THE CONTINUED DEVELOPMENT OF THE THIRD-GENERATION SHALLOW WATER WAVE MODEL "SWAN"

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LONG-TERM GOALS

The long-term goal of this effort is to provide a commonly accepted third-generation wave model for shallow water to the international community of scientists and engineers for the purpose of basic research and operational wave computations (public agencies such as army, navy, harbour authorities, universities and private industry such as oil companies, engineering companies, etc.).

OBJECTIVES

The main objective is to support and assist the continued development, validation and verification of the SWAN model and its use in operational conditions. The development will be based on new scientific insights in the evolution of waves in shallow water. The verification and validation will be based on field observations and laboratory experiments supplemented with numerical experiments. Operational use will be supported with first-line assistance and diagnostics.

APPROACH

The continued development of the SWAN model is envisioned as a community effort of the wave modellers presently working in this field of technology, most of whom coordinate their efforts in an international forum called WISE (Waves In Shallow Environments, established in 1993 as the shallow-water follow-up of the WAM group and the HISWA group).

We will provide support and assistance to these and other ONR-designated investigators. We will assist in the installation of SWAN under conventional operating systems (also as a sub-model in larger systems of models such as atmospheric and ocean circulation models). The present extensive and detailed documentation (100 pages) will be supplemented with introductory documentation. User questions will be answered and errors will be located and repaired (often in response to problems encountered by the users). Updated program codes (including new cycles) will be communicated to the users. This support is expected to operate through electronic-mail facilities.

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We will collaborate with ONR-designated investigators to improve the model technology of SWAN. We will independently add wave reflections (including scattering) to the model for sub-grid elements (e.g. breakwaters) and coastlines.

This approach is essentially a continuation of the development of the SWAN model over the years 1992 - 1996 by J.A. Battjes, L.H. Holthuijsen and N. Booij and their Ph.D. students. This consists of designing, implementing and testing a fully spectral third-generation wave model for shallow water with a fully implicit propagation scheme. Battjes supervises the scientific developments, Booij supervises the numerical developments. Holthuijsen is responsible for project management and overall supervision. In addition, IJ. Haagsma carries out the upgrading of the computer code as regards system requirements and provides first-line support for the users. A. Kieftenburg carries out the upgrading of the computer code as regards scientific and numerical aspects and she shares the first-line support with Haagsma.

WORK COMPLETED

Installation, nesting and linkage of SWAN:

a) The source code of the SWAN model (SWAN Cycle 2) has been released in public domain on April 1, 1997 (with experimental options for nonstationary computations on a curvi-linear grid).
b) A SWAN homepage on the internet with reference to a public domain site and SWAN literature has been installed on an NT server (on a dedicated PC).
c) At the time of writing (Nov. 1997) SWAN has been downloaded by approximately 70 institutions.

User documentation of SWAN:

a) The SWAN user manual has been updated to include the new (experimental) options of nonstationarity and curvi-linear grids and sub-grid obstacles (see below).
b) The user manual (WP5.1 and Postscript), the implementation manual and test examples (including real field cases with observational data) were released in the public domain on April 1, 1997.

User support, diagnostics and repairs:

a) Several (minor) errors have been detected (particularly by different compilers) and repaired.
b) To avoid confusion of the users (who should activate initial wave growth explicitly), the initial sea state in the nonstationary option of SWAN has been changed (from flat sea to JONSWAP spectrum).
c) Some users were assisted in implementing SWAN on different computer platforms.
d) The test bank of SWAN Cycle 1 was modified to accommodate SWAN Cycle 2 (stationary and recti-linear tests).

Improvement of model technology

a) Partial transmission through sub-grid obstacles has been implemented and tested.
b) The code for triad wave-wave interactions has been modified to replace the earlier published version of Eldeberky by the version of his Ph.D. thesis (to be published by Eldeberky and Battjes).
c) The breaking criterion for depth-induced breaking due to Nelson was added.
d) An option for 1D-computations has been developed (it still needs to be added to the public domain version).
e) Options (1-D and 2-Dimensional) for computing the wave-induced set-up of mean water level in an approximate manner has been developed (from the rotation-free part of the radiation stresses). These will shortly be added to the public domain version.

RESULTS

The significance of the above completed work is that the most advanced wave model to date for coastal applications (scales of 25 km, or less and 20 m water depth, or less) has been made available free of charge to the international community of scientists and engineers. The initial phase of this first year had a surprisingly rapid start both as regards the work achieved and the number of institutions that have downloaded the model (approximately 70 from all over the world).

IMPACT/APPLICATIONS

SWAN provides scientists with a common platform for their research of the generation, propagation and dissipation of wind surface waves in shallow water. The community SWAN model facilitates the integration of these aspects and avoids the need to develop supplementary models in each individual research project. Moreover, with the support provided here, the results of such projects will be implemented in a fully operational cycle of the SWAN model thus serving the community in general (for this purpose the SWAN model is freely available to all). It therefore also provides a common standard for engineering applications accepted by a large number of institutions worldwide.

TRANSITIONS

The SWAN model is available free of charge to anyone at request (essentially in the public domain). Its use is supported by the original authors under this project. SWAN is aimed at operational use by such government agencies as army and navy, national weather services and others in the USA and abroad. Also private industry is using SWAN, mostly to determine the coastal wave climate for the purpose of design of structures and off-shore operations.

RELATED PROJECTS

Considerable efforts are being carried out by others to further develop the SWAN model. In the USA this is coordinated mostly through the DRI and BE programs of ONR. In Europe, similar efforts (on a smaller scale) are carried out by groups of investigators funded by the EC and by national governments (notably in the Netherlands, Germany and England). The nature of these efforts is both theoretical and empirical and require extensive field work and computer experiments. The level of funding is several million US dollars per year.

REFERENCES

The SWAN model and its documentation are available on the SWAN home page:

http://swan.ct.tudelft.nl

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