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

PLAN OF ACTIVITIES FOR 1995

HONDURAS

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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 Honduras. 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.

The document has been prepared by DHI in cooperation with Gladis Rojas (DGRH), Roberto Avalos (UNAH), Glenda Castillo (ENEE) and Diomar Mendoza (ENEE). The proposed project activities have also been discussed with Roberto Dimas Alonzo (COPECO).

2. PROJECT STATUS

2.1 Institutional framework

Dirección General de Recursos Hídricos (DGRH)

DGRH is the national hydrological and hydrometrical service. DGRH operates approximately 138 of the hydrometeorological stations in Honduras and serves also as hydrometeorological data bank. It is persons from the Hydrological and Climatological division of DGRH who have participated in the project in 1993-94.

DGRH is frequently in charge of a number of hydrological studies in Honduras, e.g. feasibility studies for irrigation, hydro power or drinking water supply. DGRH intends to apply the MIKE 11 modelling technology as a standard tool in future studies.

DGRH has a genuine interest in the modelling of the Sula Valley. Although the telemetry system most likely not will be operated from DGRH, all data and model setup for the Sula Valley model must be available at DGRH for investigations and further analysis. Together with ENEE and CEVS, DGRH will

be responsible for the maintenance of the telemetry system.

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

Empresa Nacional de Energía Eléctrica (ENEE)

ENEE is the national power company responsible for the majority of the hydro power production in Honduras including the production from the large El Cajón dam and reservoir. ENEE also operates and maintains around 133 hydrometeorological stations. It is mainly persons from the Hydrology department (estudio basicos) who have participated in the project in 1993-94

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

The Sula Valley model is of great interest of ENEE, not least because ENEE has the responsibility for operating the El Cajón dam and reservoir. It is anticipated that ENEE will be operating the telemetry system in Sula Valley. ENEE will also be responsible for executing daily flood forecasting/warning procedures. Maintenance and future recalibrations will be carried out in cooperation with DGRH.

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

Universidad Nacional Autonóma de Honduras (UNAH).

UNAH is the largest national university. The Civil Engineering Faculty has a staff of approximately 30 persons and teaches around 600 students a year. Several courses in hydrology and hydraulics are given. It is associate professor Roberto Avalos from the Civil Engineering Faculty who have participated in the project in 1993-94.

UNAH will play an important role in securing the project sustainability in the long term perspective. UNAH will gradually include the modelling technology in courses (hydrology, hydraulics) at medium and advanced level as well as applying it for thesis work. UNAH will develop course material and sample exercises for relevant courses. By interacting with DGRH and ENEE, UNAH will also be able to provide the students with actual field data for investigations and detailed thesis work.

Comisión Ejecutiva de Valle de Sula (CEVS).

CEVS is mainly financed by private companies, e.g. the banana industry, in Sula Valley with the objective of enhancing infrastructure, flood protection and general development in the Sula Valley. CEVS is operating 5-6 hydrometeorological stations with a manual UHF telemetry system. CEVS has participated in the preparation and signing of the Inter-Institutional agreement made prior to the installation of the telemetry system provided by DANIDA and ASDI. One person form CEVS has received training in installation, operation and maintenance of the new telemetry system. Beside these activities CEVS has not participated in the project in 1993-94.

It is clear that CEVS is an important future end-user of the results and therefore should be involved in a more formal way in the project in the coming years. In addition hereto, CEVS will be operating and maintaining a section of the telemetry system in the Sula Valley. However, the number of staff members at CEVS with experience in hydrology and hydraulics is very limited.

Comité Permanente de Contingencias (COPECO).

COPECO is the national disaster organisation. COPECO is expected to play an important role in the dissemination of Flood Warnings but has not been involved directly in project activities in 1993-94. The project's National Representative of Honduras is the technical director of COPECO.
It is clear that COPECO is an important future end-user of the results and therefore should be involved in a more formal way in the project from 1995.

2.2 Counterpart staff

In total 4 counterparts have been attending the 6 month overseas training course in Denmark:

* Gladis Rojas (DGRH), who is hydrologist at the hydrological and climatological division of DGRH.

* Glenda Castillo (ENEE), who is hydrologist in the hydrology department.

* Diomar Mendoza (ENEE), who is chief of the hydrology department.

* Roberto Avalos (UNAH), who is hydrologist in the hydrology department.

In addition to these persons training of additional staff in operating the modelling system at DGRH and ENEE has been initiated. At DGRH Silvia Viera and Juan Ramón Garcia has been updating the databases. At ENEE Fanny Cardona has been introduced to the modelling system and has carried out HBV simulations within the catchment Cangrejal. This new model application in the north-eastern part of Honduras is initiated by a hydrological feasibility study for a new hydro power plant.

The training of additional counterpart staff to operate the modelling system has been discussed with DGRH, ENEE and UNAH. At present it is anticipated that through the next 2-4 years approximately 6 staff members (2 from DGRH, 2 from ENEE and 2 from UNAH) will be frequent users of the modelling system given they will receive training and gain on-the-job experience in operating the modelling system.

2.3 Hardware and software installations

In total 4 hardware installations (PC, printer, UPS) have been made. One installation at DGRH, two at ENEE and one at UNAH. Proper earth grounding and air conditioning facilities are exist. In January 1995 the MIKE 11 version 3.11 (for windows) has been installed on the four computers. Backup to tape has been made and no virus problems have been detected on the computers.

At UNAH three additional MIKE 11 version 3.11 installations are being prepared based on a request from the University. The installations are being made on powerful PC computers provided by the University. Final installations will be made by the consultant in April-May 1995.

At ENEE one additional MIKE 11 version 3.11 installations have been made based on a request from ENEE. The installations has been made on a powerful PC computer (ACER) provided by the ENEE.

In summary, 5 MIKE 11 installations are available at present for the flood modelling activities in Honduras in 1995. 3 more installations are ready by April-May 1995.

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 Sula Valley case study

Located in the north-eastern part of Honduras, the Sula Valley basin covers an area of approx. 27.000 km2 equal to 25 % of the country area. The two major rivers which run through the Valley is the Chamelecon river in the West and the Ulua river in the central part.

Upstream on the Ulua river, the El Cajón dam is operated mainly for hydropower production purposes with an installed capacity of 300 MW. It accounts for 57 % of the hydropower production in the country. The hydrometeorological stations in the Sula Valley are operated by ENEE and DGRH and a few stations by SMN. For the main part of the approximately 77 rainfall stations and approximately 30 discharge/water level stations, data from 1970 to date are available.

Very severe flooding problems occur quite often in the Valley, threatening people and damaging

agricultural lands, properties and infrastructure with great economic losses as a result. In view of the importance of the area, a Commission for the Sula Valley has been formed which may be become The Sula Valley Authority following the approval of the Congress. It is not the intention to create a new giant institution, however, but rather rely on the support of existing organisations.

Two very relevant applications of the modelling system have been identified with the following main objectives:

- To develop and implement a flood forecasting and warning system which will enable the authorities in charge to warn the people in the downstream part of Sula Valley and protect property threatened by the floods. Real-time inflow forecasts to the reservoirs may optimize the hydropower production and improve flood protection. Also very important will be to provide general flood hazard mapping.

- To develop and implement a comprehensive management tool for the flood control and dam operation activities in the basin. It may be used as a basis for the planning and design of alternative measures to control the more frequent type of flooding.

It will be relevant to include dam break and sediment transport modelling at a later stage during the application and consolidation phase. However, during 1995 the development and implementation of a flood forecasting and warning system has the highest priority and will require comprehensive inputs. It is therefore not likely that dam break and sediment transport modelling will be included in the activities in 1995.

Following the two overseas training courses in Denmark a comprehensive model setup for the Sula Valley has been created. The total model area has been divided into 35 subcatchments and all main tributaries and rivers are represented as well as the El Cajón reservoir. A thorough HBV/HD calibration has been carried out.

However, before a final calibration is reached, a number of measures has to be taken. Some of the HBV subcatchments have been assigned calibration parameters from neighbouring catchments. In some areas this has proven not to be adequate and a recalibration is required within these areas. Calibration problems have also been experienced in the El Cajón reservoir. This is believed to be due to inadequate topographical data and erroneous data from the reservoir operation unit, i.e. a further data analysis and a recalibration is needed. Finally, more topographical data from the downstream part of Sula Valley needs to be imported into the HD model setup. Most of these data are available at present in topographical maps.

It is believed that further data import and analysis and a subsequent final calibration can be completed by June 1995. At this time the model should be ready to carry out real-time flood forecasts/warnings on an experimental basis given that the installation of the telemetry system in Sula Valley has been completed by then. During the rest of the wet season the model shall be applied for real-time flood forecasting/warning on an experimental basis and recalibrated as appropriate.

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 Honduras 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 Sula Valley Flood Forecasting/Warning model.**
- * **To carry out final design and installation of telemetry system and obtain on-the-job experience in operation and maintenance of the system.**
- * **Application of the Sula Valley model for real-time flood forecasting/warning on an experimental basis.**
- * **The completion of a 3 week course in Tegucigalpa for training of additional counterpart staff from the participating institutions.**
- * **The preparation of course material and computer exercises together with UNAH.**
- * **Participation of new counterpart staff in a Regional training course.**
- * **Improvement of the general data management at DGRH.**
- * **The execution of new applications within 2-4 new model areas.**
- * **To prepare further dissemination of flood warning results.**

4. PROJECT ACTIVITIES

4.1 The Sula Valley case study

4.1.1 Preparation of additional available hydrometeorological and topographical data from remaining periods and stations within the Sula Valley.

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 May 1995.

4.1.2 Final calibration and experimental test of the Sula Valley Flood Forecasting/Warning model.

Following the completion of the databases, the Sula Valley model must be recalibrated and a final calibration obtained by June 1995.

4.1.3 Real-time flood forecasting on an experimental basis with the Sula Valley Flood Forecasting/Warning model.

Given that the installation of the telemetry system in the Sula Valley is completed by June 1995, the model shall be used for real-time flood forecasting /warning on an experimental basis during the rest of the 1995 wet season.

4.2 Telemetry

4.2.1 Final design, installation and on-the-job experience in operation and maintenance of the telemetry system.

The proposal for a final design of the telemetry network has been made and the model performance using the selected network has been analyzed. The size of the network with a total of 19 stations must be considered as a minimum configuration. However, it is expected that the received real-time data be enable the calculation of reliable flood forecasts/warnings at key locations in the river system.

The telemetry network is due to be installed during the period February - May 1995. This will unfortunately only leave very short time for on-the-job experience in operation and maintenance of the

telemetry system before the experimental forecast procedures will be initiated.

4.2.2 Support to operation of interface between telemetry system and modelling system.

An interface between the output facility of the telemetry system and the MIKE 11 FF databases will be prepared and installed prior to the start of the experimental forecasts, i.e. it shall be ready in May 1995.

4.3 Training

4.3.1 A 3 week course in Tegucigalpa for training of additional counterpart staff from all participating institutions.

The training of additional counterpart staff from DGRH, ENEE and UNAH is very important for the sustainability of the project activities in Honduras. It is anticipated that approximately 6 additional staff members (2 from DGRH, 2 from ENEE and 2 from UNAH) 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 4 students/professors from UNAH, a national course with 10 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 four trained counterparts.

4.3.2 Preparation of course material and computer exercises for UNAH.

As a support to the integration of the modelling technology at UNAH, 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.

4.3.3 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.

4.4 New applications

4.4.1 General support to new applications.

The final calibration of the Sula Valley model and subsequent flood forecasting/warning activities will require comprehensive efforts and inputs from the involved institutions and counterparts. However, it is believed that time will be available for setting up the models within new areas. At DGRH the preparations for model activities in the Nacaome basin (southern part of Honduras) have been made. The objective for this study is to access the impact from the establishment of a multi-purpose reservoir. At ENEE modelling in the Cangrejal basin (in the northern part of Honduras) have already started. The objective for this study is to carry out a feasibility study for a new hydro power plant. Hence, the selection of 2-4 new areas where modelling will be relevant is possible and support for such new applications will be given in 1995 as required.

4.4.2 Support to general data management at DGRH.

At DGRH 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.

4.5 Dissemination of results

4.5.1 Preparations for dissemination of flood forecasting/warning results.

COPECO will be responsible for the dissemination of the forecasting/warning results. Although the results in 1995 only will be made on experimental basis and mainly serve the purpose of testing the performance of the telemetry and modelling system, COPECO shall be involved in the forecasting activities in 1995. It is essential that COPECO being provided with information and specifications on model capabilities and the output which will enable COPECO to distribute and communicate real-time forecast/warning information. It is therefore proposed that COPECO will monitor closely the modelling activities from June 1995 where experimental forecasting procedures are initiated.

At the regional workshop in October 1995 COPECO will present their preparations for dissemination of results made prior to the wet season of 1996, where forecasts will be issued on operational basis.

5.1 Activity schedule and staff input (Honduras)