conductivity. The most important plant properties are: development of vertical root distributions, the surface resistance for water flow between plant and atmosphere during periods with a non limiting water storage in the soil, how the plants regulate water uptake from the soil and transpiration when stress occurs, how the plant cover influences both aerodynamic conditions in the atmosphere and the radiation balance at the soil surface.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water and heat flows between Atmosphere-Vegetation, snow-surface water-soil water and ground water.

Number of rate variables: 23 + multiplication of soil flows.

State variables: Water in soil layers, on the soil surface and in snow heat in soil layers, salt in soil layers.

Number of state variables: 7 + multiplication for soil layers.

Input data: All of the soil-plant-atmosphere system properties, meteorological data are driving variable to the model. Most important of those are precipitation and air temperature but also air humidity, wind speed and cloudiness are of great interest.

Number of input data: Depends on application.

Output data: Temperature, content of ice, content of unfrozen water, water potential, vertical and horizontal flows of heat and water, water uptake by roots, storages of water and heat, snow depth, water equivalent of snow, frost depth, surface runoff, drainage flow and deep percolation to ground water.

Number of output data: 10-400, depending on options.

Time interval of simulation: Depends on application, from minutes to day.

Basic spatial unit: m² - ha.

References general validation:

Eckersten, H. & P.-E. Jansson, 1991. Modelling water flow, nitrogen uptake and production for wheat. *Fertilizer Research* 27: 313-329

Stand alone model: Yes.

Parentage: SOIL model first developed 1977.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Preferable 486 processor.

Programming language: Microsoft FORTRAN and C.

Other software required: PC-based IBM, MS-DOS.

User's guide available:

Jansson, P.-E., 1994. SOIL model, user's manual. 3rd edition Division of Agricultural Hydrotechnics Communications 94: 3. Department of Soil Sciences, Swedish University of Agricultural Sciences, Uppsala. 66 pp.

Technical reference:

Jansson, P.-E., 1991. Soil water and heat model. Technical description. Division of Agricultural Hydrotechnics Report 165, Department of Soil Sciences, Swedish University of Agricultural Sciences, Uppsala. 72 pp.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: The SOIL model has its own home page: URL:

<http://bgfserver.mv.slu.se/soil.htm> More details could be found there as well as instructions for how to download the model to your own computer.

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GENERAL OVERVIEW

Name and version: Soil_Depl

Title: Soil Depletion Estimates Model.

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

Subject: Soil science, and agricultural economics.

Aggregation level: Farm, and other: field.

Description: The Soil Depletion Estimates Model is a numerical model that examines the long-term physical and economic impacts of soil depletion resulting from alternative management practices. The model is applied on an individual soil basis and computes an estimate of the depth of soil lost due to erosion, crop yield, net returns, and the sum of present value of net returns. These values are computed separately for each resource management system (RMS - combination of rotation, tillage method, and conservation practice) specified for that soil. An analysis of individual RMS results allows comparison of the impact of depletion on yields and net returns over a specified time period. The results for all resource management systems considered can be compared to determine relative profitability at any time period. Keywords: soil, erosion, crop yields, resource management system. Other: This model is useful for global change investigations in which soil erosion dynamics are expected to change under climate modifications or if agricultural land use patterns change. The model can provide an economic assessment of these changes.

Input data: Soil family texture classes, crop market price and output unit, soil physical properties, resource management data including discount rate, tillage code, cost of production, soil slope, tillage type, conservation practice, and soil temperature value, initial yield data for each crop, rotation acres for each crop, and erosion rate information. Model input data source: SCS, Soils 5 Interpretation Record, user.

Output data: Productivity index by soil horizon, yield for each crop, erosion, predicted net return.

Time interval of simulation: Temporal scale: up to 100 year planning horizons.

Basic spatial unit: Spatial scale: Farm/field.

Stand alone model: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: IBM or compatible PC with DOS 2.10 or later and a math co-processor.

Programming language: ANSI FORTRAN-77.

User's guide available:

Soil Depletion Estimates: Version 2: A Users Guide to a Personal Computer Model for Estimating Long-term On-site Physical and Economic Impacts of Soil Depletion. USDA, ERS Staff report No. AGES 9005

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SOILN 8.0

Date first profile: December, 1994.

Date last profile: December, 1994.

Update: December, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Crop science, soil science, and environmental science.

Aggregation level: Cropping system/animal husbandry system.

Description: SOILN simulates carbon and nitrogen flows both in soil and plant of agricultural land. The soil mineral nitrogen pools receive nitrogen by mineralization of litter and humus, nitrification, fertilisation and deposition and lose nitrogen by immobilization to litter, nitrification, leaching, denitrification and plant uptake. It is also influenced by vertical redistribution. All biological processes depend on soil water and temperature conditions. The soil is divided into layers from which plant is taken nitrogen in various rate. Uptake depends on plant growth. Each plant is divided into two pools (biomass and nitrogen). Leaves take up carbon and roots take up nitrogen. Stem pool is used for storage as is the grain pool during grain development. Leaf area captures the radiation to be used in photosynthesis. Actual growth is the potential growth (which is proportional to radiation intercepted) reduced by non optimal temperature, leaf nitrogen concentration and transpiration. The nitrogen demand is proportional to the daily growth. Actual uptake is the lowest value of demand and the amount available in soil which is a fraction of the mineral nitrogen.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Depends on application.

Number of rate variables: Soil: 19 per layer, soil surface 11, plant 6-29.

State variables: Carbon and nitrogen; fences, litter, humus, nitrate, ammonium, fertilizer, above ground litter, leaves, stems, roots, grains, perennial pools, available assimilates.

Number of state variables: Soil: 7 per layer, soil surface 3, plant 6-14.

Input data: Weather data and soil water and heat data, fertilisation.

Number of input data: 5 + 4 per layer.

Output data: Depends on application.

Number of output data: > 100.

Time interval of simulation: Days - years.

Basic spatial unit: Ha.

References general validation:

Eckersten, H. & P.-E. Jansson, 1991. Modelling water flow, nitrogen uptake and production for wheat. *Fertilizer Research* 27: 313-329

Eckersten, H., 1994. Modelling daily growth and nitrogen turnover for a short rotation forest over several years. *Forest Ecology and Management* 69: 57-72

Johnsson, H., L. Bergstrom, P.-E. Jansson & K. Paustian, 1987. Simulation of nitrogen dynamics and losses in a layered agricultural soil. *Agriculture, Ecosystems and Environment* 18: 333-356

Stand alone model: No.

Parentage: Normally based on SOIL-model simulations.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Preferable 486 processor.

Programming language: Microsoft FORTRAN and C.

Other software required: PC-based IBM, MS-DOS.

User's guide available:

Eckersten, H., P.-E. Jansson & H. Johnsson, 1994. SOILN model, user's manual. 2nd edition
Division of Agricultural Hydrotechnics Communications 94: 4. Department of Soil Sciences,
Swedish University of Agricultural Sciences, Uppsala. 58 pp.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SOL4 2.1

Title: -

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Crop science (horticulture), and soil science.

Description: A subprogram to calculate vertical solute transport, in a conical shaped pot. The program must be linked with a water transport model. The non-linear differential equation for convective/diffusive transport is solved with an implicit finite difference 'Crank-Nicholson' approximation. Numerical dispersion is suppressed by a second order derivative according to Bressler (1973).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water dynamics, diffusion constant.

State variables: Water content, solute content, conical shape pot, dispersion length.

Input data: Water flow (from main program), boundary conditions, diffusion constant, dispersive length.

Output data: Solute content related to depth.

Time interval of simulation: Variable.

Basic spatial unit: M2.

References general validation:

Otten., W., 1994. Dynamics of water and nutrients for potted plants induced by flooded bench fertigation: experiments and simulation. Thesis Wageningen. 115 pp.

Stand alone model: No.

Parentage: LEACHM*.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: VAX.

Programming language: Microsoft FORTRAN.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: This subprogram is developed as part of the program POTPLANT* to simulate water and nutrient dynamics in potted plants using flooded bench fertigation.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SOLTRANS

Title: SOLute TRANsport Simulator.

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: No, two versions available (i.e. in- or excluding the endodermis).

Subject: Crop science; be it more plant physiology.

Description: A one cell thick slice of a cylinder shaped root is considered, consisting of a number of concentric cell layers. Cell wall, cytoplasm and vacuole for each concentric layer of one cell width, and the external medium are distinguished as different compartments. Cellular compartments within the same concentric cell layer are not regarded separately. The model simulates the time course of: 1. the fraction labelled ions in all cellular root compartments during loading from a 100% labelled medium, 2. the contribution of ions from all cellular root compartments to the overall efflux into the surrounding medium, from an initially 100% labelled root with all compartments containing separate labels, and 3. the reallocation, with the cellular root compartments, of the ions remaining in this initially 100% labelled root during the efflux period. Thus, the model continuously accounts for the distribution of all ions, separately labelled indicating the original location at the start of the calculations. The efflux kinetics from wash-out experiments after a given loading period (i.e. a not 100% labelled root), are derived by multiplying the simulated efflux kinetics per compartment (ii) by the simulated fraction labelled ions in each compartment at the end of the leading period (i).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

State variables: -

Number of input data: There is one input file containing switches and input parameters.

Number of output data: There are several separate output files.

Time interval of simulation: Optimized, but generally \ll 1 second.

Basic spatial unit: cm².

Stand alone model: Yes, except for the input file and TTUTIL*.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Any fast computer will do, we used an a-VAX.

Programming language: Microsoft FORTRAN-77.

Other software required: TTUTIL*.

Source code available: Yes, under certain conditions.

Executable available: Yes.

User contract mandatory: Yes, under certain conditions.

Costs: None.

COMMENTS: -

CONTACT(S):

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16802 UNITED STATES.**

GENERAL OVERVIEW

Name and version: SOMM

Title: A model of Soil Organic Matter dynaMics.

Date first profile: June 13th, 1995.

Date last profile: June 13th, 1995.

Update: 1994.

Program type: Simulation model/module. Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Soil science, environmental science, forestry, and land use studies.

Aggregation level: Farm, region, and other: soil units.

Description: SOMM is a simulation model of soil organic matter mineralization, humification and nutrient release. The model takes into account a rate of the processes in dependence of litter fall nitrogen and ash content, soil temperature and moisture. The functioning of main complexes of soil destructors being reflected in the model. The model represents a system of linear differential equations with variable coefficients. The result of simulation shows SOMM applicability for wide range of environmental conditions from tundra to tropical rain forest. The models has supposed being used for modelling soil system and ecosystem dynamics on site, landscape and regional levels.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Soil organic matter humification and mineralization; nutrient release due to soil organic matter and nitrogen mineralization separately in litter, humified materials and humus.

Number of rate variables: 6.

State variables: Fresh undecomposed litter on/in a soil, humified organic material, humus bonded with mineral matrix.

Number of state variables: 3.

Input data: Monthly/daily means of soil temperature, moisture, undecomposed litter fall, litter nitrogen and ash content, initial amount in the soil of undecomposed litter, humified organic material and humus.

Number of input data: 9.

Output data: Simulated amount of soil organic matter and N in undecomposed litter, humified organic material and humus in mineral topsoil, C/N ratio of humus, CO₂ and N released.

Number of output data: 9.

Time interval of simulation: Day.

Basic spatial unit: Any.

References general validation:

Chertov, O.G. & A.S. Komarov, 1995. On mathematical theory of soil forming processes. 1. Theoretical background. 2. SOMM - a model of soil organic matter dynamics. 3. Basic ideas of a mineral phase modelling Russian Academy of Sciences. Pushino Research Center. Institute of Soil Science & Photosynthesis. Prepint. 41 pp.

Stand alone model: Yes.

Parentage: A model of raw humus formation and functioning (Chertov, 1985, 1990) has been used as a basis of SOMM.

Check internal consistency or material balance present: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC IBM compatible.

Programming language: TurboPascal.

Other software required: In preparation.

Source code available: Under consideration.

Executable available: Under consideration.

User contract mandatory: Not determined yet.

Costs: Not determined yet.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: SOS

Title: Spreadsheet Oriented Simulation.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, soil science, and environmental science.

Aggregation level: Crop/herd (crop population), and cropping system/animal husbandry system.

Description: The SOS model is designated for calculating the effect of soil water balance on agricultural production potential for selected crop-soil-climate combinations. SOS consists in a number of macro-functions developed under a spreadsheet environment. The production system is defined by crop species, soil type, hydrologic conditions and weather during the growing season. The user has two choices selecting the algorithms for the estimation of the water balance elements significant for crop studies, depending on the quality and the amount of available input data. The first one uses monthly values of rainfall and precipitation and a soil profile having one (averaged) layer. The other one is based on the travel time approach using daily weather data and a layered soil profile. The model has the ability to deal with various crop rotations, including fallow. As optional tools are included a weather daily data generator (using monthly averages of air temperature and precipitation) and an algorithm for the evaluation of the pedotransfer functions using soil data obtained in simple soil survey studies (texture, bulk density, organic carbon). The effects of the land slope and exposition on the ground level solar radiation are included in the weather data generator.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Net solar radiation, potential/actual evaporation and transpiration, actual infiltration rate, runoff, water fluxes between soil layers, soil water root sink rate, drainage.

Number of rate variables: < 20.

State variables: Air temperature, soil water content, dry matter (total and per plant organ), water use efficiency.

Number of state variables: < 25.

Input data: Soil physical properties per layer, standard meteorological variables, initial soil water content, crop type and cultivar, sowing date and depth.

Number of input data: < 25.

Output data: Soil water profile dynamics, biomass per plant organs, crop yield, root system development, water balance elements (evaporation, transpiration, drainage, runoff), number of workable days.

Number of output data: < 25.

Time interval of simulation: 1 Month or 1 day depending on the input data quality.

Basic spatial unit: Ha.

Stand alone model: Yes.

Parentage: The algorithm for water balance elements dynamics on a monthly base was developed by Thornthwaite, C.W., & J.R.Mather. 1957. Instructions and tables for computing potential evapotranspiration and the water balance. Drexel Institute of Technology. Publications

in Climatology, X(3), Centerton, New Jersey. SOS uses for crop development algorithms from EPIC*, SWATRE and BACROS* models.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM-PC compatible with a 486 processor or better and 8 Mb RAM. Math co-processor is highly recommended.

Programming language: Microsoft VisualBasic under Excel 5.0 environment.

Other software required: Microsoft Windows 3.11, MicrosoftOffice is recommended.

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

Costs: No.

COMMENTS: SOS is a very friendly application due to its spreadsheet oriented character.

Windows and Microsoft Office software gives the environment for an easy link between graphs, databases and text processors.

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GENERAL OVERVIEW

Name and version: SOYBEAN

Date first profile: November, 1995.

Date last profile: November, 1995.

Program type: Simulation model/module.

Purpose: To determine how weather parameters impact crop yield.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: Yes.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: The soybean and crop growth model of Sinclair et al. (Sinclair et al., 1986) is a mechanistic models that examines how temperature, rainfall and solar radiation impact soybean crop yields. Keywords: crop growth, soybean, wheat, mechanistic, temperature, rainfall, solar radiation. Other: These models could be used in global change research to understand how changes in temperature, solar radiation and precipitation might affect soybean and wheat yields.

Input data: Daily weather data (solar radiation, minimum and maximum temperatures and precipitation), organic nitrogen, solar radiation (optional), maximum depth of rooting, minimum and maximum temperature, and precipitation. Whatever weather data is available from weather stations etc. Organic methane is from experimental sites.

Output data: Daily leaf area index, biomass accumulation, seed growth, seed weights, transpiration, soil evapotranspiration, and accumulated water.

Time interval of simulation: Day.

Basic spatial unit: Plot.

References general validation:

Aslyng, H.C. & S. Hansen, 1985. Radiation, water and nitrogen balance in crop production. Field experiments and simulation models WATCROS and NITCROS. Hydrotechnical Laboratory. The Royal Veterinary and Agricultural University, Copenhagen. 146 pp.

TECHNICAL SPECIFICATIONS

Hardware: DOS based machines. Run time is very fast.

Programming language: BASIC (in the future it will be in Microsoft FORTRAN).

Other software required: The models run in a DOS environment.

Technical reference:

Sinclair, T.R., 1986. Water and nitrogen limitations in soybean grain production. Field Crops Research 15: 125-141.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SOYCROS 1.0

Title: Soybean Crop Simulator.

Date first profile: December, 1994.

Date last profile: October, 1995.

Update: October, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Crop science, soil science, farming systems, and agricultural economics.

Aggregation level: Other: field.

Description: SOYCROS is a summary model to simulate growth and production of soybean varieties. It is based on MACROS*, and contains crop physiology, agrometeorology and soil physics, with additions pertaining to water stress and functioning of roots. In the model, daily rates of crop photosynthesis, respiration, carbohydrate partitioning, phenological development, transpiration, and of infiltration, drainage and movement of water in the soil are calculated in relation to the status of the crop, the soil water and current weather conditions. Nitrogen balance processes are not explicitly simulated. Rates are integrated at the end of each day to update the weight of the crop organs and the water contents of the soil layers. The cycle is repeated until the end of the growing season is reached. The following items were added with respect to SUCROS*: - A choice of four crop management situations: rainfed and irrigated upland, and rainfed and irrigated lowland. - Simulation starts at the beginning of the turn around period. - Germination simulated in relation to soil moisture. - The effect of N-redistribution on photosynthesis is included. - After-effect of severe water stress is included. - Effect of anaerobiosis in the root environment is simulated. After simulation, a spreadsheet can be used with fixed prices and costs to compute net returns.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Rates of canopy photosynthesis, respiration, transpiration (= water uptake), crop development, leaf area growth, saturated and unsaturated flow of water in soil.

Number of rate variables: About 20.

State variables: Weight of crop organs, leaf area, water content in 10 soil layers; seed germination status.

Number of state variables: About 20.

Input data: Weather, irrigation schedule, depth ground water table, soil, crop characteristics, prices inputs.

Number of input data: About 30.

Output data: Any rate or state variable, accumulated values.

Number of output data: Typical 5-10.

Time interval of simulation: 1 day.

Basic spatial unit: 1 ha.

References general validation:

Penning de Vries, F.W.T., J. Timsina, M.J.C. Alagos, L. Velasco & R.K. Pandey, 1992.

Opportunities for soya beans after rice in the Philippines: an exploration by simulation. CABO-DLO, Simulation Report 25, November 1992, 60 pp.

Stand alone model: Yes.

Parentage: MACROS* (1989).

Check internal consistency or material balance present: C and H₂O balance.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC 286 or more.

Programming language: CSMP*.

Other software required: Microsoft Excel if spreadsheet is used.

Source code available: Yes.

Executable available: No.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

COMMENTS: Ground water level dynamics plays a crucial role.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SPATANAL, CROSS, MAPIT, WLSFIT and SURFER

Title: Geostatistical software.

Date first profile: December, 1994.

Date last profile: December, 1994.

Update: -

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science.

Description: The software is developed to analyze spatial variability, and to interpolate point data to areas of land using kriging and co-kriging.

Number of input data: Maximum 900.

Output data: Output is in the form of a map.

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC/MS-DOS.

Programming language: Pascal.

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: Spring wheat 2.0

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop science, and soil science.

Description: The model describes the phenological and morphological development, the carbon and nitrogen balance of the crop and soil and the soil water balance as dictated by environmental conditions. Daily total gross assimilation is calculated according to Goudriaan (1986).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Growth and development of crop, transpiration, nitrogen uptake, mineralization, rate of change in amount of soil water.

Number of rate variables: 325.

State variables: Carbon and nitrogen status of crop organs and soil, water status of the soil, crop development and organ formation.

Number of state variables: 53.

Input data: Daily weather data, soil moisture characteristics, carbon and nitrogen contents of the soil, initial soil water contents.

Number of input data: 15.

Output data: User-defined.

Number of output data: Variable.

Time interval of simulation: 1 day.

Basic spatial unit: Ha.

References general validation:

Keulen, H. van & N.G. Seligman, 1987. Simulation of water use, nitrogen nutrition and growth of a spring wheat crop. Simulation Monographs. Pudoc-DLO, Wageningen, The Netherlands. 308 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Partially.

TECHNICAL SPECIFICATIONS

Hardware: PC, VAX, Apple, Sun workstation.

Programming language: Microsoft FORTRAN-77.

Other software required: TTUTIL*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-W AU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SUCRBARL 1.0

Title: SUCROS*-model applied on spring barley (competition and plant density effects included).

Date first profile: September, 1994.

Date last profile: October, 1995.

Update: August, 1992.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: The model simulates 2 spring barley varieties with densities NPL (plant density), competing for light in a potential production environment. The model is based on the SUCROS* spring wheat model. It has been extended for light interception and distribution within the heterogeneous crop. The model may be applied in plant breeding and crop science.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Phenological development, leaf and canopy photosynthesis (gross; net), maintenance/growth respiration, crop growth, plant organ growth, light interception (and others).

Number of rate variables: > 50.

State variables: Biomass (per plant organ and total), leaf area indices, intercepted light, radius plants, plant heights (per variety).

Number of state variables: > 50.

Input data: Geographical latitude and longitude, weather data, variety specific physiological and morphological characteristics.

Number of input data: > 50.

Output data: Crop rate and state variables (per variety).

Number of output data: About 25.

Time interval of simulation: 1 day.

Basic spatial unit: Ha.

References general validation:

Schut, J.W., 1992. The effect of several physio-morphological traits on yield of two contrasting spring barley varieties at different plant densities in monoculture and mixture: simulation and field trial. Scriptie Agricultural University, Department of Theoretical Production Ecology, The Netherlands. 118 pp.

Stand alone model: Yes.

Parentage: SUCROS* (for spring wheat).

Check internal consistency or material balance present: No.

Input check in model: No

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, (IBM compatible ?).

Programming language: CSMP* with Microsoft FORTRAN-routines.

Other software required: TTUTIL*, CABO/TPE Weather System* and daily weather data.

Source code available: Yes.

Executable available: No.

User contract mandatory: No.

Costs: None.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SUCROS1

Title: Simple and Universal CROp growth Simulator.

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 3

New release expected: Yes.

Subject: Crop science.

Description: Crop growth model for potential production. SUCROS1 is a mechanistic crop growth model as influenced by environmental conditions. SUCROS1 simulates potential growth of a crop, i.e. its dry matter accumulation under ample supply of water and nutrients in a pest-, disease- and weed-free environment under the prevailing weather conditions. The rate of dry matter accumulation is a function of irradiation, temperature and crop characteristics. The basis for the calculation is the rate of CO₂ assimilation (photosynthesis) of the canopy; it is a function of incoming radiation and light. After subtraction of maintenance respiration, growth of leaf, stem, root and storage organs are simulated. Biomass partitioning depends on crop development stage, which is computed as a function of temperature only. With crop specific input parameters different crops can be simulated.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Development, gross CO₂ assimilation, carbohydrate/dry matter production, maintenance, dry matter partitioning, growth of plant organs and translocation.

Number of rate variables: 47.

State variables: Weight of leaves, stems, storage organs, roots; leaf area; crop development stage; gross CO₂ assimilation.

Number of state variables: 12.

Input data: Daily weather (minimum and maximum temperature, global radiation), crop specific physiological and morphological properties.

Number of input data: 8.

Output data: Values of all state and rate variables, and their cumulative values.

Number of output data: User defined.

Time interval of simulation: 1 day.

Basic spatial unit: 1 ha.

References general validation:

Laar, H.H. van, J. Goudriaan & H. van Keulen (editors), 1992. Simulation of crop growth for potential and water-limited production situations, as applied to spring wheat. Simulation Reports 27. 72 pp.

Rabbinge R., S.A. Ward & H.H. van Laar (editors), 1989. Simulation and systems management in crop protection. Pudoc-DLO, Wageningen, The Netherlands. Simulation Monographs 32. 147-181

Stand alone model: Yes, but also with other modules.

Parentage: BACROS*, ELCROS, SUCROS82, SUCROS89 and MACROS*-L1D.

Check internal consistency or material balance present: Yes, for carbon.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, IBM compatible PC/AT.

Programming language: Microsoft FORTRAN.

Other software required: TTUTIL* and a FORTRAN compiler.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

COMMENTS: SUCROS1 is used in many slightly different versions, targeted for specific questions. It is also available in CAI-form. For information, contact first author.

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GENERAL OVERVIEW

Name and version: SUCROS2

Title: Simple and Universal CROP growth Simulator.

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 3

Subject: Crop science (and soil science).

Description: Crop growth model for water-limited conditions. SUCROS2 describes crop growth (as applied to spring wheat) under water-limited conditions by including water balances of crop and soil in the SUCROS1* model. Conditions of other growth factors are supposed to be optimal, i.e. ample nutrients and a pest-, disease- and weed-free environment. With the SUCROS2 model, options for soil and water conservation can be studied. The crop/soil water balances in SUCROS2 are based on earlier versions documented by Stroosnijder (1982) and Penning de Vries et al. (1989). SUCROS2 can only be understood on the basis of SUCROS1*, the crop growth model for potential production. The effect drought-stress is transmitted through two variables, one acting on daily gross CO₂ assimilation and the other one acting on root-shoot partitioning.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Crop growth and development under water-limited conditions.

Number of rate variables: 220.

State variables: Compartments of SUCROS1*, Penman equation, soil water balance, rooted depth, transpiration, evaporation, effects of water stress, water use efficiency, weather characteristics.

Number of state variables: 28.

Input data: SUCROS1*, rooted depth at emergence, initial moisture, stored water, water stress factor on CO₂ assimilation.

Number of input data: 12.

Output data: Day number, development stage crop, total biomass, total above-ground dry weight, leaf area index, harvest index, (evapo-)transpiration, precipitation, rainfall intercepted by canopy, runoff, drainage, surface storage, variable to check water balance, factor for crop water requirements, uptake water soil, water stress, rooted depth, water soil profile.

Number of output data: Variable; user defined.

Time interval of simulation: 1 day.

Basic spatial unit: Ha.

References general validation:

Laar, H.H. van, J. Goudriaan & H. van Keulen (editors), 1992. Simulation of crop growth for potential and water-limited production situations, as applied to spring wheat. Simulation Reports 27. 72 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: -

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, IBM compatible PC/AT.

Programming language: Microsoft FORTRAN.

Other software required: TTUTIL*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: SUKAM 1.1

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: May, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop science.

Aggregation level: Crop/herd.

Description: SUKAM calculates the daily rate of gross photosynthesis and dry matter production of a greenhouse crop from daily radiation, temperature and CO₂ concentration, based on SUCROS*87. Instantaneous rates of radiation during the day are generated from daily totals of radiation. The model incorporates the effects of light, CO₂ concentration and temperature on photosynthesis and dry matter production.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Crop gross photosynthesis, dry matter production, maintenance costs.

Number of rate variables: About 10.

State variables: None.

Number of state variables: None.

Input data: Greenhouse cover transmissivity, crop data, experimental data, greenhouse climate.

Number of input data: 15.

Output data: Daily photosynthetic active radiation inside greenhouse, daily crop photosynthesis, dry matter production, maintenance costs.

Number of output data: 4.

Time interval of simulation: 1 Day.

Basic spatial unit: m².

References general validation:

Gijzen, H., 1992. Simulation of photosynthesis and dry matter production of greenhouse crops. CABO/TT. Simulation Report nr. 28. 69 + 49 pp.

Gijzen, H., 1994. Ontwikkeling van een simulatiemodel voor transpiratie en wateropname en van een integraal gewasmodel. AB-DLO Report nr. 18. AB-DLO, Wageningen, The Netherlands. 90 + 116 pp. (partly in Dutch).

Stand alone model: Yes.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Any computer.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: SUNDIAL 93-7

Title: SimUlation of Nitrogen Dynamics In Arable Land.

Date first profile: December 12th, 1995.

Date last profile: December 12th, 1995.

Update: December 1st, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, soil science, farming systems, environmental science, and land use studies.

Aggregation level: Crop/herd.

Description: The Nitrate Issue. Agricultural land is a major source of nitrate in drinking water in the United Kingdom. The maximum concentration permitted by the 1980 EC Directive on the Quality of Water Intended for Human Consumption is 50 mg/dm³. The implementation of the EC drinking water directive requires nitrate losses associated with agricultural management to be predicted. The SUNDIAL model can be used to predict nitrate losses by simulating the dynamics of nitrogen turnover in the soil/crop system. How does SUNDIAL work? The SUNDIAL model incorporates current scientific knowledge on the individual processes of nitrogen turnover. The computer program can calculate how these processes will combine in the complete soil system. The processes of the nitrogen cycle are described by empirical equations with a weekly timestep. Each week, the uptake of nitrogen by the crop is calculated from the estimated harvested yield and the cumulated temperature since sowing. The return of carbon and nitrogen to the soil as crop debris are calculated similarly. Crop debris carbon and nitrogen are partitioned into the biomass and humus pools in the soil. The biomass and humus pools either take up nitrogen (immobilization) or release nitrogen (mineralization) so as to maintain a constant C:N ratio. Nitrogen is immobilized preferentially from the available ammonium in the soil and then from the available nitrate. Nitrogen is mineralized as ammonium. Released ammonium may then be nitrified to nitrate depending on the temperature and moisture content of the soil. Gaseous losses of nitrogen by denitrification are calculated according to the carbon and moisture contents of the soil. Nitrate is lost by leaching with the water moving down the soil profile. The model can output the total amount of nitrate leached as well as the concentration of nitrate in the drainage water. Application of SUNDIAL. SUNDIAL has been distributed to over 50 researchers worldwide and is being used to interpret the results of field experiments. In the next 3 years, SUNDIAL will be built into a new decision support system for fertilizer recommendation. Farmers, growers, and advisers will be consulted on the design and implementation of this new system.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Nitrate uptake, ammonium uptake, debris return, debris decomposition, organic matter turnover, mineralization, immobilization, nitrification, denitrification, leaching, volatilization.

Number of rate variables: 11.

State variables: Nitrate-N, ammonium-N, biomass-N, humus-N, debris-N, crop-N.

Number of state variables: 6.

Input data: Weekly rainfall, temperature, evapotranspiration, soil type, crop types, sowing and

harvest dates, yield, fertilizer types (application dates, amounts), manure types (application dates, amounts).

Number of input data: 14.

Output data: N and ¹⁵N in nitrate, ammonium, debris, biomass, and humus, crop, N and ¹⁵N denitrified, leached, and mineralized.

Number of output data: 18.

Time interval of simulation: Week.

Basic spatial unit: Ha.

References general validation:

Bradbury et al., 1993. Journal of Agricultural Science 121: 363-379

Smith, et al., 1996. Agronomy Journal (In Press).

Stand alone model: Yes.

Parentage: Rothamsted Carbon Model (ROTHC*).

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: 386 IBM compatible PC.

Programming language: C++ and Microsoft FORTRAN-77.

Other software required: None.

User's guide available:

Smith, J.U. & N.J. Bradbury, 1995. A user-guide for SUNDIAL.

Application reports:

Jenkinson, D.S. et al., 1994. Long-term experiments in agricultural and ecological sciences. In: Leigh, R.A. & A.E. Johnston (Editors). Proceedings of a conference to celebrate the 150th anniversary of Rothamsted Experimental Station, held at Rothamsted, 14-17 1993. Wallingford: CAB International.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: None.

COMMENTS: Prefer to supply model for collaborative work.

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GENERAL OVERVIEW

Name and version: SWACROP 2.02

Title: A Water Management and Crop Production Simulation Model.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 2

New release expected: Yes, under another name: SWAP*.

Subject: Crop science, and soil science.

Description: SWACROP 2.02 is a dynamic one-dimensional finite difference model for simulation of both unsaturated and saturated soil water flow. The model offers many top and bottom boundary conditions (inclusive ground water level). It takes into account a root-system in a heterogeneous soil profile. It accounts for water uptake by the roots. Crop production is included for potato, wheat, maize and grass. A number of options are available to simulate various irrigation and drainage situations.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evaporation, transpiration, flux through the soil, seepage, percolation, infiltration, irrigation, drainage, maintenance and growth respiration.

Number of rate variables: > 100.

State variables: Theta (volume moisture content), pressure head, hydraulic conductivity, ground water level, daily and total biomass.

Number of state variables: > 100.

Input data: Physical and hydrological soil properties, crop characteristics (soil cover, leaf area index, crop height etc.), daily meteorological data, drainage and irrigation specific data.

Number of input data: > 50.

Output data: Flow rate through profile, state variables, crop rate and state variables.

Number of output data: > 50.

Time interval of simulation: 1 day.

Basic spatial unit: m² to field level.

References general validation:

Clemente, R.S., R. de Jong, H.N. Hayhoe, W.D. Reynolds & M. Hares, 1994. Testing and comparison of three unsaturated soil water flow models. *Agricultural Water Management* 25: 135-152

Faria, R.T., C.A. Madramootoo, J. Boisvert & S.O. Prasher, 1992. A comparison of the versatile soil moisture budget and SWACROP models in Brazil. ASAE paper no. 922114. Summer Meeting 1992, N.C., U.S.A. 30 pp.

Kabat, P., B.J. van den Broek & R.A. Feddes, 1992. SWACROP: A Water Management and Crop Production Simulation Model. SWACROP: Un modele de simulation pour la question d'eau et la production des cultures. *ICID Bulletin* 1992, Vol. 41, no. 2. 61-84

Kabat, P., B.J. van den Broek, B. Marshall, J. Vos & H. van Keulen (Editors), 1994. Modelling and parameterization of the soil-plant-atmosphere system: A Comparison of Potato Growth Models. 450 pp.

Wesseling, J.G., P. Kabat, B.J. v.d. Broek & R.A. Feddes, 1992. SWACROP, version 2.02. Documentation package IGWMC-FOS 45. Distribution by International Ground Water

Modelling Centre (IGWMC-Delft), c/o Institute of Applied Geoscience, P.O.Box 285, 2600 JA Delft, The Netherlands.

Zepp, H. & A. Belz, 1994. Sensitivity and problems in modelling soil moisture conditions. Journal of Hydrology 131 (1992): 227-238

Stand alone model: Yes.

Parentage: The SWACROP 2.02 model is derived from SWATRE which was in turn derived from the SWATR model. The SWACROP 2.02 model is actually an update of the SWATRE model. The SWATR and SWATRE models are no longer available under those names. - SWATR: Feddes, R.A., P.J. Kowalik and H. Zaradny, 1978. Simulation of field water use and crop yield. Simulation Monograph. Pudoc-DLO, Wageningen, The Netherlands. 189 pp. - SWATRE: Belmans, C., J.G. Wesseling and R.A. Feddes, 1993. Simulation model of the water balance of a cropped soil: SWATRE. Journal of Hydrology 63 (1983) 3/4: 271-286

Check internal consistency or material balance present: No.

Input check in model: Some.

TECHNICAL SPECIFICATIONS

Hardware: >= 640 Kb RAM, math co-processor, EGA/VGA graphics.

Programming language: Microsoft FORTRAN-77.

Other software required: FORTRAN utility library.

Application reports:

Feddes, R.A., M. de Graaf, J. Bouma & C.D. van Loon, 1988. Simulation of water use and production of potatoes as affected by soil compaction. Potato Research 31: 225-239

Jong, R. de & P. Kabat, 1990. Modeling water balance and grass production. Soil Science Society of America Journal 54: 1725-1732

Ragab, R., F. Beese & W. Ehlers, 1990. A soil water balance and dry matter production model. I. Soil water balance of oat. Agronomy Journal 82: 152-156

Ragab, R., F. Beese & W. Ehlers, 1990. A soil water balance and dry matter production model. II. Dry matter production oat. Agronomy Journal 82: 157-161

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes.

Costs: US \$ 500 (SWACROP 2.02 and BALANCE*).

COMMENTS: Included with the SWACROP model is the graphical package BALANCE* to assist in output interpretation. - Wesseling, J.G., 1993. BALANCE*: a package to show the components of the water balance of a one-dimensional soil profile in time. Environmental Software 8 (1993): 247-253 The model SWACROP 2.02 and the graphical package BALANCE* are both available at the following address: IGWMC-Delft TNO - Inst. of Applied Geoscience Mr. A.H.M. Kremers P.O. Box 6012 2600 JA Delft The Netherlands Telephone: +31.15.697215 Telefax: +31.15.564800

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GENERAL OVERVIEW

Name and version: SWAGMAN Destiny

Title: A simulation model for Salt, Water and Groundwater Management.

Date first profile: February 12th, 1996.

Date last profile: February 12th, 1996.

Update: February 12th, 1996.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, soil science, farming systems, and environmental science.

Aggregation level: Crop/herd, and other: field level.

Description: Identifying crop and land management strategies which minimise watertable rise and salinity development which are also economically viable in both the short and long term is a considerable challenge. SWAGMAN is a computer simulation model which examines how management may impact future crop yields, groundwater levels and salinisation on a yearly basis for up to 30 years. The model is one dimensional (point scale) and estimates water and salt distributions and balances in a defined soil and crop situation. The program also has a basic economic component which enables the user to assess the economic viability of management options. Inputs of weather data, crop type, soil type, watertable level, piezometric conditions, irrigation practice and production costs can be modified or added to the program. This allows the user to explore various management options by manipulating the crop and soil scenario and examining the trends over a maximum 30 year period in continuous model. Access to all databases and configuration of simulation run scenarios is facilitated via a user-friendly shell. This shell program also invokes analysis programs and graphical output displays on completion of simulation runs. In strategic mode the user can select a weather period or length, up to ten years, which remains fixed for each run. The user can then develop five runs or scenarios which are the same except for one variable. The variable can either be the watertable level, watertable EC, soil EC, irrigation water EC, irrigation effectiveness or soil type. The initial conditions at the start of the year are the same for each particular run, therefore each year is independent. Output from SWAGMAN Destiny is presented in graphical form which enables the user to easily identify trends. Output can be printed on most printers including Postscript printers.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Water and salt fluxes, crop growth rates.

Number of rate variables: About 40-50.

State variables: Soil water, salt and water table and crop growth related variables.

Number of state variables: About 50-60.

Input data: Daily weather data, soil hydraulic properties, irrigation and crop management data, crop parameters.

Number of input data: About 40.

Output data: Components of soil water and salt balance, crop growth yield and stress information, water table dynamics.

Number of output data: About 50.

Time interval of simulation: 1 Day.

Basic spatial unit: A point in the landscape - units uses = 1 ha.

References general validation:

Resource potential of shallow water tables. Report to NRMS (In press).

Godwin, D.C. & W.S. Meyer, December 1995. Balancing crop production with salinity and watertable management. Paper presented to Second International Symposium on Systems Approaches for Agricultural Development (SAAD2). 6-8 December 1995. Held at International Rice Research Institute, Los Banos, Phillipines.

Stand alone model: Model operates within a shell which communicates with a database. The model can however be run stand alone.

Parentage: The model was derived from SWAGMAN Whatif - a static model and educational tool for salinity and water table management. The agronomic water balance and growth components have evolved from CERES*-type models with other components drawn from various sources.

Check internal consistency or material balance present: Yes, internal mass balance checks for water and salt.

Input check in model: Performed by associated data base management system for weather, soils and crop data.

TECHNICAL SPECIFICATIONS

Hardware: 80386 based PC or higher 640K.

Programming language: Microsoft FORTRAN (model) turbo pascal (shell) Paradox (data base).

Other software required: DOS only.

Application reports:

Rabbinge R. & C.T. de Wit, 1989. Systems, models and simulation. Pudoc. - Ill. - (Simulation Monographs; 32): 3-15

Source code available: On request.

Executable available: Yes.

User contract mandatory: No.

Costs: ?

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GENERAL OVERVIEW

Name and version: SWAP 1.0

Title: Soil Water Atmosphere Plant.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: August, 1994.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 2

New release expected: -

Subject: Crop science, and soil science.

Description: A water management, crop production and solute transport model.

Unsaturated/saturated soil water flow, swelling/shrinking and by-pass flow, water extraction by roots, heterogeneity and scaling of soil hydraulic parameters, hysteresis, heat dynamics in the soil, solute dynamics in the soil (convection, dispersion, advection; mobile and immobile fate), evaporation process (energy balance, turbulent fluxes of water vapour and heat), irrigation scheduling and drainage options, potential and water limited crop production.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evaporation, transpiration, flux through the soil, seepage, percolation, infiltration, irrigation, drainage, maintenance and growth respiration, solute transport.

Number of rate variables: > 100.

State variables: Theta (vol. moisture content), pressure head, hydraulic conductivity, ground water level, daily and total biomass, solute.

Number of state variables: > 100.

Input data: Physical and hydrological soil properties, crop characteristics (soil cover, leaf-area-index, crop height etc.), daily meteorological data, drainage and irrigation specific data, solute transport data, hysteresis, scaling.

Number of input data: > 75.

Output data: Flow rate through profile, state variables, crop rate and state variables, solute rate and state variables.

Number of output data: > 75.

Time interval of simulation: Variable from minute to 1 day.

Basic spatial unit: m² to field level.

References general validation:

Feddes, R.A. & P. Kabat (Eds.), 1994. SWAP model - Soil_Water_Atmosphere_Plant. I. Theory and Model Description. (In preparation).

Kabat, P. & R.A. Feddes (Eds.), 1994. SWAP model - Soil_Water_Atmosphere_Plant. II. Model Execution and Case Studies. Pudoc-DLO, Wageningen, The Netherlands (In preparation).

Stand alone model: Yes.

Parentage: SWACROP* 2.02.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: \geq 640 Kb RAM, math co-processor, EGA/(S)VGA graphics.

Programming language: Microsoft FORTRAN-77.

Other software required: FORTRAN utility library.

Source code available: No.

Executable available: Depending on contract.

User contract mandatory: Yes.

Costs: To be determined at a later date.

COMMENTS: The SWAP model is currently being tested and only available to researchers closely affiliated with the participating institutes. The model will be ready by 1995.

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GENERAL OVERVIEW

Name and version: SWELTER

Title: Synthetic Weather Estimator for Land use and Terrestrial Ecosystem Research.

Date first profile: March, 1996.

Date last profile: March, 1996.

Update: June, 1995.

Program type: Simulation model of weather patterns - part of the TRESTLE* model.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science, forestry, and land use studies.

Aggregation level: Region, and other: site, catchment, nation.

Description: SWELTER is stochastic-deterministic weather generator for use in research on ecosystem dynamics and the effects of climate variability. Monthly instrumental weather data for mean temperature, precipitation and wind speed are inputted into a first-order Markov chain, coupled to an autocorrelation intensity factor, to generate daily- or hourly-scale estimates of mean, maximum and minimum temperature and wind speed. The same approach is used in a two-state domain to estimate the mean amount of precipitation on a rain day. Algorithms are outlined to estimate precipitation intensity and duration, and relative humidity. Total, direct and diffuse solar radiation are approximated using a spherical geometry approach, corrected for altitude and latitude. The model is validated from 15 sites within the European Union, and are representative of a range of climates. All predicted values were within the 95% confidence interval of the instrumental data. Ranking carried out to indicate the model's predictive ability, based on statistical appraisal of results, shows fair to good predictions for 6 variables [mean, minimum and maximum temperature, precipitation, solar radiation, relative humidity and wind speed], and poor predictions for precipitation duration. Sensitivity analysis has shown that values for the SD and the 1st order autocorrelation can be substituted by constants. This reduces the input data requirements. Use of the model in ecosystem research may represent a suitable alternative to the acquisition of instrumental meteorological daily-scale data within the geographical area of the European Union, since it is able to generate good quality synthetic daily values for a range of climate parameters, derived from more widely available monthly scale instrumental series.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Daylength, extra-terrestrial radiation, terrestrial radiation (direct & diffuse) [2 methods], solar angle, minimum temperature, maximum temperature, mean temperature, relative humidity, atmospheric pressure, cloudiness, saturated vapour pressure, rainfall amount, rainfall duration, rainfall intensity, windspeed, evapotranspiration according to Penman-Monteith, Feddes et al. & Doorenbos-Kassam equations.

Number of rate variables: 19.

State variables: Altitude, latitude, slope, aspect.

Input data: Temperature, windspeed (mean, standard deviation, 1st order autocorrelation), precipitation (total/month, number of rain days), altitude, latitude, slope, aspect.

Number of input data: Minimum: 8; Maximum: 12.

Time interval of simulation: Hour or day.

Basic spatial unit: m².

References general validation:

Evans, S.P. & M.D.A.Rounsevell (submitted). Ecological Modelling.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC 486.

Programming language: Visual preparation.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes.

Costs: To be confirmed.

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GENERAL OVERVIEW

Name and version: TCG_CROP 1.0

Date first profile: September 6th, 1994.

Date last profile: September 6th, 1994.

Update: January 24th, 1994.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Farming systems.

Description: This program calculates production output variables (e.g. crop yield and quality), environmental output variables (total N-loss, N in NH₃-volatilization, N in NO₃-leaching, N in N₂O-denitrification, N-mineral in autumn and use of active ingredients in crop protection means) the use of labour hours per two month, fertilizer quantity N, P₂O₅, K₂O, manure (name and quantity), costs of machinery, costs of contract labour and costs of other production means per land use variable.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: None.

Number of rate variables: -

State variables: Crop yield, N-loss, NH₃-volatilization, N-leaching, N-denitrification, N-mineral in autumn, the use of labour hours, fertilizer quantity, costs of machinery, costs of other production means, length of the rotation, etc.

Number of state variables: About 17.

Input data: Choice of environment, crops, rotation-length, level and means of fertilization, level and means of crop protection, choice of catch crops, choice of variety, parameters to calculate the state variables.

Number of input data: > 100.

Output data: Crop yield and quality, total N-loss, N in NH₃-volatilization, NO₃-leaching, N₂O-denitrification, N-mineral and use of active ingredients in crop protection means), labour hours per two month, fertilizer quantity N, P₂O₅, K₂O, manure, costs of machinery, costs of contract labour and costs of other production means per land use variable.

Number of output data: About 17.

Time interval of simulation: No simulation, static model.

Basic spatial unit: Ha.

References general validation:

Habekotte, B., 1994. TCG_CROP, een model voor berekening van produktie- en milieuvariabelen van verschillende gewassen; ontwikkeld ten behoeve van het project 'Introductie Geïntegreerde Akkerbouw'. Simulation Reports CABO-TT no. 35. Maart 1994. 33 pp.

Stand alone model: No.

Parentage: The model is inspired but different from GRASMOD* (grassland management model to calculate nitrogen losses from grassland).

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, 2 Mb RAM and Microsoft FORTRAN power-station.

Programming language: Microsoft FORTRAN.

Other software required: -

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: TCG_CROP_BULB

Title: Technical coefficient generator for bulb crops.

Date first profile: November 30th, 1995.

Date last profile: November 30th, 1995.

Update: December, 1994.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Farming systems.

Aggregation level: Crop/herd.

Description: This program composes different growing systems for the bulb crops tulip, daffodil, lily and hyacinth from the characteristics 'previous crop', 'growing frequency', 'crop protection and cultivar' and 'nitrogen fertilization'. These growing systems are used in the model MGOPT_CROP to compose production systems.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: None.

Number of rate variables: -

State variables: Crop yield, N- P- and K-demand, the use of labour hours, costs of contract labour, costs of machinery, costs of other production means, use of pesticides.

Number of state variables: About 20.

Input data: Different options of the characteristics 'previous crop', 'growing frequency', 'crop protection and cultivar' and 'nitrogen fertilization'. These are described in effect on yield, costs and use of pesticides and nitrogen.

Number of input data: About 450 per crop.

Output data: Growing systems composed of different options of the characteristics and described in terms of bulb yield, organic waste, costs, NPK-requirement, labour.

Number of output data: 20 Per growing system.

Time interval of simulation: Not applicable.

Basic spatial unit: Hectare.

References general validation:

Ruijter, F.J. de & J.E. Jansma, 1994. De bol in getal. Modelmatige beschrijving van produktie- en milieuvariabelen van bloembolgewassen met behulp van het rekenmodel TCG_CROP. Rapport 17, AB-DLO, Wageningen, 36 pp. + 13 pp. bijl.

Stand alone model: No.

Parentage: TCG_CROP* 1.0, and GRASMOD*.

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX computer.

Programming language: Microsoft FORTRAN.

Other software required: -

Application reports:

Jansma, J.E., W.A.H. Rossing, F.J. de Ruijter & J. Schans, 1994. De bol aan de rol. Verkenning

van ontwikkelingsrichtingen voor duurzame bollenteelt. Rapport 103, Wetenschapswinkel, Wageningen. 60 pp. + 78 pp. bijl.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: TETrans

Title: Trace Element Transport.

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: October, 1995.

Program type: Simulation model/module.

Purpose: TETrans was designed to be a preliminary assessment tool for assessing the movement of both point and non-point source pollutants, (eventually) through vadose zones.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

Subject: Soil science, and environmental science: non-point source pollution.

Description: TETrans is a functional model examining the vertical movement of non-volatile solutes and non-point source pollutants through the vadose zone. It is a functional, one-dimensional model of solute transport in the vadose zone. It uses a mass-balance, layer equilibrium approach which is sometimes referred to as the "tipping bucket" approach. The model accounts for adsorption-desorption reactions, preferential flow, mass flow, plant water uptake, infiltration and redistribution. The time-step is from one irrigation/precipitation event to the next. A total of 25 soil horizons/layers are possible. The output includes solute concentration distributions, drainage, solute loading, leaching fraction, water uptake by plant. Because TETrans is a preliminary assessment model it is specifically designed to give an approximation of how a pollutant will move through the vadose zone with the most readily available data.

Keywords: hydrology, solute transport, GIS (Geographic Information System). Global change implications: This model could be used in global change research to examine the effects of chemical inputs and hydrologic dynamics in soils.

Input data: Plant parameters: maximum root penetration depth, plant water uptake distribution, planting date, days to maturity of crop, and harvest date. Chemistry parameters: adsorption coefficients, bulk density of soil. Hydraulic parameters: field capacity, wilting point by mass coefficient. Initial conditions: initial water content, initial solute concentration. Boundary conditions: irrigation/precipitation amount, time of irrigation/precipitation, evapotranspiration amount, solute in irrigation/precipitation water. All data is readily available from the Soil Conservation service, irrigation districts and individual farmers.

Output data: The output includes solute distributions through the vadose zone over time and the amount of solute loading to the ground water.

Time interval of simulation: There is no time limit to the temporal range beyond 2 irrigation/precipitation events.

Basic spatial unit: Currently a 1-D vertical transport model, and TETrans has been coupled to a GIS to give it 3-D capability.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: TETrans was designed to run on the cheapest of computers. (i.e., 8086 or 68000). DOS and Macintosh.

Programming language: There are two versions of TETrans: IBM written in Microsoft FORTRAN and Macintosh written in C and FORTRAN.

User's guide available:

TETrans User's Guide (Macintosh version 1.6 or IBM version 1.5).

Application reports:

Corwin, D., P. Waggoner & V. Rhoades, 1991. A Functional Model of Solute Transport that Accounts for Bypass. *Journal of Environmental Quality* 20: 647-658

Corwin, D., P. Waggoner & V. Rhoades, 1992. Simulating the movement of a reactive solute through a soil lysimeter column using a function transport model. *Journal of environmental science and health A27(7)*: 1875-1913

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: No charge.

CONTACT(S):

Name: **Dr. D.L. Corwin.**

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GENERAL OVERVIEW

Name and version: The major soils of the world

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Other.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: -

Subject: Soil science.

Description: The course deals with the classification, occurrence, genesis, properties and use of the major soils of the world as distinguished in the Revised Legend (1990) to the FAO-Unesco Soil Map of the World.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

References general validation:

Driessen, P.M. & R. Dudal, 1991. The major soils of the world: lecture notes on their geography, formation, properties and use. Wageningen Agricultural University, Department of Soil Science and Geology, The Netherlands. 309 pp.

TECHNICAL SPECIFICATIONS

CONTACT(S):

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GENERAL OVERVIEW

Name and version: TOPMODEL

Title: -

Date first profile: October, 1995.

Date last profile: October, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: Yes.

Subject: Soil science: hydrology.

Aggregation level: Other: Hillslope, catchment.

Description: TOPMODEL simulates the movement of precipitation over and through watersheds. It is a basin hydrologic model that attempts to simulate evapotranspiration, subsurface flow and overland flow. TOPMODEL is based primarily on the continuity equation and Darcy's Law. Digital Elevation Model (DEM) data are used to compute the spatial distribution of a topographic parameter before running TOPMODEL. The model equations are evaluated at each location where the topographic parameter has been computed. Spatial distributions and watershed-average values of hydrologic variables are computed for each time step of the simulation. The model can be run with or without calibration. The equations that determine the fluxes of water through infiltration, evapotranspiration, and subsurface flow are physically based. The model simulates explicit ground water/surface-water interactions by predicting the movement of the water-table, which determines where saturated land-surface areas develop and have the potential to produce Dunne overland flow. The model requires as input: DEM, soil survey data, daily maximum and minimum temperature and precipitation. The model predicts streamflow, soil moisture, evapotranspiration, discharge to the water table, overland flow and subsurface flow. Keywords: basin hydrologic model, precipitation movement, evapotranspiration topography, subsurface flow, overland flow, watershed hydrology. Other: This model provides another means of evaluating streamflow and soil moisture under varying climatic conditions.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Evapotranspiration, recharge, saturation-excess overland flow, infiltration-excess overland flow, subsurface flow, return flow.

Number of rate variables: 10.

State variables: Soil moisture content, depth to water table.

Number of state variables: 5.

Input data: Topography data (DEM), soil survey data, time series of air temperature and precipitation, measured streamflow, (if calibration is desired). Model input data source in the United States: USGS DEM's, SCS soil survey, NWS (National Weather Service) meteorologic stations.

Output data: Spatially and temporally variable streamflow, soil moisture, evapotranspiration, depth to the water table, overland flow, subsurface flow.

Time interval of simulation: Fifteen minute to daily time steps.

Basic spatial unit: Spatial scale: Five m to 90 m-depends on the DEM.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC, workstation, mainframe, and the code.

Programming language: Microsoft FORTRAN.

Other software required: None.

Technical reference:

Beven, et al., 1994. TOPMODEL and GRIDATB. Centre for Research on Environmental Systems and Statistics. Technical Report TR 110/94, Lancaster University, Lancaster, UK.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: Torbert N

Date first profile: November, 1995.

Date last profile: November, 1995.

Update: 1995.

Program type: Simulation model/module.

Purpose: Intended as tool for teaching N processes. Describes major components of N cycle and how they interact.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

New release expected: No.

Subject: Soil science: nutrient dynamics.

Aggregation level: Other: corn field.

Description: Torbert N simulates the processes of the N cycle. Torbert N is a computer model characterizing the balance of soil-plant N is described, which is coded in a language that provides a graphic interface for use by students and others with minimal programming experience. Equations representing simultaneous water, C, and N balance reactions in a soil-plant system are solved over time. Both qualitative relationships between various interacting system components are presented in graphic form to facilitate an intuitive understanding of the dynamic interactions between system functions. By manipulating various combinations of input functions, the students can see the likely consequences of different biological and weather related parameters upon the N-cycle. Three uses for the model are proposed: orienting beginning students toward an understanding of fundamental components of the soil N-cycle, providing in-depth information for advanced students including access to the defining equations and citations of relevant journal articles, and supplying source-equations for scientists who wish to extend the model or explore the dynamic consequences of using alternate formulations. The Torbert N Model contains several modules: fertilizer application, growing crop, atmospheric-N, soil organic matter and a ground water N-input module. The weather generator component contains the Richardson weather simulator for crop management (WGEN). Keywords: N cycle, educational, denitrification, mineralization, nitrification, immobilization, leaching. Global change implications: This model could be used for global change research program both as a teaching tool as well as a research tool. Because it is developed using a powerful and flexible modeling package (Stella II), this model can potentially be modified to test assumptions of the effect of global climate change on nitrogen cycling on small agricultural fields.

Input data: None.

Output data: The model produces data in both tabular and graphical forms.

Time interval of simulation: Day.

Basic spatial unit: Spatial scale: 1 acre furrow slice.

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: The model uses "Stella" software and the Macintosh operating system for computers, or Microsoft Windows for DOS.

Programming language: "Stella" software for modeling.

Technical reference:

Torbert, H.A., M.G. Huck & R.G. Hoefl. Simulation of soil plant nitrogen interactions for educational purposes. Journal of Natural Resources and Life Science Education 23(1): 35-42

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

Name: **Dr. H.A. Torbert.**

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GENERAL OVERVIEW

Name and version: TPE-Aphdam 2.0

Title: Simulation of damage by aphids in winter wheat.

Date first profile: January, 1993.

Date last profile: October, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop protection.

Aggregation level: Crop/herd.

Description: Growth and development of winter wheat during the post-anthesis phase is simulated as a function of injury by *Sitobion avenae*, the English grain aphid. The model applies to the time interval from flowering to ripeness which constitutes the main period of grain aphid immigration and development in winter wheat in the Netherlands. The crop model describes crop growth and development as a function of the prevailing weather and the available amount of soil nitrogen and consists of sink-source relations and distribution functions for carbohydrates and nitrogen. Injury by *S.avenae* affects crop growth both directly and indirectly. Direct effects on growth are due to aphid feeding. Indirect effects are caused by the aphid excretion product honeydew which affects leaf net carbon dioxide assimilation. Alternative hypotheses on the nature of the direct effects are formulated. Inputs to the model are average daily temperature, daily global radiation, the amount of nitrogen in the soil and the density on the aphid population. The major output is grain weight.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Phenological development, leaf and canopy photosynthesis, maintenance and growth respiration, crop growth, growth of plant organs, soil nitrogen uptake, plant nitrogen distribution, assimilate uptake by aphids.

Number of rate variables: About 50.

State variables: Biomass (total and per crop organ), leaf area index.

Number of state variables: About 30.

Input data: Data relating to parent crop growth models, aphid density (x/tiller).

Number of input data: About 30.

Output data: User-defined.

Number of output data: Variable.

Time interval of simulation: 1 day.

Basic spatial unit: m² - ha.

References general validation:

Rossing, W.A.H., 1991. Simulation of damage in winter wheat caused by the grain *Sitobion avenae*. 2. Construction and evaluation of a simulation model. *Netherlands Journal of Plant Pathology* 97: 25-54

Stand alone model: Yes.

Parentage: SUCROS*87, SWHEAT and NWHEAT*.

TECHNICAL SPECIFICATIONS

Hardware: IBM compatible PC.

Programming language: PCSMP* in combination with TTSELECT* and BAT procedure.

Other software required: -

Application reports:

Rossing, W.A.H., 1991. Simulation of damage in winter wheat caused by the grain Sitobion avenae. 3. Calculation of damage at various attainable yield levels. Netherlands Journal of Plant Pathology 97: 87-103

Source code available: Yes, subject to some conditions.

Executable available: Yes.

User contract mandatory: No.

Costs: No.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: TPE-Uncon/Risk 1.0

Title: UNCertainty analysis applied to supervised CONtrol of aphids and brown rust in winter wheat.

Date first profile: January, 1993.

Date last profile: October, 1995.

Update: -

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Crop protection, and environmental science.

Aggregation level: Crop/herd.

Description: Uncertainty in predicted costs associated with different strategies of control of aphids and brown rust in winter wheat is calculated in a Monte Carlo approach with time steps of one day. Time horizon of the model is approximately 6 weeks. Four sources of uncertainty are distinguished: parameters, initial conditions, predictions of average daily temperature and white noise. The model can be run in two modes. To estimate (aspects of) the probability distribution of financial costs random inputs are generated by latin hypercube sampling. Results are summarized in tables. To assess the contribution of various sources of uncertainty to model output uncertainty random varieties are generated by simple random sampling. Results are stored in a data file for analysis with the SPIRAL programme of M.J.W. Jansen (Agricultural Mathematics Group (GLW-DLO), P.O.Box 100, 6700 AC Wageningen, The Netherlands).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Phenological development, aphid growth, brown rust growth, yield loss increase, pesticide effect.

Number of rate variables: About 15.

State variables: Phenological development, aphid density, brown rust density, yield loss.

Number of state variables: About 10.

Input data: Daily weather data, initial aphid density, initial brown rust density, initial phenological development stage, uncertainty in parameters, inputs and white noise.

Number of input data: Some 40.

Output data: Two output files are written.

Number of output data: Variable.

Time interval of simulation: 1 day.

Basic spatial unit: m² - ha.

References general validation:

Rossing, W.A.H., R.A. Daamen & M.J.W. Jansen, 1994. Uncertainty analysis applied to supervised control of aphids and brown rust in winter wheat. Part 1. Quantification of uncertainty in cost-benefit calculations. *Agricultural Systems* 44: 419-448

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX.

Programming language: Microsoft FORTRAN-77.

Other software required: TTUTIL* and CABO/TPE Weather System*, two FORTRAN programs to generate input files with uncertainty samples (LHSGEN.FOR and DYNGEN.FOR).

Application reports:

Rossing, W.A.H., R.A. Daamen & E.M.T. Hendrix, 1994. Framework to support decisions on chemical pest control under uncertainty, applied to aphids and brown rust in winter wheat. Crop Protection, Volume 13 (1): 25-34

Rossing, W.A.H., R.A. Daamen & M.J.W. Jansen, 1994. Uncertainty analysis applied to supervised control of aphids and brown rust in winter wheat. Part 2. Relative importance of different components of uncertainty. Agricultural Systems 44: 449-460

Source code available: Yes, subject to some conditions.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: TRANSECT 2.04

Title: Tillage and Crop Residue Transect.

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: August 22nd, 1994.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 3

New release expected: Yes.

Subject: Farming systems.

Aggregation level: Region.

Description: TRANSECT is a program developed at Purdue University for Indiana's T-by-2000 soil conservation education program to summarize data collected from roadside surveys of agricultural lands. These surveys are designed to collect information on agricultural practices, with a focus on tillage systems and crop residue management. Points of observation are predetermined at standard intervals with a minimum of 460 points desired for accurate analysis.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Present and previous crop; site, tillage practice; percent residue; percent slope; slope length; ephemeral/gully erosion; tolerable soil loss; erodibility; tillage practice.

Number of rate variables: 11.

State variables: Rainfall index by location.

Number of state variables: 1.

Input data: Present crop; previous crop; site locations; tillage system; % residue cover; percent slope; slope length; ephemeral/gully erosion; tolerable soil loss; soil erodibility; tillage practice.

Number of input data: 11.

Output data: Single and multiple county of watershed outputs in percentages or number of observations form in charts, graphs, or maps.

Number of output data: Various.

Time interval of simulation: Year of growing season.

Basic spatial unit: County/parish or watershed.

Stand alone model: Yes.

Parentage: TRANSECT 2.03.

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: Minimum requirements: IBM PC or compatible; 384 Kb available memory; DOS 3.1 or later; hard disk with at least 2 Mb free space; high density 5 1/4" (1.2 Mb) or 3 1/2" (1.44 Mb) floppy drive.

User's guide available:

Hess, P., December 1994. TRANSECT User's guide Purdue University, Agronomy department.

Technical reference:

Hill, P., 1995. A roadside survey method for obtaining reliable county and watershed-level tillage, crop residue and soil loss data. AGRY-95.

Source code available: No.

User contract mandatory: Yes.

Costs: Free for non-commercial use.

CONTACT(S):

Name: **Mr. K.J. Eck.**

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GENERAL OVERVIEW

Name and version: TRANSOL 2.3

Title: TRANsport of a SOLute.

Date first profile: September, 1994.

Date last profile: November 21st, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Soil science, and environmental science.

Description: Dynamic simulation of transport and transformation of a solute in an unsaturated and saturated soil system. The model was developed to analyze the leaching of pesticides from the soil surface to ground water and surface waters. Hydrological data must be supplied by another model. Model system is a multi-layer one-dimensional soil column. The upper boundary is the soil surface, the lower boundary is the depth of the local ground water flow and the lateral boundary is defined by the surface water system(s). Main processes included in the model are: degradation/transformation as first order process, equilibrium sorption to/from the soil complex, crop uptake, runoff, discharge to different surface water systems and leaching to ground water. Production, transport and transformation of metabolites is simulated optionally.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Degradation rate, sorption rate, 14 different water fluxes (precipitation, runoff, seepage, leaching, 1st, 2nd and 3rd order drainage and infiltration, 3 evaporation terms, transpiration).

Number of rate variables: About 20.

State variables: Moisture contents, quantities of sorbed and soluted pesticides.

Number of state variables: > 50.

Input data: Extended soil water balance, pesticide management (amount, sorption coefficient, time and depth of application), soil physical properties (pF, bulk density, 5 temperature parameters), soil chemical properties (pH, organic matter content), boundary and initial conditions.

Number of input data: About 30.

Output data: All terms of complete balances of a soil-water-crop system for water and a pesticide.

Number of output data: Variable (> 100).

Time interval of simulation: 1-30 days.

Basic spatial unit: 1 m².

References general validation:

Kroes, J.G., 1994. TRANSOL Version 2.3. A dynamic model for transport and transformation of solutes in soils. User's guide. Interne mededeling 110, DLO Winand Staring Centre, Wageningen.

Kroes, J.G. & P.E. Rijtema, 1995. TRANSOL, A dynamic model for transport and transformation of solutes in soils. Report in preparation. DLO Winand Staring Centre, Wageningen.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: VAX, IBM compatible PC.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Application reports:

Kroes, J.G. & J.J.T.I. Boesten, 1993. Een vergelijking van de modellen TRANSOL en PESTLA. Rapport, Staring Centrum, Wageningen. 40 pp.

Rijtema, P.E. & J.G. Kroes, 1994. Chemigation and modelling the behaviour of fertilizers and pesticides. Working paper for the Expert Consultancy meeting FAO on Fertigation and Chemigation Cairo 8-12 September 1991.

Source code available: No (for research contact DLO Winand Staring Centre).

Executable available: Yes.

User contract mandatory: Yes.

Costs: 0-300 ECU.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: TREGRO 3.0

Title: TREE GROwth.

Date first profile: October 12th, 1995.

Date last profile: October 12th, 1995.

Update: October 1st, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: Yes, June 1996.

Subject: Forestry.

Aggregation level: Plant.

Description: TREGRO is a mechanistic process model. The model was developed as part of the ROPIS (Response of Plants to Interacting Stresses) program. It is used to evaluate air pollution effects on trees in the context of interacting anthropogenic and natural environmental stresses. It analyzes the short-term (hourly) and long-term (decades) growth response of individual trees exposed to combinations of conditions involving drought, nutrient deficiency, climate change, acidic deposition, and tropospheric ozone. TREGRO predicts growth and patterns of carbon allocation expected for an isolated tree exposed to various levels of ozone, nutrient stress, and water availability. The tree is divided into the following components: buds; a canopy consisting of up to 10 leaf year classes; branches; stem; and a fine and coarse root pool in each of three soil layers. The model calculates the photosynthesis of the entire tree each hour as a function of ambient environmental conditions and the availability of light, water, and nutrients. The model keeps track of the flow of carbon to the sites of fixation within the leaves, the availability of light, water, and nutrient resources needed for the fixation process, and the amounts of these nutrient resources and fixed carbon available to build the component tissues of the plant. The model also estimates the quantity of essential nutrients and the water available in each soil horizon and the amount of these resources taken up by the tree. The model predicts the growth of the tree over periods ranging from one hour (the basic model time step) to many years.

Keywords: forest, physiological effects, ozone stress, air pollution water stress, nutrient deficiencies, environmental stress, growth, respiration, photosynthesis, carbon budget, carbon allocation. **Global change implications:** This model can examine the effects of multiple types of stresses on tree growth at the same time. This is one of only a few models in this survey that examine the effects of ozone stress on plant growth.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Photosynthesis rate, respiration rate, maximum allocation rate.

Number of rate variables: More than 100.

State variables: Biomass by leaf class, branch, stem, coarse and fine root (by soil depth), and each of these subdivided into structure, wood, and non-structural carbohydrate.

Input data: Hourly meteorologic data including air temperature, humidity, vapour pressure, photosynthetically active radiation, rainfall, ozone. Missing data is estimated by model routines. Starting values for the amounts and forms of carbon in each of the tree compartments. Soil data, nutrient data, hydrologic simulation parameters, maximum potential growth rates, respiration rates, photosynthesis parameters. **Model input data source:** Most input data is provided by user in the form of HyperCard interface. Parameter values are provided for red spruce; the user must determine for their species. Meteorologic data, and hydrologic data must be provided by the user from an external source file.

Number of input data: More than 100.

Output data: For each simulated day, TREGRO writes 256 output variables to a binary file. The user can examine the daily values of any or all of these in a graph against time, a graph against another variable, or a text table. Variables most often examined include carbon budgets (tree tissue sizes, photosynthesis, respiration), soluble carbon pools, and cumulative ozone uptake.

Number of output data: More than 100.

Time interval of simulation: Temporal scale: Hourly (basic time step) to decades.

Basic spatial unit: Spatial scale: single tree and its soil block.

Stand alone model: Yes, can be run with or without HyperCard interface and YASE, soil equilibrium mode.

Parentage: The model is original with the exception of the calculation of photosynthesis, for which we use the equations of Farquhar (Farquhar et al., 1980. *Planta* 149: 78-90) as modified and coded by T. Ball (unpublished).

Check internal consistency or material balance present: Yes.

Input check in model: Some.

SCIENTIFIC SPECIFICATIONS FOR OPTIMIZATION MODELS

Type of variables/activities: Non linear discrete time.

Number of variables/activities: Many.

Type of constraints: Many.

Number of constraints: Many.

Type of objective functions: Photosynthesis, respiration, allocation, growth, uptake.

Number of objective functions: More than 50.

Basic spatial unit: Soil block dominated by 1 tree, typically 10m x 10m.

Time horizon: 1 to 100 years.

Parentage: Farquhar photosynthesis model, Barber-Casham nutrient uptake model, Chess soil equilibrium model.

TECHNICAL SPECIFICATIONS

Hardware: TREGRO runs on Macintosh personal computers equipped with systems software version 6.0.5 or later, 2 MB RAM and 3 MB free hard disk storage. Each 2-year model run requires an additional 1 MB hard disk storage space.

Programming language: The model is written in Microsoft FORTRAN with a HyperCard Interface.

User's guide available:

Weinstein, D.A., R.M. Beloin, R.D. Yanai, C.G. Zollweg & B. Gollands, In Review. TREGRO simulation model of carbon, water, and nutrient balances of a plant soil system. Model Version 3.0 Description and Parameter Requirements. Electric Power Research Institute. Research Project 2799-1.

Application reports:

Weinstein, D.A. & R.D. Yanai, 1995. Integrating the effects of simultaneous multiple stresses on plants using the simulation model TREGRO. *Journal of Environmental Quality*. (In Press).

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: TRESTLE

Title: Tree Response, Establishment and Succession in the Transient Landscape of Europe.

Date first profile: March, 1996.

Date last profile: March, 1996.

Update: November, 1995.

Program type: Simulation model/module: forest gap model.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science, forestry, and land use studies.

Aggregation level: Region, and other: site, catchment.

Description: TRESTLE, Tree Response, Establishment and Succession in the Transient

Landscape of Europe, is a modularised, process-based model of tree growth integrating energy-water-carbon-nitrogen cycles with a description of the key physiological processes operating within the plant, embedded into a community dynamics forest model of the gap-type. Six of the nine forecasted modules comprising the TRESTLE model have so far been developed: 1.

SWELTER*, a Synthetic Weather Estimator for Land use and Terrestrial Ecosystem Research;

2. precipitation interception by the tree canopy; 3. snow formation and snow snowmelt model; 4.

SWBCM, a Soil Water Balance Capacity Model; 5. plant physiological processes, 6. the

TRESTLE data-base, collating species-specific variables required as model inputs. MODULE 1:

SWELTER*, (Synthetic Weather Estimator for Land use and Terrestrial Ecosystems Research)

is a stochastic-deterministic weather model which generates synthetic time series of a number of physically interpretable phenomena (rainfall, temperature etc.) at different timescales (hourly, daily, etc.). These time series are robustly estimated from limited climatic statistics derived from instrumental data; in other words, synthetic series will have the same 'intrinsic' properties as the instrumental meteorological data from which they are derived. MODULE 2: Model on

precipitation interception processes by the tree canopy. This is a semi-dynamic model of canopy interception of precipitation is outlined. The model uses species-specific constants coupled to inputs developed by SWELTER* in combination with other TRESTLE model components to predict: - the quantity of precipitation intercepted by the canopy during rainfall events of

different duration and intensity; - the quantity of precipitation reaching the soil surface through throughfall and stem throughflow. MODULE 3. The Snow Formation and Snowmelt Model is an

energy flow model used to calculate snow formation and snowmelt at the daily time-step. The

model combines a suite of pre-defined constants with outputs from SWELTER* to calculate: -

evaporation from the snow surface; - snowmelt water developing at the base of the snow pack.

MODULE 4. The Soil Water Balance Capacity Model (SWBCM) estimates water fluxes under

forest conditions. It is a deterministic model operating at the daily time-step, and calculates: -

soil water content - drainage rate - lateral flow for unsaturated and saturated layers - surface

runoff - water loss through soil evaporation and plant transpiration for soils of known texture and

under vegetational cover of known composition and structure, for both free-draining profiles and

profiles overlying impermeable layers. MODULE 5. Key plant physiological processes are

numerically described, which determine the production of new leaf area and woody tissue, and

which influence the competition status of the individual species, thereby affecting the potential

for survival. The following processes are calculated at the daily time step, as are their

dependencies on fluctuations in different biophysical states: - photosynthesis - stomatal

conductance - dark respiration - CO₂ fertilisation effects MODULE 6. A database containing a

set of values for parameters on native European tree species, required as default inputs to the TRESTLE model, in the absence of user-defined values.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Too many to list.

State variables: Too many to list.

Time interval of simulation: Hour or day.

Basic spatial unit: m².

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC 486.

Source code available: No.

Executable available: Not at present.

User contract mandatory: No.

Costs: To be confirmed.

COMMENTS: The model is currently undergoing development.

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GENERAL OVERVIEW

Name and version: TRIWACO 7.0

Date first profile: November 27th, 1995.

Date last profile: November 27th, 1995.

Update: November 1st, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 2

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Environmental science.

Aggregation level: Region, and supra region.

Description: TRIWACO is a complete package for ground water simulation, based on the finite element method, steady state and transient.

Input data: Geohydrolic data of the subsurface, precipitation, top system data, rivers, drains, walls.

Output data: Piezometric heads and fluxes, water balances, pathlines.

Time interval of simulation: Variable.

Basic spatial unit: Variable.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: 386 DX or higher compatible.

Programming language: Microsoft FORTRAN-77 31-bit / C++.

Other software required: DOS, WINDOWS, OS/2 or UNIX.

Costs: Depending on package.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: TTSELECT 2.21

Date first profile: January 26th, 1995.

Date last profile: January 26th, 1995.

Update: December, 1994.

Program type: Simulation tool: graphing tool for use with TTUTIL*, FSE* and FST*.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Graphing tool.

Aggregation level: Not applicable.

Description: TTSELECT can be used to view model results graphically after a simulation run.

Model results for different variables and for multiple model runs can be viewed in the same graph. Prints can be made on HP Deskjet and HP laserjet printers.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: -

State variables: Not applicable.

Number of state variables: -

Input data: Not applicable.

Number of input data: -

Output data: Not applicable.

Number of output data: -

Time interval of simulation: Not applicable.

Basic spatial unit: Not applicable.

Stand alone model: Not applicable.

Parentage: Not applicable.

Check internal consistency or material balance present: Not applicable.

Input check in model: Not applicable.

TECHNICAL SPECIFICATIONS

Hardware: IBM-PC's or compatibles.

Programming language: Microsoft FORTRAN-77 (MS-FORTRAN 5.1).

Other software required: None.

Source code available: No.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 150,=.

COMMENTS: TTSELECT can only be used when data are output with the OUTDAT routine of TTUTIL*.

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GENERAL OVERVIEW

Name and version: TTUTIL

Title: FORTRAN utility library.

Date first profile: January 26th, 1995.

Date last profile: January 26th, 1995.

Update: December, 1994.

Program type: Simulation tool: library with FORTRAN-77 programming utilities.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: Yes.

Subject: Not applicable.

Aggregation level: Not applicable.

Description: A number of FORTRAN-77 subroutines and functions. Many routines are utilities in the sense that they do not make use of any mathematical or numerical method, do not contain measured data and do not depend on assumptions concerning some described system. Utilities simply perform a technical task with respect to input, output, string handling, file handling, etc. They are tools for writing reliable and readable FORTRAN programs.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Not applicable.

Number of rate variables: -

State variables: Not applicable.

Number of state variables: -

Input data: Not applicable.

Number of input data: -

Output data: Not applicable.

Number of output data: -

Time interval of simulation: Not applicable.

Basic spatial unit: Not applicable.

Stand alone model: Not applicable.

Parentage: Not applicable.

Check internal consistency or material balance present: Not applicable.

Input check in model: Not applicable.

TECHNICAL SPECIFICATIONS

Hardware: Machine with decent FORTRAN-77 compiler.

Programming language: Microsoft FORTRAN-77.

Other software required: None.

User's guide available:

Rappoldt, C & D.W.G. van Kraalingen, 1990. Reference manual of the FORTRAN utility library TTUTIL with applications. Simulation Report CABO-TT no. 20. Centre for Agrobiological Research and Dept. of Theoretical Production Ecology. Wageningen. The Netherlands. 122 pp.

Source code available: No, depends on type of application of TTUTIL*.

Executable available: Yes, is library.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 150,=.

COMMENTS: TTUTIL contains the basic routines for FSE* and FST*.

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GENERAL OVERVIEW

Name and version: TUCROS

Date first profile: October, 1994.

Date last profile: October, 1994.

Update: 1985.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop science.

Description: A model for simulation of potential production of tulip, cultivar 'Apeldoorn'. It calculates total crop growth and growth of plant organs. A distribution of the calculated bulb yield into size is given. The model is calibrated for use of a planting stock of bulb size 9 only.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Canopy photosynthesis, maintenance respiration, crop growth, growth of plant organs, phenological development

Number of rate variables: About 15.

State variables: Weight of: planted bulb, leaves, stems, flowers, bulbs, roots, leaf area index.

Number of state variables: About 20.

Input data: Weather data (average soil and air temperature), radiation.

Number of input data: -

Output data: Bulb yield and distribution of the bulb weight in a number of size classes. Option for output of other state and rate variables.

Number of output data: -

Time interval of simulation: 1 day.

Basic spatial unit: 10 m².

References general validation:

Benschop, M., 1985. TUCROS, een simulatiemodel voor de tulpecultivar 'Apeldoorn'. Simulation Report CABO-TT No. 6. 83 pp.

Stand alone model: Yes.

Parentage: SUCROS*.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: VAX, PC/AT.

Programming language: CSMP*.

Other software required: -

Source code available: Listing in report, not on disk.

Executable available: No.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

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GENERAL OVERVIEW

Name and version: UCD/LLNL MAS Model

Title: Mesoscale Atmospheric Simulation Model.

Date first profile: November 11th, 1995.

Date last profile: November 11th, 1995.

Update: November 11th, 1995.

Program type: Simulation model/module.

Purpose: Numerical weather prediction and simulation.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 1

Subject: Soil science, and environmental science (atmosphere).

Aggregation level: Region.

Description: Regional scale primitive equation numerical weather prediction and climate model.

The model was developed to specifically examine airflow and precipitation over mountainous areas in California. The model uses either observations or global model outputs as the lateral boundary condition to generate the regional scale climate information, including precipitation, cloud cover, evapotranspiration. Two related models comprise the mesoscale model; a hydrostatic model and an atmospheric convection model. The hydrostatic model also contains a simulation component that includes soil and boundary layers. Keywords: Regional scale model, climate model, numerical weather prediction model. Global change implications: This model could be used for predicting future local/regional weather conditions based on global climate conditions.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Rain, snow, evapotranspiration, run off.

State variables: Pressure, temperature, wind (u, v, o), mixing ratio (cloud, rain, ice, snow).

Input data: Basic variables: pressure, wind speed and direction, temperature, water vapour.

Land use patterns: vegetation cover, soil and vegetation type, soil moisture. Model input data source: National Weather Service global analysis, outputs from global climate models, land use and soil data from NCAR.

Output data: Wind, temperature, precipitation, cloud cover, snow depth, radiation, evapotranspiration rate.

Time interval of simulation: Temporal scale: A few days to a few months.

Basic spatial unit: Spatial scale: 50-2 000 kilometers.

Stand alone model: Yes.

Parentage: None.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: 1 Hour computer time for 48 hour prediction on Alpha Station using one processor.

Programming language: Microsoft FORTRAN.

Technical reference:

Kim, J. & S.T. Soong, 1994. Simulation of a Precipitation Event in the Western United States. Preprint 6th Conference on Climate Variations. AMS 403-406

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: UPDA3 1.0

Title: -

Date first profile: October 16th, 1995.

Date last profile: October 16th, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 3

New release expected: No.

Subject: Crop science (horticulture), and soil science.

Description: The model generates scanning curves for hysteretic behaviour of the water retention characteristic. The model from Kool et al. (1987) was slightly adapted so that each generated scanning curve closes at the previous reversal point. This adaptation was necessary to reduce the artificial effect of 'water pumping' which might under cyclic variation of pressure head otherwise. The routine requires a Van Genuchten description of the water retention characteristic and generates new parameters for a scanning curve if a reversal of drying or wetting occurs in the profile.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: -

Number of rate variables: 0.

State variables: Pressure head and water content in profile and at reversal and closure point of the scanning curve; Van Genuchten parameters.

Number of state variables: 10.

Input data: Van Genuchten parameters; pressure head and water content.

Number of input data: 8.

Output data: Van Genuchten parameters for soil water retention characteristic.

Number of output data: 6.

Time interval of simulation: -

Basic spatial unit: m².

References general validation:

Otten., W., 1994. Dynamics of water and nutrients for potted plants induced by flooded bench fertigation: experiments and simulation. Thesis Wageningen. 115 pp.

Stand alone model: No.

Parentage: SWATRE.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: VAX.

Programming language: Microsoft FORTRAN.

Other software required: None.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: Not a stand-alone model. Model works as part of a water flow model (e.g.

SWATRE). This subroutine is developed as part of the program POTPLANT* to simulate water and nutrient dynamics in potted plants using flooded bench fertigation.

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GENERAL OVERVIEW

Name and version: Wageningen Carbon Cycle Model

Title: The Global Carbon Cycle.

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

Subject: Environmental science.

Description: The model contains the carbon reservoirs, and the 13 and 14 isotopes, in the ocean (12 layers, Pacific/Indian and Atlantic) and in the terrestrial biosphere (soil carbon, woody and herbaceous biomass, 6 vegetation types).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Net primary productivity, deforestation, plankton production.

Number of rate variables: -

State variables: See description, further phosphate and oxygen contents of sea-water.

Number of state variables: 252.

Input data: Fossil fuel combustion, vegetation properties, rate of deforestation, ocean circulation, atmosphere-ocean exchange rate.

Number of input data: About 100.

Output data: See state variables, atmospheric CO₂.

Number of output data: Hundreds.

Time interval of simulation: 1 year.

Basic spatial unit: km².

References general validation:

Goudriaan, J., 1990. Biological cycling of CO₂. International Energy Agency Executive Conference on 'Solar Photoconversion Processes for Recycling Carbon Dioxide from the Atmosphere', Colorado Springs 13-16 March 1990. 5 pp.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC or Macintosh.

Programming language: Microsoft FORTRAN.

Source code available: Yes.

Executable available: Yes.

COMMENTS: A simplified version is available: no carbon isotopes, Ocean simplified to surface layer and deep water, terrestrial biosphere to soil carbon, herbaceous and woody biomass. Source available under some conditions.

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GENERAL OVERVIEW

Name and version: WASTEN

Title: A model for nitrogen behaviour in soils irrigated with liquid waste.

Date first profile: November 6th, 1995.

Date last profile: November 6th, 1995.

Update: 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: No.

Subject: Soil science: nitrate contamination.

Description: This mechanistic model was developed to describe the N behaviour in land treatment systems as affected by physical, chemical and biological processes and environmental conditions. The model is also capable of describing the fate of N in the soil profile during the growing season of agricultural crops. The region considered is a one-dimensional homogeneous or multi-layered (stratified) soil profile bounded at some depth by an impervious layer, a water table, or extends to a great depth.

State variables: N model (N uptake, transformations and transport of N species), water flow model (wastewater infiltration, water movement, plant uptake) and subroutines (initial and boundary conditions, plant root distribution, soil water properties, and nitrogen transformation processes (ion-exchange, (de-)nitrification)).

Number of state variables: 3.

Input data: Layers, rate coefficients, soil properties.

Number of input data: > 20.

Output data: Concentration profiles with depth and time.

Number of output data: Variable.

Time interval of simulation: Variable.

Basic spatial unit: Variable.

References general validation:

Selim, H.M. & E. Segall, 1981. WASTEN: A model for nitrogen behaviour in soils irrigated with liquid waste. In: Frissel M.J. & J.A. van Veen (ed.). Simulation of nitrogen behaviour of soil-plant systems. Papers of a workshop. Models for the behaviour of nitrogen in soil and uptake by plant. Comparison between different approaches Wageningen, January 28-February 1, 1980. 96-108

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Operational on IBM mainframe or other computer systems and PCs.

Programming language: Microsoft FORTRAN.

Other software required: None.

User's guide available:

Selim, H.M. & I.K. Iskandar, 1980. Simplified model for prediction of nitrogen behavior in land treatment of wastewater. USA Cold Regions Research and Engineering Laboratory, CRREL Report 80-12.

Application reports:

Reynolds, C.M. & I.K. Iskandar, 1995. A modeling-based evaluation of the effect of wastewater application practices on groundwater quality. CRREL Report 95-2. USA Cold Regions Research

and Engineering Laboratory, Hanover, NH 03755-1290

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: WATBAL 2.0

Title: WATER BALance.

Date first profile: September, 1994.

Date last profile: November 21st, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Soil science, and environmental science.

Description: The model WATBAL simulates the water balance of a (cropped) soil in a simple and fast way. The soil profile is divided into two layers: a root zone and a layer below the root zone which should include the ground water level and cover the local ground water flow to surface water systems. The model calculates analytically per time-step: the changes in moisture contents of these two layers and changes in the ground water level. These changes may be influenced by: precipitation, evapotranspiration, capillary rise from the second layer to the root zone, percolation from the root zone to the second layer, drainage to three different surface water systems.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Precipitation, percolation, capillary rise, leaching, seepage, 1st, 2nd and 3rd order drainage and infiltration, evapotranspiration.

Number of rate variables: 12.

State variables: Moisture contents.

Number of state variables: 2.

Input data: Geometry of profile, precipitation, open-water evaporation, crop transpiration reduction factors, soil cover data, drainage resistances, moisture contents at: wilting point, field capacity, saturation and start of simulation (initial conditions).

Number of input data: 30.

Output data: All terms of complete balances of a soil-water-crop system for water and a pesticide.

Number of output data: 15.

Time interval of simulation: 1-30 days.

Basic spatial unit: m².

References general validation:

Berghuys-van Dijk, J.T., 1985. WATBAL. A simple water balance model for a unsaturated/saturated soil profile. ICW Nota 1670. DLO Winand Staring Centre, Wageningen. 22 pp.

Stand alone model: Yes.

Parentage: -

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: VAX, IBM compatible PC with co-processor.

Programming language: Microsoft FORTRAN-77.

Other software required: -

Source code available: No (for research contact DLO Winand Staring Centre (SC-DLO)).

Executable available: Yes.

User contract mandatory: Yes.

Costs: 0 - 300 ECU.

COMMENTS: -

CONTACT(S):

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GENERAL OVERVIEW

Name and version: WATCROS

Title: WATER balance and CROp production Simulation.

Date first profile: December, 1995.

Date last profile: December, 1995.

Update: 1982.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

Subject: Crop science, soil science, and environmental science.

Aggregation level: Crop production at field level.

Description: The objective of the model is at field scale to simulate: - Potential production. - Water limited production. - Soil water balance. In the model a crop comprises a root and a shoot (including storage organs). The root is characterized by its dry matter content and its rooting depth. The shoot is characterized by its dry matter content and its leaf area index. The model simulates one growing season. The soil water model is of the tipping bucket type.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Infiltration, percolation out of the rooting zone, transpiration, evaporation (from soil and intercepted water), daily gross photosynthesis, respiration (maintenance and growth) and dry matter production.

State variables: Soil water content (in a number of reservoirs), accumulated dry matter content (shoot and root), development stage, leaf area index, and rooting depth.

Input data: Driving variables: global radiation, air temperature, precipitation, and irrigation (daily values). Soil and crop parameters.

Output data: Evapotranspiration, percolation, soil water storage, dry matter content (shoot and root), leaf area index and rooting depth.

Time interval of simulation: Daily time step.

Basic spatial unit: A field.

References general validation:

Aslyng, H.C. & S. Hansen, 1985. Water balance and crop production simulation. Model WATCROS for local and regional application. The Royal Veterinary and Agricultural University, Copenhagen.

Russell, R. & G.W. Wilson, 1992. An agricultural information system for the European Community. Agriculture. An agro-pedo-climatological knowledge-base of wheat in Europe. Final Report. Draft. University of Edingburgh. December 1992.

Stand alone model: Yes.

Check internal consistency or material balance present: Yes.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: PC.

Programming language: Microsoft FORTRAN IV (a version in PASCAL exist).

Source code available: Yes.

User contract mandatory: No.

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GENERAL OVERVIEW

Name and version: WAVE 2.0

Title: A mathematical model for simulating Water and Agrochemicals in the soil and Vadose Environment.

Date first profile: November 6th, 1995.

Date last profile: November 6th, 1995.

Update: December, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 1

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, soil science, environmental science, and land use studies.

Aggregation level: Farm.

Description: The WAVE model is a process based, deterministic, mathematical model simulating the movement of water and the transfer and fate of (agro-)chemicals in the soil-crop continuum. The model describes the one-dimensional transport of matter and energy in agricultural soils. It is a unique ad-hoc simulation tool that can be used as basis for improving management practices, controlling the transport of water and chemicals in soils, evaluating experimental data, designing laboratory and field experiments, predicting short- and long-term effects of farming and other land-uses on the quality of soils and aquifers and developing environmental oriented policies regarding the use of fertilizers, pesticides and herbicides.

Structure of the model. The WAVE model is an open modular software tool, and whenever new knowledge becomes available, modules can be added or existing modules can be replaced by new modules. The modules available in the present version of the WAVE model simulate the following soil processes: the energy balance, the flow of water, the transport of non-reactive and reactive solutes, and the movement and transformations of nitrogen. In addition, the WAVE model simulates crop growth for several field crops. The modular structure enables the user to start only the modules required to analyze his problem. The model distinguishes different soil horizons that are divided in soil compartments with equal thickness. A water, heat and solute mass balance is developed for each compartment allowed for different sink/source terms. Flow equations are implemented which are solved numerically using finite difference schemes. A dynamic time step is used to reduce numerical errors.

Description of the model. Water movement is described using the Richards' equation, driven by parametric models for the moisture retention characteristic and the hydraulic conductivity soil water content relation. Both non-hysteretic and hysteretic moisture retention models are available. Distinction is made between non-modal and multi-porosity retention curves. The hydraulic conductivity soil water content relation is modelled using empirical, semi-empirical and theoretical statistical pore size distribution conductivity models. Water extraction by the crop is mimicked in a macroscopic way, with the water sink term corrected for anaerobiosis and wilting in wet and dry soils, respectively. Solute transport is modelled with a non-equilibrium two-site/two-region convection dispersion model. The exchange rate between an immobile and mobile soil region is diffusion based. Sorption on the mobile and immobile sorption sites is described with a linear equilibrium isotherm. Decay of the solute is characterized with a first order reaction kinetic. The heat flow equation combines Fourier's heat flux law and the heat conservation equation. Soil thermal conductivity is calculated based on the geometry, the soil density, the volume of water and air. Soil thermal capacity and conductivity are updated as the moisture content of the soil changes. For the description of the mineral N-transformation processes (urea hydrolysis, ammonia nitrification,

nitrate denitrification) first-order kinetics are used. The rate constants are reduced for temperature and soil water content, to mimic reduced microbial activity in extreme wet and/or dry conditions, or extreme warm and cold conditions. The soil organic N pool is subdivided into three sub-pools (the litter, humus and manure pool) and the transfer between these sub-pools is controlled by first-order rate constants. These constants vary with depth and are adjusted for extreme moisture and temperature conditions. The mineralization/immobilization is driven by a constant C/N ratio of the biomass in the soil. Crop growth is simulated using a universal crop growth model, describing the dry matter accumulation in different plant parts as a function of the development stage, air temperature, incident radiation and crop physiological parameters. The daily gross photosynthetic assimilation rate is reduced when water and/or nitrogen content is limited in the root zone. The potential nitrogen content in the crop organs determines the target nitrogen demand of the crop in the root system. Both convective and diffusive uptake of nitrogen are calculated and their sum defines the actual plant nitrogen uptake.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Simulation dependent, maximum about 30.

Number of rate variables: Simulation dependent, maximum about 30.

State variables: Soil moisture, soil pressure head, soil solute concentrations, soil temperatures, crop dry matter, crop organ dry matter, crop N content, etc.

Number of state variables: User dependent.

Input data: Climate (rain, evapotranspiration, temperature, relative humidity, radiation), soil (retention, conductivity, dispensivity, texture), land use (fertilization, etc.).

Number of input data: User specified.

Output data: User specified.

Time interval of simulation: < Day.

Basic spatial unit: Field.

References general validation:

Vanclouster, M., P. Viaene, J. Diels & J. Feyen, 1995. A deterministic validation procedure applied to the integrated soil crop model WAVE. *Ecological Modelling*. (In Press).

Stand alone model: Yes.

Parentage: SWATRER, LEACH and SWATNIT.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC, UNIX, MAC.

Programming language: Microsoft FORTRAN.

Other software required: No.

User's guide available:

Vanclouster, M., P. Viaene & J. Diels, 1994. WAVE: a mathematical model for simulating water and agrochemicals in the vadose environment: reference and user's manual (release 2.0).

Katholieke Universiteit Leuven. 154 pp.

Application reports:

Gonzalez, C., M. Vanclouster, J. Diels, D. Mallants & J. Feyen, 1995. Comparing laboratory with in-situ measured hydraulic conductivity. Submitted to European Water Resources Research.

Vanclouster, M., R. Angulo-Jaramilo, B. Normand, E. Fernandez, F. Moreno, N. Kosmas, C. Moustakis & G. Vachaud, 1995. Simulating the fate of nitrogen in the soil-crop environment using the WAVE-model. Part 2: Evaluation of the model on the WASTES experimental facilities. Submitted to Agricultural Water Management.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: 10.000 BEF.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: WEPP 95.7

Title: The Water Erosion Prediction Project Model.

Date first profile: November 22nd, 1995.

Date last profile: November 22nd, 1995.

Update: August, 1995.

Program type: Simulation model/module.

Purpose: Replace USLE, RUSLE* as erosion prediction tool for United States erosion assessment, conservation planning, environmental impact.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Soil science, and environmental science.

Aggregation level: Other: small watershed level.

Description: WEPP is a continuous simulation model used to predict soil erosion for conservation planning and assessment of environmental impacts. The model was developed to replace the USLE and RUSLE* as a soil erosion prediction system. The model is designed for use on non-gauged areas of less than 640 acres. The model simulates daily erosion and incorporated aspects such as: Climate-stochastic weather generator (CLIGEN). Infiltration: 1 - layer green ampt infiltration (time variant conductivities). Water balance: up to 1.8 meter soil depth, evapotranspiration, percolation. Winter: snowmelt, frozen soils, frost lenses. Runoff: kinematic wave for flows. Erosion: process based rill/inter-rill source equations. Deposition: uses Yalin transport capacity-deposition. Slope: curvilinear (parabolic slope segments). Daily plant growth, tillage, operations, residue and root decay. Keywords: erosion hydrology, plant growth, Green and Ampt Infiltration, residue decomposition, tillage, sediment yield, decomposition, climate generation. Global change implications: This model is relevant to investigations of land use and conservation of agricultural resources. Changing climates can be input to determine the effects of changes in long-term soil erosion characteristics of an area.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Detachments, transport, deposition, evapotranspiration, infiltration, runoff.

Number of rate variables: > 100.

State variables: Temperature, soil moisture, canopy cover, residue cover, soil roughness.

Number of state variables: > 100.

Input data: Climate: CLIGEN generated or measured data. Soil: Effective GA conductivity (guidelines and Slope- Slope/ segments along hillslope / channel flow path est. procedure provided). Plant: Crop/Tillage database provided-user must input specific management dates. Rill/Inter-rill Erodibility: texture, OM, CEC, rocks. Model input data source: Climate: CLIGEN. Soil: SCS soils database. Slope: Topographic map of field measurements of soil map. Management: Site/Region specific.

Number of input data: > 200.

Output data: Daily model output includes runoff volumes and peaks, plant-canopy, biomass, residue cover, roots, buried residue, soil detachment-along hillslope/channel, deposition, sediment yield, soil water by layer, snow melt/frost lenses, sediment size distributions. In addition to the daily information, the model also provides the user with the option of average annual, detailed annual, and monthly runoff and erosion summary reports.

Number of output data: > 200.

Time interval of simulation: Single storm or continuous 1-100 years or more.

Basic spatial unit: Spatial scale: Small-up to 640 acres. No perennial stream or classical gully processes.

Stand alone model: Yes.

Parentage: Some portions of WEPP were derived from other models, including CREAMS, and EPIC*.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: IBM or compatible PC. Run time on 486 machine approximately 10 seconds per year. Requires 386 to run the interface (w/co-processor).

Programming language: Microsoft FORTRAN for model. C for interface/file builders.

Other software required: DOS 5.0 or greater.

Technical reference:

Flanagan & M.A. Nearing, 1995. National Soil Erosion Research Laboratory. Report No. 10.

Flanagan & Livingston, 1995. National Soil Erosion Research Laboratory. Report No. 11.

Nearing, M.A. et al., 1989. Transactions American Society of Agricultural Engineers 32: 1587-93

Laflen, J.M. et al., 1991. Journal of Soil and Water Conservation 46: 39-44

Application reports:

Chaves, H.M.L. & M.A. Nearing, November/December 1991. Uncertainty analysis of the WEPP soil erosion model. Transactions of the A.S.A.E. / American Society of Agricultural Engineers 34(6): 2437-2444

Elliot, W.J., P.R. Robichaud & C.H. Luce, 1995. Applying the WEPP erosion model to timber harvest areas. In: Ward, T.J.. Watershed management: planning for the 21st century. Symposium August 1995, San Antonio, TX. American Society of Civil Engineers. Water Resources Engineering Division. Watershed Management Committee. New York. 83-92

Huang, C. & J.M. Bradford, September/October 1993. Analyses of slope and runoff factors based on the WEPP erosion model. Soil Science of America Journal 57 (5): 1176-1183

Kottwitz, E.R. & J.E. Gilley, 1995. Estimating irrigation induced erosion using the WEPP model. In: Heatwole, C. Water quality modeling. International symposium April 1995. Orlando, FL. ASAE publication 5/95: 449-458

Laflen, J.M., 1994. The WEPP models and its applicability for predicting erosion on rangelands. In: Flanagan, D.C., J.C. II Ascough, M.A. Weltz & J.S. Stone. SSSA special publication 38: 11-22

Nearing, M.A. , L. Deer-Ascough & J.M. Laflen, May/June 1990. Sensitivity analysis of the WEPP hillslope profile erosion model. Transactions of the A.S.A.E. / American Society of Agricultural Engineers 33(3): 839-849

Povilaitis, A, P. Robichaud, A. Dumbraskas & R. Tumas, 1995. Erosion prediction in the Republic of Lithuania with the WEPP model. In: Heatwole, C. Water quality modeling. International symposium April 1995. Orlando, FL. ASAE publication 5/95: 333-340

Risse, L.M., M.A. Nearing & M.R. Savabi, March/April 1994. Determining the green-Ampt effective hydraulic conductivity from rainfall-runoff data for the WEPP model. Transactions of the A.S.A.E. / American Society of Agricultural Engineers 37 (2): 411-418

Risse, L.M., M.A. Nearing & X.Z. Zhang, July 1995. Variability in Green-Ampt effective hydraulic conductivity under fallow conditions. Journal of hydrology 169 (1/4): 1-24

Risse, L.M., B.Y. Liu & M.A. Nearing, February 1995. Using curve numbers to determine baseline values of green-ampt effective hydraulic conductivities. Water resources bulletin 31 (1):

147-158

Source code available: Not currently.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

COMMENTS: The objective of the Water Erosion Prediction Project is to develop new generation prediction technology for use by the USDA-Natural Resources Conservation Service, Forest Service, USDI-Bureau of Land Management and others involved in soil and water conservation and environmental planning and assessment. This improved erosion prediction technology is based on modern hydrologic and erosion science, is process-oriented, and is computer-implemented. The WEPP erosion model is a continuous simulation computer program which predicts soil loss and sediment deposition from overland flows on hillslopes, soil loss and deposition from concentrated flows in small channels, and sediment deposition in impoundments. The model computes spatial and temporal distributions of soil loss and deposition, and provides explicit estimates of when and where in a watershed or on a hillslope that erosion is occurring so that conservation measures can be selected to most effectively control soil loss and sediment yield. WEPP materials can be accessed through anonymous FTP to 'soils.ecn.purdue.edu' and through our World-Wide-Web site:
<http://soils.ecn.purdue.edu:20002/~wepp>.

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GENERAL OVERVIEW

Name and version: WEPS (Beta version)

Title: Wind Erosion Prediction System.

Date first profile: November 3rd, 1995.

Date last profile: November 3rd, 1995.

Program type: Simulation model/module.

Purpose: To simulate wind erosion, soil loss and deposition.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

New release expected: Yes.

Subject: Soil science.

Aggregation level: Other: field(s).

Description: WEPS uses a simulation model that integrates the specific factors of weather, crops, tillage, and soils to compute soil erosion and deposition. WEPS was developed to simulate the horizontal and vertical movement of wind eroded soil as influenced by soil, climate and management conditions. Additionally, WEPS simulates the loose material on crusted soils and the development of surface crust as influenced by soil texture, rainfall, tillage, and crop residues. The WEPS structure has the following submodels; WEATHER, CROP, DECOMPOSITION, HYDROLOGY, SOIL, MANAGEMENT, and EROSION. A weather generator simulates daily weather to drive submodels which predict field surface conditions. These include soil, crop growth, and residue decomposition. For WEATHER, a data base was developed with more than 900 stations of monthly climatic wind statistics for each of 16 directions. A stochastic wind simulator was also developed. For CROP, the EPIC* model crop growth sections were incorporated. The HYDROLOGY submodel was developed which predicts soil water balance and soil surface wetness. An EROSION submodel predicts soil loss/deposition subhourly on days with wind erosion. Theoretical equations were developed for conservation of saltation and creep size aggregates in a control volume considering sources and sinks. SOIL and MANAGEMENT submodels incorporated theoretical equations. Keywords: wind erosion, soil, aggregates, dust. Global change implications: Soil erosion prediction models can assist in land use and land management decisions in areas with potentially erodible land.

Input data: Climate statistics, parameters for management such as tillage tool parameters, soil data, crop growth and decomposition parameters. Model input data source: Climate database. SCS soils database.

Output data: Data output includes soil loss and deposition, including a suspension component, water balance, and crop biomass.

Time interval of simulation: The temporal scale is daily, but erosion calculations are sub-hourly.

Basic spatial unit: The spatial scale is approximately 640 acres.

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: 486 PC.

Programming language: Microsoft FORTRAN, C in interface.

Technical reference:

1991. Journal of Soil and Water Conservation 46 (2): 105-111

1995. Wind Erosion Prediction System Technical Description. Proceedings of Symposium: 'WEPP/WEPS: A new generation of water and wind erosion prediction technology'. Soil and Water Conservation Society, Ankeny, Iowa, United States.

Source code available: No.

Executable available: Yes.

User contract mandatory: No.

Costs: None.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: WHCO2T 3

Date first profile: September, 1994.

Date last profile: September, 1994.

Update: May, 1993.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

Subject: Crop science, and environmental science.

Description: The model is described in the PhD thesis of S. Nonhebel: 'The importance of weather data in crop growth simulation models and assessment of climatic change effects', Wageningen Agricultural University, 1993. This version available is the one used in chapter 7 of the thesis, a detailed description is found in chapter 6. The model is developed to simulate the effects of increased atmospheric CO₂ concentration on wheat yields in Europe solely or in combination with changes in air temperature. The model simulates both potential and water-limited production of a wheat crop and is based on SUCROS*87. For further description is referred to data sheets of SUCROS1* and SUCROS2*. The model is also used in: Nonhebel, S., 1993. The effect of changes in temperature and CO₂ concentration on simulated spring wheat yields in The Netherlands. *Climatic Change* 24: 311-329. Nonhebel, S., 1994. The effect of use of average instead of daily weather data in crop growth simulation models. *Agricultural systems*, 44 (4), 377-396. Nonhebel, S., 1994. The effect of inaccurate or missing weather data on crop growth simulation results. I Potential production. *Climatic Research*, 1 (4): 47-60. Nonhebel, S., 1994. The effect of inaccurate or missing weather data on crop growth simulation results. II Water-limited production. *Climatic Research*, 1 (4): 61-74.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Phenological development, leaf and canopy photosynthesis, maintenance and growth respiration, crop growth, growth of plant organs, evaporation, transpiration.

Number of rate variables: 75.

State variables: Biomass (total, and per crop organ), development stage, leaf area index, intercepted light, water content various soil layers.

Number of state variables: 75.

Input data: Site information: latitude, longitude, altitude, daily weather data, atmospheric CO₂ concentration, expected temperature rise, available water holding capacity of the soil, water content profile at sowing, crop information.

Number of input data: 25.

Output data: Crop data: total above ground biomass, grain yield, weight other organs, leaf area index, phenological information: emergence, heading, flowering and harvest, transpiration, evaporation, water contents soil profile, water shortage.

Number of output data: 15.

Time interval of simulation: 1 day.

Basic spatial unit: Ha.

References general validation:

Nonhebel, S., 1993. The importance of weather data in crop growth simulation models and assessment of climatic change effects. PhD thesis, Wageningen Agricultural University. 144 pp.

Stand alone model: Yes.

Parentage: SUCROS*87.

Check internal consistency or material balance present: Yes, water in soil profile.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: Macintosh.

Programming language: Microsoft FORTRAN-77.

Other software required: FORTRAN library, TTUTIL* and TTLIB.

Source code available: Yes, subject to some conditions.

Executable available: No.

User contract mandatory: No.

Costs: None.

COMMENTS: For scientific specifications is referred to data sheets SUCROS1* and SUCROS2*.

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GENERAL OVERVIEW

Name and version: Wheat

Date first profile: November 24th, 1995.

Date last profile: November 24th, 1995.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 2

use of model for APPLICATIONS: 3

Subject: Crop science.

Aggregation level: Crop/herd.

Description: The Wheat model is a mechanistic model that uses simplified functions to describe crop development and growth. Daily predictions of crop mass accumulation and water loss are generated. The most complicated version includes the soil and crop budget.

Number of rate variables: Approximately 8.

Number of state variables: Approximately 6.

Input data: Minimum and maximum temperature, solar radiation, precipitation.

Time interval of simulation: Daily.

Basic spatial unit: M2.

References general validation:

Amir & Sinclair, 1991. Field Crops Research 28: 47-58

Amir & Sinclair, 1991. Field Crops Research 28: 59-69

Sinclair & Amir, 1992. Field Crops Research 30: 63-78

Stand alone model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: DOS.

Programming language: BASIC.

Source code available: Yes.

User contract mandatory: No.

CONTACT(S):

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GENERAL OVERVIEW

Name and version: WINDINGS wssa11, winding stairs sample analyzer

Title: -

Date first profile: October, 1995.

Date last profile: October, 1995.

Update: October, 1995.

Program type: Simulation tool.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

Description: Uncertainty analysis studies the accuracy of model prediction with current knowledge, and the prospects to improve accuracy by gaining new knowledge. The winding stairs method performs a non-parametric uncertainty analysis of a deterministic model. It may prove useful on failure of simpler methods, e.g. based on regression. Sources of uncertainty are: initial values, parameters values, exogenous variables, etc. Uncertainties are accounted for by randomness of sources. A scalar model output Y depends deterministically on a number of random, vector-valued, inputs say A , B and C . Thus $Y = f(A,B,C)$. The method applies when these vectors are stochastically independent. Elements of the same vector may be dependent. Several scalar model outputs can be analyzed consecutively with one call of the program. The method estimates uncertainty contributions of the sources A , B , C ..., and of groups of sources; it also provides accuracies of these estimates. The program analyzes winding stairs samples of output values Y . Let $A1$..., $B1$..., and $C1$... denote aselect drawings from the sources. A sample with, say 8, cycles consists of the model-outputs: $f(A1,B1,C1)$ $f(A1,B2,C1)$ $f(A1,B2,C2)$ $f(A2,B2,C2)$ $f(A2,B3,C2)$ $f(A2,B3,C3)$ $f(A3,B3,C3)$ $f(A3,B4,C3)$ $f(A3,B4,C4)$ $f(A4,B4,C4)$ $f(A3,B5,C4)$ $f(A4,B5,C5)$ $f(A5,B5,C5)$ $f(A5,B6,C5)$ $f(A5,B6,C6)$ $f(A6,B6,C6)$ $f(A6,B7,C6)$ $f(A6,B7,C7)$ $f(A7,B7,C7)$ $f(A7,B8,C7)$ $f(A7,B8,C8)$ $f(A8,B8,C8)$ $f(A8,B9,C8)$ $f(A8,B9,C9)$
Indications and conditions for application: - unsuccessful simple approximation of output as function of inputs; - presence of bulky sources like weather data; - requirement to consider uncertainty of aggregated sources; - independent vector-valued sources; - feasibility of many model runs.

TECHNICAL SPECIFICATIONS

Hardware: VAX, ALPHA or PC.

Programming language: ANSI C.

Other software required: None.

Application reports:

Jansen, M.J.W., W.A.H. Rossing & R.A. Daamen, 1994. Monte Carlo estimation of uncertainty contributions from several independent multivariate sources. In: Grasman, J. & G. van Straten (eds.), 1994. Predictability and Nonlinear Modelling in Natural Sciences and Economics. Kluwer, Dordrecht. 334-343

Rossing, W.A.H., R.A. Daamen & M.J.W. Jansen, 1994. Uncertainty analysis applied to supervised control of aphids and brown rust in winter wheat. Part 1. Quantification of uncertainty in cost-benefit calculations. *Agricultural Systems* 44: 419-448

Rossing, W.A.H., R.A. Daamen & M.J.W. Jansen, 1994. Uncertainty analysis applied to supervised control of aphids and brown rust in winter wheat. Part 2. Relative importance of different components of uncertainty. *Agricultural Systems* 44: 449-460

Source code available: If necessary.

Executable available: Single file (VAX, ALPHA or PC).

User contract mandatory: No.

Costs: None.

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GENERAL OVERVIEW

Name and version: WOFOST 6.0

Title: World Food Studies: crop growth simulation model.

Date first profile: January 31st, 1996.

Date last profile: January 31st, 1996.

Update: July 1st, 1994.

Program type: Simulation model/module: with datasets.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 3

use of model for TEACHING: 2

use of model for APPLICATIONS: 1

New release expected: Yes.

Subject: Crop science, and land use studies.

Aggregation level: Crop/herd.

Description: The World Food Studies model developed at Wageningen (van Diepen et al., 1989) simulates annual crop production for selected combinations of crop species, soil type and climate. The model was developed originally for agriculture in the tropics, but version 6 was adapted to European conditions. Datasets for wheat, grain, maize, barley, rice, sugar beet, potato, fieldbean, soybean, oilseed rape and sunflower are in the standard data files. Characteristics of the crop are read from an input file: initial dry weight, life span of leaves, rate of phenological development, death rates, partitioning coefficients, properties determining assimilation and respiration rates and minimum and maximum nutrient concentrations per plant organ.

Theoretical yields are calculated, and the relative importance of the major constraints on crop production (water, nutrients, light, temperature) can be assessed, and used to plan optimum input strategies. Interactions between water and nutrient supply are not taken into account. The model can be applied at three levels of increasing complexity: (a) potential crop production under optimum water and nutrient regime, limited only by light and temperature (b) water limited production under optimum nutrient regime (c) nutrient limited production. The time unit of 1 day is used for the crop growth and soil water balance calculations, nutrient uptake is modelled for the whole growing season. Certain procedures, including carbon dioxide assimilation, have been taken directly from the SUCROS* model.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Assimilation, evapotranspiration, respiration, growth rates of leaves, stems, storage organs, roots, death rates per organ, development rate, soil water balance rates.

Number of rate variables: 20.

State variables: Stems, storage organs, leaves subdivided over daily leaf age classes, leaf area, roots, development stage, accumulated values of respiration, soil water storage.

Number of state variables: 12.

Input data: 60 crop parameters (initial values and coefficients), and daily weather (radiation, minimum and maximum temperature, vapour pressure, wind, rainfall).

Number of input data: 80 (including arrays).

Output data: Selection of daily values of rate and state variables, at any desired interval. Choice of standard output options; means and variation over years.

Number of output data: 40.

Time interval of simulation: One day.

Basic spatial unit: Point, representing crop field or agro-ecological zone.

References general validation:

Boons-Prins, E.R., G.H.J. de Koning, C.A. van Diepen & F.W.T. Penning de Vries, 1993. Crop

specific simulation parameters for yield forecasting across the European Community. Simulation Report CABO-TT no. 32. CABO-DLO, SC-DLO. Study carried out on behalf of: Agricultural Information Systems, Institute for Remote Sensing Applications, Joint Research Centre of the Commission of the European Community. June 1993. 43 pp.

Diepen, C.A. van, C. Rappoldt, J. Wolf & H. van Keulen, 1988. Crop growth simulation model WOFOST, Documentation Version 4.1. Stichting Onderzoek Wereldvoedselvoorziening/Centre for World Food studies. Staff working paper SOW-88-01. 299 pp.

Diepen, C.A., J. Wolf, H. van Keulen & C. Rappoldt, 1989. WOFOST: a simulation model of crop production. *Soil Use and Management* 5(1): 16-24

Diepen, C.A. van, 1992. An agrometeorological model to monitor the crop state on a regional scale in the European Community: concept, implementation and first operational outputs. In: Tosselli, F. & J. Meyer-Roux (Eds.). *Proceedings of the conference on application of remote sensing to agricultural statistics*, November 1991, Belgirate, Italy. ECSC-EEC-EAEC, Brussels, Belgium. 269-277

Hijmans, R.J., I.M. Guiking-Lens & C.A. van Diepen, 1994. User's guide for the WOFOST 6.0 crop growth simulation model. Technical document 12. DLO Winand Staring Centre, Wageningen, The Netherlands. 145 pp.

Hooyer, A.A. & T. van der Wal, 1994. CGMS version 3.1: user manual. Technical document 15.1. SC-DLO, Wageningen, The Netherlands. 170 pp.

Koning, G.H.J. de & C.A. van Diepen, 1992. Crop production potential of the rural areas within the European Communities. IV: Potential water-limited and actual crop production. Technical working document W68. Netherlands scientific council for government policy, The Hague. 83 pp.

Koning, G.H.J. de, M.J.W. Jansen, E.R. Boons-Prins, C.A. van Diepen & F.W.T. Penning de Vries, 1993. Crop growth simulation and statistical validation for regional yield forecasting across the European Community. Simulation Reports CABO-TT no. 31. May 1993. 105 pp.

Supit, I., A.A. Hooijer & C.A. van Diepen, 1994. System description of the WOFOST 6.0 crop simulation model implemented in CGMS. Volume I: Theory and algorithms. Report EUR 15956, Joint Research Centre of the Commission of the European communities, Luxembourg. 146 pp.

Wolf, J., I. Supit, C.A. van Diepen, J.J.R. Groot & R.J. Hijmans, 1996. System description of the crop simulation models WOFOST and NWHEAT. In: Wolf, J. *Effects of climate change on yield potential in Europe*. PhD thesis, Wageningen, the Netherlands.

Parentage: SUCROS* family of models, FSE* application.

Check internal consistency or material balance present: Yes.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: PC-DOS 486 or pentium.

Programming language: Microsoft FORTRAN.

Other software required: WOFOST uses TTUTIL* library.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: No.

Costs: Dfl. 500,-

COMMENTS: The WOFOST model combines a rather detailed crop growth module with a simple dynamic soil water module and a static nutrient module. WOFOST has been linked to Arc/Info and/or ORACLE data base in special applications. So far WOFOST has been applied for the assessment of regional crop production, and for yield forecasting in the European Union. Its most recent application is the Crop Growth Monitoring System of the MARS project of the

European Commission.

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GENERAL OVERVIEW

Name and version: WOFOST-TULIP

Title: Simulation of potential growth of tulip.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: August, 1993.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for TEACHING: 3

use of model for APPLICATIONS: 2

New release expected: No.

Subject: Crop science.

Description: In the framework of the CABO-DLO/TPE-LUW project 'Development of methods for design, validation and optimization of integrated cropping systems' three explanatory models were compared to identify the most suitable one for simulation of potential growth of tulip. The model WOFOST* appeared most suitable for simulation of tulip growth and was selected for further use in the project and adapted for simulation of tulip. The model was calibrated with datasets of seven field trials. After calibration the model was validated with some independent datasets. Yield level was well simulated but variation in yield between years was not fully explained by the model. Also the model was not sensitive enough in total seed bulb weight. The model may be improved by incorporating the contribution of seed bulb carbohydrates to initial leaf growth. Adaptations to WOFOST*: - the light interception by way of growing on beds. - the remobilization of carbon hydrates from the planting material - the flower as separate organ.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: As WOFOST*.

Number of rate variables: > 25.

State variables: As WOFOST*.

Number of state variables: No, WOFOST*.

Input data: As WOFOST*.

Number of input data: About 55.

Output data: As WOFOST*.

Number of output data: About 10.

Time interval of simulation: 1 day.

Basic spatial unit: Ha.

References general validation:

Ruijter, F.J. de, W.A.H. Rossing & J. Schans, 1993. Simulatie van opbrengstvorming bij tulp met WOFOST. Simulation Reports CABO-TT no. 33. Augustus 1993, Wageningen. 29 pp.

Stand alone model: Yes.

Parentage: WOFOST*.

Check internal consistency or material balance present: As WOFOST*.

Input check in model: As WOFOST*.

TECHNICAL SPECIFICATIONS

Hardware: VAX.

Programming language: Microsoft FORTRAN.

Other software required: ?

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 70,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: WWFLEVO

Title: Growth model to simulate crop growth, optical reflectance and radar backscatter of winter wheat.

Date first profile: September, 1994.

Date last profile: November, 1995.

Update: -

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

use of model for APPLICATIONS: 2

Subject: Crop science.

Description: The model simulates daily growth of a winter wheat crop on the basis of underlying physiological and physical processes (e.g. light interception, photosynthesis, respiration), and its optical reflectance and radar backscatter on the basis of physical interaction processes. The crop model part is SUCROS*87 for potential crop growth (i.e. ample supply of water and nutrients, no pests, weeds and diseases). Rate of dry matter accumulation is a function of irradiation, temperature and crop characteristics. The optical reflectance model is EXTRAD: optical reflectance is simulated in the green, red and infrared bands from soil and crop optical properties, leaf area index, canopy architecture and illumination conditions. The vegetation indices NDVI, WdVI and IR/R-ratio are calculated. The radar backscatter model is CLOUD: radar backscatter (γ) is simulated from the amount of water in the soil and in the canopy and from soil and canopy backscatter characteristics for several angles of incidence, VV and HH polarization and in Ku1, Ku2, X, C, S and L-bands. All submodels have been parameterized and validated on data collected during several remote sensing campaigns in (South-)Flevoland, The Netherlands, between 1980-1988 (ground based ROVE, Agriscatt).

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Phenological development, leaf and canopy photosynthesis (gross net), maintenance and growth respiration, crop growth, growth of plant organs.

Number of rate variables: > 50.

State variables: Biomass (total, and per crop organ e.g. leaf, stem, ear, root), leaf area index, soil cover, intercepted light. Auxiliary variables: reflected solar radiation, vegetation indices, radar backscatter.

Number of state variables: > 50.

Input data: Geographical latitude and longitude, weather data (daily radiation, minimum and maximum temperature), top soil moisture content, crop specific physiological and morphological properties, canopy reflection characteristics, canopy and soil radar backscatter characteristics, crop management information.

Number of input data: 75 (some input as array).

Output data: Crop rate and state variables (e.g. leaf area index, soil cover, biomass), optical canopy reflection, vegetation indices (NDVI, WdVI, IR/Gr ratio), radar backscatter (multi-incidence angle, VV and HH polarization, multi-frequency).

Number of output data: 15.

Time interval of simulation: 1 day.

Basic spatial unit: Field level (some m²).

References general validation:

Bouman, B.A.M., 1992. SBFLEVO and WWFLEVO, Growth models to simulate crop growth, optical reflectance and radar backscatter of sugar beet and winter wheat, calibrated for

Flevoland. CABO-DLO report 163. CABO-DLO Wageningen, The Netherlands. 116 pp.

Stand alone model: Yes.

Parentage: SUCROS*87 and EXTRAD.

Check internal consistency or material balance present: No.

Input check in model: No.

TECHNICAL SPECIFICATIONS

Hardware: VAX computer, IBM compatible PC/AT \geq 640 Kb RAM.

Programming language: Microsoft FORTRAN-77.

Other software required: FORTRAN utility library.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: -

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GENERAL OVERVIEW

Name and version: Yet to be baptised (version 1 December 1994)

Date first profile: December, 1994.

Date last profile: December, 1994.

Update: December, 1994.

Program type: Simulation model/module.

Relevancy of model, on a scale of 1 to 3 (1 is most relevant)

use of model for RESEARCH: 1

New release expected: -

Subject: Crop science.

Description: The model is part of the SUCROS*/LINTUL* family developed at Wageningen. The objective is to simulate the dry matter production and distribution of a potato crop. Light interception is modelled as a function of leaf area index. The intercepted photosynthetic active radiation is multiplied with the light use efficiency to obtain potential production. The dry matter allocation is different from the standard SUCROS* and LINTUL* models. Here it is a function of the sink strength of the tuber and influenced by temperature and daylength. The length of the growth cycle and therefore the production ability of the crop is directly influenced the dry matter allocation. The leaf senescence is modelled with a boxcar.

SCIENTIFIC SPECIFICATIONS OF SIMULATION MODELS

Rate variables: Growth rates of total crop, leaf, stem and tubers. Senescence rates of leaves and stems. Increase of temperature sums, rate of emergence, rate of tuberinitiation.

Number of rate variables: About 15.

State variables: Temperature sums, weights of tubers, stems and leaves, sprout lengths and tuberinitiation status. Weight of dead leaves and stems. Leaf area index.

Number of state variables: About 15.

Input data: Radiation, minimum temperature, maximum temperature, plants per m², planting date, leaf growth parameters, tuber growth parameters, light use efficiency, extension coefficient.

Number of input data: About 20.

Number of output data: About 35.

Time interval of simulation: 1 day.

Basic spatial unit: Ha.

Stand alone model: Yes.

Parentage: SUCROS* and LINTUL* models.

Check internal consistency or material balance present: No.

Input check in model: Yes.

TECHNICAL SPECIFICATIONS

Hardware: Every machine with FORTRAN-77 compiler.

Programming language: Standard Microsoft FORTRAN.

Other software required: FSE*, TTUTIL* and CABO/TPE Weather System*.

Source code available: Yes.

Executable available: Yes.

User contract mandatory: Yes, in principle this software product may be used only for non-commercial purposes. The product is accompanied by an AB-DLO/TPE-WAU Licence agreement and warranty disclaimer.

Costs: Dfl. 270,=.

COMMENTS: At 7th July 1994 the model is already developed. Now we are in the process of validating. The process will be finished somewhere in autumn 1994.

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