ECASA - Model description template

NAME of model	**reporter/institute *(a)*:**
EcoWin 2000 (E2K)	Ana Sequeira, João Gomes Ferreira / IMAR

Short DESCRIPTION of model*:* E2K makes use of an object-oriented programming (OOP) approach to implement ecological models for aquatic systems. The basic underlying structure is that of a spatial (1D, 2D and 3D) framework of boxes, within each of which the relevant biogeochemistry and population dynamics are resolved.

Main state variables: Each object in E2K groups together multiple state variables [Ferreira 1995]. E2K contains about one hundred objects, corresponding to hierarchies for simulating e.g. hydrodynamics, air temperature, oyster growth, seeding and harvesting processes, etc.
Example: E2K was used to develop a model for the Ria Formosa eutrophication assessment, where the main state variables were nutrients (such as dissolved inorganic nitrogen), macroalgae and dissolved oxygen. [Nobre et al. 2005]

Scale to which applicable: This ecological model is applicable to the ecosystem scale, corresponding in a CSTT scale to zones B and C - Water body and Regional scale.

General description: The usage of object-oriented methods to simulate processes in ecological systems simplifies model development due to the flexibility associated with the modularity and inheritance properties of the objects themselves and provides a much greater conceptual approximation between natural ecosystems and interacting objects relative to structured programming. [Ferreira 1995]

Forcing data needed: Values needed for initial and boundary conditions, bathymetry, etc.

Possibly relevant INDICATORS *(f)*
e.g. chlorophyll *a*

STATUS of model *(g)*

Origin (ator): The development of E2K began in late 1991 using Carlingford Lough (Ireland) and the Tagus estuary (Portugal) systems. More recently E2K was used in a variety of other systems such as Maputo bay (Africa), Sanggou bay (China) and Ria Formosa (Portugal).

Present development state (has been tested, under development, etc):
Ria Formosa model: the EcoWin 2000 ecological modelling platform was used to implement a research model simulating the major biogeochemical processes of pelagic and benthic eutrophication in the Ria Formosa. Water and pelagic state variables were redistributed within the Ria Formosa and exchanged with the ocean using the flows calculated with an hydrodynamic model (MOHID), and appropriate forcing was imposed at land and ocean boundaries for salinity, nutrients and phytoplankton [Nobre et al. 2005]. This model was tested and can be used to assess the eutrophication status of the Ria Formosa. In order to assess the carrying capacity of the system some variables must be developed / improved, such as the benthic variables and the seeding/harvesting features.

Present use: E2K models for Sanggou bay (China) and Ria Formosa (Portugal) are being improved.

Claimed robustness and scientific basis of this:
Several papers can be consulted and serve as scientific basis of the E2K robustness:
[Nobre et al. 2005; Ferreira 1995; Bricker et al. 2003; Ferreira et al. 1998; Nunes et al. 2003]

IMPLEMENTATION OF MODEL

State of implementation *(h)*
Widely tested in areas including eutrophication [Nobre et al. 2005; Bricker et al. 2003] and aquaculture [Nunes et al. 2003].

State of documentation
Mainly web-based (http://www.ecowin.org) together with journal papers (e.g. [Ferreira 1995; Nobre et al. 2005; Nunes et al. 2003; Ferreira et al. 1998; Bricker et al. 2003;])

Intellectual property* concerns *(i)
Model can be made available at no charge for research purposes as executable code.

TESTING

Summary of conditions and measurements needed - including critical forcing data *(j)*
Measurements on hydrodynamic, physical and biological parameters are needed.

Criteria for model rejection
Unsuitable spatial / temporal domains.
Applications of inverse modelling.

OTHER models

Used with this model *(k)*

ASSETS screening model (see model description template), and hydrodynamic models such as Delft3D or MOHID.

Delft3D: is the Model System of the WL|Delft Hydraulics where hydrodynamical, ecological and morphodynamical modules are integrated. The FLOW module of D3D is a multidimensional (2D or 3D) hydrodynamic (and sediment transport) simulation program which calculates non-steady flow and transport phenomena resulting from tidal and meteorological forcing on a curvilinear, boundary fitted grid.
(http://www.wldelft.nl/soft/d3d/intro/index.html)

MOHID: a three-dimensional water modelling system following and object oriented philosophy; develop by MARETEC (Marine and Environmental Technology Research Centre) at IST (Instituto Superior Técnico) which belongs to Technical University of Lisbon. [Cancino and Neves 1998a; Cancino and Neves 1998b]

Similar models *(l)*
Several models are used to accomplish parts of the E2K functionality, e.g. Delft3D for circulation; Gangnery et al. 2004 and Guillaud et al. 2000 for biogeochemistry; Gangnery et al. 2004 for population dynamics.

References

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