MATHEMATICAL MODELLING FOR REAL-TIME FLOOD FORECASTING AND FLOOD CONTROL IN CENTRAL AMERICA

PLAN OF ACTIVITIES FOR 1995

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TABLE OF CONTENTS

1. INTRODUCTION

Within the present project Mathematical modelling for real time flood forecasting and flood control in Central America, modelling technology is being transferred to the six participating countries, including El Salvador. In 1993 and 1994 the main project activities have been an Inception Phase from January to July 1993 followed by a Data Collection and Training Phase from July 1993 to December 1994. The main activities have been data collection in the case study areas, regional workshops, two oversees training courses and transfer and installation of hard- and software to the participating Institutions. In January 1995 the project is entering into its Application and Consolidation Phase with a duration of two years.

The objective of the present document is to describe project activities during the Application and Consolidation Phase with special emphasis on project status, targets for 1995, identification of activities required to achieve these targets and a scheduling of the necessary inputs.

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2. PROJECT STATUS

Below is given a short status of the project as of January 1995.

2.1 Institutional framework

Dirección General de Recursos Naturales (DGRN)

DGRN includes the national hydrological and hydrometrical service. DGRN operates approximately 70 of the hydrometeorological stations in El Salvador and serves also as hydrometeorological data bank. It is staff from the Hydrological and Meteorological divisions of DGRN who have participated in the project in 1993-94.

Permanently DGRN is executing a number of hydrological studies in El Salvador, e.g. feasibility studies for irrigation, drainage or flood control. DGRN intends to apply the MIKE 11 modelling technology as a standard tool in future studies.

DGRN has a genuine interest in the modelling of the Rio Lempa basin. Although a possible future telemetry system most likely not will be operated from DGRN, all data and model setup for the Rio Lempa basin must be available at DGRN for investigations and further analysis.

DGRN has no standard procedures for data management, i.e. the storing and handling of hydrometeorological data. Various procedures and formats are applied. DGRN is aiming at applying the database facilities in MIKE 11 for an increasing number of stations in the future. Since DGRN is operating a number of hydrometeorological stations, it will also serve a public databank in the future.

Comisión Ejecutiva Hidroeléctrica del Rio Lempa (CEL)

CEL is the national power company responsible for the power production in El Salvador. CEL also operates and maintains a very limited number of hydrometeorological stations. It is mainly staff from the civil engineering department who have participated in the project in 1993-94

CEL is executing a number of hydrological studies every year and intends, like DGRN, to apply the MIKE 11 modelling system as a standard tool for these studies. Future studies may include new feasibility studies and flood forecasting/warning in connection with new hydro power plant facilities. An increasing number of hydrometeorological data will be stored applying the MIKE 11 database facility.

The Rio Lempa model is of great interest of CEL, not least because CEL operates the 4 consecutive reservoirs and dams throughout the river system. CEL intends to improve the general operation of the reservoirs through simulations applying the Rio Lempa model. It is anticipated that CEL will be operating a possible telemetry system in the Rio Lempa basin if such a system can be provided by the project or other sources. CEL will also be responsible for executing daily flood forecasting/warning procedures if a telemetry system is established. Future model recalibrations will be carried out in cooperation with DGRN.

Since CEL is operating a number of hydrometeorological stations, it will also serve a public databank in the future.

Universidad Centroamericano 'José Simon Cañas' (UCA).

UCA is the largest private national university. The Civil Engineering Faculty has a staff of approximately 15 persons and teaches around 300 student a year. 4 courses in hydrology and hydraulics are given. During 1993-94 UCA has assisted in preparing data for the Rio Lempa case study.

UCA will play an important role in securing the project sustainability in the long term perspective. However, UCA has not been able to provide staff members for the Overseas training courses in 1994. No permanent staff members at UCA are therefore at present capable of applying the modelling system. To account for this situation an amendment to the existing Operating Agreement between CEPREDEN-AC and UCA is being prepared. The amendment describes the requirements and obligations for UCA to resume its participation in the project throughout the application and consolidation phase.

UCA will gradually include the modelling technology in courses (hydrology, hydraulics) at medium and advanced level as well as applying it for thesis and master thesis work. UCA will develop course material and sample exercises for relevant courses. By interacting with DGRN and CEL, UCA will also be able to provide the students with real-life data and model setup for investigations and thesis work.

2.2   Counterpart staff

In total 2 counterparts have been attending the 6 month overseas training course in Denmark:

*   Ana Deisy Lopez Ramos (DGRN), who is hydrologist at the hydrological division of DGRN.

*   Jaime E. Contreras (CEL), who is hydrologist in the civil engineering department of CEL.

In addition to these staff members training of additional staff in operating the modelling system at DGRN has been initiated. Alex R. Sorto has participated in updating the databases for the Rio Lempa case study.

The training of additional counterpart staff to operate the modelling system has been discussed with DGRN, CEL and UCA. At present it is anticipated that through the next 2-4 years approximately 8 additional staff members (4 from DGRN, 2 from CEL and 2 from UCA) will be frequent users of the modelling system given they will receive training and gain on-the-job experience in operation the modelling system.

It is evident that due to the present very low number of trained counterparts the project activities in 1995 must focus very strongly on dissemination of the modelling technology to additional staff members at the three institutions.

2.3   Hardware and software installations

In total 2 hardware installations (PC, printer, UPS) have been made. One installation at DGRN and one at CEL. Proper earth grounding and air conditioning facilities are present. In January 1995 the MIKE 11 version 3.11 (for windows) has been installed on the two computers. Backup procedures have been established. On the computer at DGRN severe virus problems were detected and solved in January 1995. Subsequently, virus protection procedures have been enhanced.

At UCA one MIKE 11 version 3.11 installation have been made on a powerful PC computer provided by the University. Based on an evaluation of the activities in 1995, a hardware installation (PC, printer, UPS) may be provided by the project at the beginning of 1996.

In summary, 3 MIKE 11 installations are available at present for the flood modelling activities in El Salvador in 1995.

Requests for additional 3 installations (one at DGRN, CEL and UCA respectively) have be made during the visit of the Consultant.

Based upon experiences from participating institutions installing unauthorised software on the supplied computers, is must be strongly recommended NOT to initiate any kind of software updating on the provided computers without consulting DHI in advance.

2.4   The Rio Lempa case study

The Lempa river is the largest river in the country. The river and its tributaries are draining approximately 10.250 km2 or about 50 % of the total area of El Salvador. The total catchment area is about 18.250 km2, some of which are located in Honduras and a minor part in Guatemala.

Flooding is a very significant problem in the lower parts of the river draining to the Pacific. People are moving into the fertile flood plain areas believed to be safe, but flooding and subsequent damages still occur. Some flood control investigations have been undertaken in the past and structures built, but recent experience with damages in 1992 has proven the measures taken to be insufficient.

The need for a coordinated operation of the reservoirs and dams has been stressed. First of all because a joint dam operation is a prerequisite for flood protection during high flow situations. Further, it is anticipated that the power production can be increased following an improved operation of the reservoirs at high flow situations. Finally, it has been mentioned that draught problems during low flow winter seasons also have called for an improved joint dam operation. Significant problems with sedimentation of the river bed adds to the complexity of the above mentioned problems. Hence, the future flood control activities should also take into account the sedimentation problems.

In summary the selection of the Lempa basin as case study area has been based on the following main objectives:

o   To develop and implement a flood forecasting and warning system which will enable the authorities in charge to warn the people who are being affected by the floods and to protect the property threatened by the floods. Also important is to enable general flood hazard mapping.

o   To develop and implement a comprehensive management tool for the flood control and dam operation activities in the basin.

o   To enhance the flood control activities by focusing on the sedimentation problems and modelling of appropriate measures to be taken.

Following the two training courses in Denmark a HBV/HD model covering the entire Lempa basin has been setup. Mainly data from 1973-75 have been used for the calibration. 10 out of 29 subcatchments have been calibrated directly using measured discharges. The remaining subcatchments have been assigned parameters from calibrated catchments. A number of the subcatchments are located in Guatemala and Honduras.

More recent hydrometeorological data from 1975 to today have partially been prepared during the training courses in order to provided the basis for a more thorough calibration including also the incorporation of all the four reservoirs in the river system.

The entire model setup has been transferred into FF mode. Tributaries represented as lateral inflow has been replaced by HBV catchment runoff and updating procedures have been established. Forecasts on experimental basis have been issued.

A major effort must be made to complete the update of the hydrometeorological databases. Following this activity, a final calibration of the present river and reservoir system can be completed. It is expected that the update of databases and the final calibration cannot be completed before the end of 1995.

Experimental tests of the Rio Lempa FF/FW model and other preliminary model applications, e.g. sedimentation studies, in the Rio Lempa basin will be made primarily towards the end of 1995. Support for modelling of sediment transport will be given in May-June 1995.

3.   PROJECT TARGETS

The general immediate objectives of the present project has been defined as follows:

o   to enhance the capability of the countries to plan, design and operate flood mitigation measures

o   to contribute to the improvement of flood preparedness programs by improving flood forecasts methods and increase lead times.

Through discussions with the institutions and counterparts involved in the project in El Salvador these objectives have been further detailed in more specific long and short term targets reflecting the needs and possibilities. The short term targets to be accomplished within 1995 are listed below:

3.1   Specific targets for 1995

*   **Final calibration and experimental test of the Rio Lempa flood Forecasting/Warning model.**

*   **Application of the Rio Lempa model for flood control studies and sediment transport modelling.**

*   **The completion of a 3 week course in San Salvador for training of additional counterpart staff from the participating institutions.**

*   **The preparation of course material and computer exercises together with UCA.**

*   **Participation of new counterpart staff in a Regional training course.**

*   **Improvement of the general data management at DGRN.**

*   **The execution of new applications within 1-3 new model areas.**

*   **To carry out final design of a telemetry network for the Rio Lempa basin if funds for such a system becomes available.**

A national work plan prepared by DGRN in July 1994 includes a number of the above targets and related project activities. The work plan clarifies the responsibilities among the participating institutions and details the work to be carried out. It is proposed that this plan being updated in February-March 1995 so it includes all of the above targets.

4. PROJECT ACTIVITIES

4.1 The Rio Lempa case study

4.1.1 Preparation of additional available hydrometeorological and topographical data from remaining periods and stations within the Rio Lempa river system.

Remaining hydrometeorological data (new stations, extended periods) shall be imported into the MIKE 11 databases. Available survey data shall also be imported. The databases must be complete by December 1995.

4.1.2 Final calibration and experimental test of the Rio Lempa Forecasting/Warning model.

Following the completion of the databases, the Rio Lempa model must be recalibrated and final calibrations obtained by December 1995.

4.1.3 Model applications.

During the national training course and throughout the rest of 1995, the Rio Lempa model setup or selected parts of it shall be used for various flood control studies. Sediment transport modelling will be initiated.

4.2 Training

4.2.1 A 3 week course in San Salvador for training of additional counterpart staff from all participating institutions.

The training of additional counterpart staff from DGRN, CEL and UCA is very important for the sustainability of the project activities in El Salvador. It is anticipated that approximately 8 additional staff members (4 from DGRN, 2 from CEL and 2 from UCA) will be frequent users of the modelling system given they will receive training and gain on-the-job experience in operating the modelling system. By allowing the participation of additional 3 students from UCA, a national course with 11 participants seems appropriate.

Principal instructors will be the four trained counterparts assisted with one or two instructors from DHI/SMHI. The course shall comprise the basic elements from the HIS, HBV and HD modules with emphasize on application of the modules using data from the case study or new applications.

The course duration will be 3 weeks but with activities only half day (morning or afternoon). The location and period is to be decided. Responsible for course planning and execution of the programme are the two trained counterparts.

4.2.2 Preparation of course material and computer exercises for UCA.

As a support to the integration of the modelling technology at UCA, the Consultant will assist in preparing computer exercises and lecture notes for the University courses. This will be carried out during the period of the national training course.

4.2.3 Participation in a Regional training course.

3-5 new counterparts shall be nominated for and participate in a Regional training course scheduled for november 1995. The nomination will be made shortly after the national training course.

4.3 New applications

4.3.1 General support to new applications.

The final calibration of the Rio Lempa model and subsequent model applications will require comprehensive efforts and inputs from the involved institutions and counterparts. Only very limited time in 1995 will be available for setting up the models within new areas. However, the selection of 1-3 new areas where modelling will be relevant is considered by DGRN and support for such new applications will be given in 1995 as required.

4.3.2 Support to general data management at DGRN.

At DGRN hydrometeorological and topographical data are stored in various formats ranging from tables in annual reports to numerous formats on diskettes. It is the intention to standardize the database procedures by making most data available in MIKE 11 or HOMS format and to prepare interface software (small fortran programs) between these formats.

The Consultant will throughout 1995 assist in making the interface software.

4.4 Telemetry

4.4.1 Design of a telemetry network for the Rio Lempa basin if funds for such a system becomes available.

In the case that funds will be provided for at telemetry system for the Rio Lempa river system, the model must be utilized to investigate the design of the station network.

5.1 Activity schedule and staff input (El Salvador)

Activity	Inputs National weeks	Inputs DHI/SMHI weeks
Programming of 1995	2	1
Case study Update of databases	80	5.6
Final calibration of Rio Lempa		
Exp. test FF/FW Rio Lempa		
Other applications Rio Lempa		
Design of telemetry network		
Training Prep. of National Course	42	1
National Course		
Regional Training Course		
University strengthening Prep. of courses at UCA	6	
University seminar		
Regional Workshop	8	
New applications Setup and calibration	15	0.4
Data management		
Steering Committee meeting	2	
	155	**8**
Support by the Consultants		
Progress reports		

Total project input