GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

Flood Plan Coordination Organization

FAP-25
FLOOD MODELLING AND MANAGEMENT

COORDINATION ADVISORY TEAM

FIFTH MISSION REPORT

JANUARY 1994

Governments of
Denmark, France,
The Netherlands and
United Kingdom

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LIST OF ABBREVIATIONS

AFPM	Active Flood Plain Management
BIWTA	Bangladesh Inland Water Transport Authority
BLE	Brahmaputra Left Embankment
BWDB	Bangladesh Water Development Board (under MIWDFC)
CAT	Coordination Advisory Team
CE	Chief Engineer
CTA	Chief Technical Adviser
Danida	Danish International Development Assistance
DEM	Digital Elevation Model
DHI	Danish Hydraulic Institute
EC	European Commission
EDP	Electronic Data Processing
EIA	Environmental Impact Assessment
FAP	Flood Action Plan
FAPMCC	FAP Model Coordination Committee
FFM	Flood Forecasting Module
FHS	Flood Hydrology Study
FMM	Flood Management Model
FPCO	Flood Plan Coordination Organization
GIS	Geographic Information System
GM	General Model
GOB	Government of Bangladesh
HME	Hydraulic Modelling Engineer
HYMOS	Software Package for Hydrological Data Processing
MC	Model Coordinator (previous Resident Model Coordinator)
MIKE 11	Software Package for 1-D River Modelling
MIKE 21	Software Package for 2-D Estuary and Coastal Areas Modelling
MIWDFC	Ministry of Irrigation, Water Development and Flood Control
MPO	Master Plan Organisation (now WARPO)
NAM	Rainfall-runoff Model (Danish abbreviation)
NCRM	North Central Regional Model
NCRS	North Central Regional Study
NERM	North East Regional Model
NWRM	North West Regional Model
PDM	Planning Design Module
PoE	Panel of Experts
RMM	River Modelling Module
RRI	River Research Institute
SAR	Synthetic Aperture Radar
SCRM	South Central Regional Model
SERM	South East Regional Model
SOB	Survey of Bangladesh
SOM	Structures Operation Module
SWAM	South West Area Model
SWMC	Surface Water Modelling Centre
SWRM	South West Regional Model
SWSMP	Surface Water Simulation Modelling Programme
TOR	Terms of Reference
UNDP	United Nations Development Programme
WARPO	Water Resources Planning Organisation

1. INTRODUCTION

1.1 General

Component 25 of the Bangladesh Flood Action Plan (FAP 25), Flood Modelling and Management, consists of the following three components:

i) A Coordination Advisory Team (CAT)

ii) A Flood Hydrology Study (FHS)

iii) A Flood Management Model (FMM)

The project is executed by the Flood Plan Coordination Organisation (FPCO) with the Danish Ministry of Foreign Affairs (Danida) as the lead donor. The donor agencies of France, the Netherlands and the United Kingdom also contribute to the project.

The project has been ongoing since October 1990 with the coordination and the Flood Hydrology Study as the two major activities. The FHS is now completed. The Flood Management Model component started in mid October 1992 and will run in parallel with the continued coordination activities until October 1994.

The Team of Short Term Experts of the CAT held their first meeting in Bangladesh in October 1990, producing an Inception Report dated November 1990. Since then there has been three missions, in May 1991 producing the Second Mission Report dated September 1991, in December 1991 producing the Third Mission Report dated March 1992, and in December 1992 producing the Fourth Mission Report dated April 1993.

During the last mission it was decided that the present fifth mission of the team should take place in early October 1993 coinciding with the issue of the draft First Interim FMM Report. The mission was shifted to early November 1993 at the request of FPCO to allow CAT members to participate in the International Workshop on the Morphological Behaviour of the Major Rivers In Bangladesh and in the second FMM Workshop. In addition to these missions, one member of the Team of Short Term Experts has visited Bangladesh on three occasions to overview and guide the implementation of the Flood Hydrology Study (twice) and to participate in the first FMM Workshop in February 1993.

The overall objectives of the CAT, as stated in the detailed Terms of Reference of the FAP 25, are:

i) To achieve consistency, compatibility and continuity in all related modelling activities;

ii) To coordinate the supply of models as tools to the various FAP projects and the feedback of relevant data and information from

various FAP projects to the Surface Water Modelling Centre (SWMC).

The particular Terms of Reference of the Fifth CAT Mission are contained in Appendix 1.

The Team of Short Term Experts of the CAT on the fifth mission were:

Dr. Jean Cunge	FRANCE
Dr. Rodney White	UNITED KINGDOM
Dr. Torkil Jønch-Clausen	DENMARK (Team Leader)

As was the case during the previous missions, the Model Coordinator of the CAT, Mr. Jørn Rasmussen, and the Hydraulic Modelling Engineer, Mr. Emaduddin Ahmad, worked closely with the Team of Short Term Experts.

Whenever the CAT is mentioned in this report, reference is made to the Team of Short Term Experts.

The team worked in Bangladesh in the period 1-15 November 1993 and presented their conclusions and recommendations to FPCO on 15 November 1993.

The programme of the mission is included in Appendix 2, and a list of key persons consulted during the mission in Appendix 3.

The CAT would like to express its appreciation to all officials and individuals met for the kind support and valuable information which the team received during its stay in Bangladesh, and which highly facilitated its work.

This report contains the views of the CAT which do not necessarily correspond to the view of the Government of Bangladesh or the four donors. Hence, all proposals presented in the report are subject to approval by the Government of Bangladesh and the donor countries.

1.2 Comments to the Draft Report

A draft report containing the views and recommendations of the CAT was submitted a couple of weeks after the mission. Comments have been received from FPCO and Danida and duly considered in the preparation of the final version of this report.

2. FINDINGS AND RECOMMENDATIONS

The general findings and recommendations of the Fifth CAT Mission are summarised in the following sections. Unless otherwise specified, the recommendations made are directed at FPCO.

2.1 Flood Management Models (FMM)

* The CAT finds that the FMM development is progressing satisfactorily, and that significant progress has been made with respect to software development. However, in order to ensure proper communication of these results to potential users, the CAT has made proposals for re-editing of the draft Interim Report I to make it more reader friendly.

* The CAT has expressed its concern to the FAP 25 consultant that part of the short term expert input, as provided in the TOR, has been used for model development activities rather than the envisaged, more user-oriented support tasks. However, the CAT understands that FPCO has approved this change.

* The CAT understands that financial arrangements are being negotiated for the use and dissemination of dedicated Arc/Info uses within the FMM. It is stressed that such arrangements need to be finalized soon, before the Arc/Info-based development has advanced to an irreversible stage.

* As expressed throughout the preparation and execution of FAP 25 the CAT is concerned about the institutional sustainability of the FMM. The CAT finds that the logical host for the FMM upon completion is the SWMC which maintains, distributes, supports and improves models and software as required for the FMM.

* The CAT recommends that steps be taken soon to secure additional financial resources for the SWMC to enable it to absorb the FMM upon completion of FAP 25.

2.2 Morphological/Inter-regional Study

* The CAT notes with satisfaction that its previous recommendations regarding a morphological and hydrological/hydraulic nationwide study are now being taken up.

* The formulation of detailed Terms of Reference for this study does not fall within the remit of the CAT. However, in view of previous CAT involvement in advocating a study of this nature, general comments are made in this report. Key issues include the following:

- River morphology is a complex and difficult subject. The CAT, therefore, recommends the involvement of top world experts in the field of river morphology who would be involved in the formulation, monitoring and supervision of the study;

- The CAT recommends that the study should be self contained and should not venture into those issues which are best dealt with by Regional Studies. The study should be restricted to morphology and hydrology/hydraulics issues. Social, economic, environmental and other aspects should be studied on a regional level;

- The CAT urges rapid processing of the proposals for the study because of its importance and urgency. Furthermore, the study should be phased such that early results are available to support investment decisions. Consideration should be given to the previous CAT proposal of initiating the study by fielding an expert mission.

2.3 Other issues

Modelling Technology

* It is within the remit of SWMC to make changes to the coding of MIKE 11 in order to solve problems quickly for users who are experiencing difficulties with the software. The CAT recommends that when these changes are made other users in Bangladesh should be notified by newsletter. All users in Bangladesh should be issued with new release versions of the software as and when these are issued by DHI

* FAP Consultants are required to return their models to SWMC who will retain them for future use. The CAT recommends that the SWMC briefly checks these models before storing them for future use but that no routine updating of the models should be associated with their return to SWMC. The CAT further recommends that the models should be made available for future studies free of charge thus encouraging the maximum use of previous modelling investment.

Modelling Related Activities in FAP Components

* The SWSMP-II terminates by the end of 1993. At that time full regional models, properly calibrated and verified, are available to future users. While there has been some delay in model development at the SWMC, the CAT finds that the SWMC has been able to cope well with the high demands from the FAP;

* According to SWMC the full regional models are of equal quality and

represent significant improvements over the pilot models, which have been the basis for most of the regional FAPs;

* FAP 5 has used the full model for the SE-region for feasibility studies, finds the accuracy of the model satisfactory and sees the model as having a sound potential for engineering, agricultural and fishery/environmental analyses;

* The CAT finds that there is a potential risk of duplication of modelling effort between FAP 25 and FAP 10. The CAT understands that the FAP 10 appraisal mission in December, 1993 has considered the benefit of the FAP 25 FMM development for modelling activities under FAP 10;

* The CAT finds the likely potential of using ERS-1 satellite images for verification of FMM simulated flood plain inundations very interesting and recommends that it be fully explored through the continuation of FAP 19;

* The CAT observes that FAP 24 analysis of Bahadurabad discharge time series raises doubt as to the accuracy of discharges after 1988 flood. The CAT recommends that BWDB Hydrology and FAP 24 as quickly as possible, and following analysis of 1993 monsoon data, agree to a firm conclusion on this issue. The CAT notes that the ongoing updating of the GM at the SWMC would depend here on and thus also FAP projects using the GM.

Flood Hydrology Study

* Following the release of the updated General Model from the SWMC the CAT recommends that FAP 25 undertake a 25- year simulation (1965-89) to compare performance with the previous GM (run 6 of the FHS);

* If the GM performance is significantly improved, the CAT recommends that FAP 25 revises the main results of the FHS, as contained in the Tables 1 and 2 of the Executive Summary of the FHS Main Report. Any subsequent updating may logically be carried out by the SWMC.

Model Coordination

* Important coordination issues over the last couple of years have been on provision of data and models, data-base harmonization and official release of FINNMAP survey data. While some progress has been observed, the CAT notes that none of them have been finally resolved;

* The CAT supports the general procedures for updating of SWMC models, which rely on an annual verification of the models based on data from the preceding year and updating only if the verification gives unsatisfactory results or in the case of implementation of major new schemes.

Future Role and Activities of the CAT

The FMM will be the most important CAT activity in the remaining period of FAP 25. The CAT will assist and provide overall guidance of the FMM development through 1994 as follows:

* visit by two CAT members in April-May 1994 to discuss progress and strategies for the application phase (time of Interim Report II);

* visit by two CAT members in August 1994 to discuss the results achieved and advise on activities in the remaining three months of the project (time of Draft Final Report);

* discussion of the final outcome of FAP 25 and the future of the FMM during the last full CAT Mission, tentatively scheduled for mid October 1994 (around the issue of the Final Report) .

3. BACKGROUND

3.1 Flood Action Plan

The Bangladesh Flood Action Plan has been prepared by the Government of Bangladesh in close cooperation with the World Bank. The Flood Action Plan has been prepared on the basis of several studies undertaken in the wake of the disastrous floods hitting Bangladesh in 1987 and 1988. The Action Plan aims at the identification, planning, design and construction of high priority flood control projects, which are technically, economically, environmentally and socially feasible. It has been decided by the GOB that the river models being developed in the Surface Water Simulation Modelling Programme (SWSMP), including rainfall-runoff, hydrodynamic, sediment transport and salinity modules will be used in the FAP studies.

3.2 The Surface Water Simulation Modelling Programme

The SWSMP was established in 1986 because of the widespread recognition that the effective control and utilization of water resources in Bangladesh is vital to the economic and social development of the country. Mathematical models of the complex river system are in this respect indispensable tools for an integrated approach to planning and design.

The first phase (SWSMP-I) was financed by UNDP and had the objectives i) to develop the local capability in surface water simulation modelling, including a sustainable institutional setup within a permanent Master Plan Organisation (MPO) later renamed the Water Resources Planning Organisation (WARPO), and ii) to develop a structured approach to modelling with a General Model covering the whole country.

The first phase of the programme finished at the end of 1988. The ongoing second phase (SWSMP-II), financed by Danida, has a duration of four years and will finish by December 1993. The GOB has requested and Danida has agreed to support a third phase, with the main objective of consolidating achievements under the first two phases. The third phase is expected to start in January 1994 and run for three years.

The Surface Water Modelling Centre (SWMC) is implementing the programme with technical assistance from the Danish Hydraulic Institute (DHI). In 1992 the SWMC was transferred from WARPO to the River Research Institute (RRI) but retained its presence in Dhaka.

3.3 FAP 25 - Flood Modelling and Management

The FAP 25 component was originally established with the dual purposes of coordinating i) the supply of models, being developed under SWSMP-II, to the FAP projects model and ii) model applications within the FAP. During the detailed project formulation the needs of a Flood Hydrology Study and a Flood Management Model development became obvious.

4. FLOOD MANAGEMENT MODEL

4.1 General Project Status

Work on the Flood Management Model (**FMM**) commenced in mid-October 1992, following approvals by GOB and the donor agencies. The Consultant (from DHI, BCEOM and Euroconsult) and local staff have been recruited, and computer hardware and software have been procured and installed in the FAP 25 Project Office.

The first FMM Workshop was held on 9-10 February 1993 towards the end of the Inception Phase with 61 participants from various GOB, NGO and FAP organizations. A CAT representative participated in the Workshop and discussed the draft Inception Report with the FMM team. This report was subsequently issued in April 1993. Few of the comments of the CAT were considered in this report.

A training course consisting of four modules each with a duration of two weeks is presently being conducted by FAP 25 with a total of 11 participants from FPCO, SWMC and BWDB.

A draft Interim Report I, including Reference Manuals for the MIKE 11-GIS interface and the MIKE 11- NAM coupling, have been produced by October 1993 and comments are being received.

4.2 Review of Project Progress

The CAT has reviewed project achievements, attended software demonstrations, studied the draft Interim Report I and the draft Reference Manuals, and discussed in detail with the FMM team.

Based on this the CAT finds that the FMM development is progressing satisfactorily, and that significant progress has been made with respect to software development. Although some delay (about 1.5 months) has occurred in completion of reports, the project is generally implemented on schedule. The Reference Manuals have been prepared ahead of schedule which is of considerable benefit to users and collaborating projects and organizations.

The CAT is generally impressed with the activities of the FMM team to arrange workshops and training sessions. Such activities are crucial to the communication of this new technology to potential users, as well as to the feedback from such users to the FMM development.

Although the draft Interim Report I may be quite acceptable from a technical point of view, the *CAT has recommended* a major re-editing of the main body of the report, with inclusion of technical details in appendices. A revised outline has been proposed by the CAT and discussed with the team. The main report should be easy to read for decision makers and prospective

users who may not be familiar with the technicalities and jargon of models and software development. The report should convey a clear description of the capabilities and limitations of the FMM, and allow the reader to assess project progress against the Terms of Reference.

4.3 Specific Issues and Recommendations

In the report (dated April 1993) of the Fourth CAT Mission a number of specific recommendations with respect to the FMM development were made. The CAT has the following comments to the follow-up on these recommendations, as well as to other specific issues raised during the discussions:

Collaboration with FAPs and the SWMC

The FMM team has established good working relationships with FAP 10 (BWDB), FAP 19 and FAP 20.

The collaboration between the FMM team and SWMC was discussed with both. The *CAT finds* that a closer and more informal collaboration needs to be established between them, not least because the SWMC is likely to continue FMM activities after completion of the FAP 25 project (see section 4.4).

Basic Software Changes

Some internal basic changes to MIKE 11 software, not specifically related to FMM, have been referred to DHI Denmark as proposed by the Fourth CAT Mission. However, for reasons of expediency some basic developments which ought to have been referred to DHI appear to have been carried out by FAP 25, The CAT recognizes that this is a 'grey area', but *stresses* that FAP 25 resources must be dedicated to FMM development, rather than to basic software improvements. In this context the CAT has expressed its concern to the FAP 25 consultant that part of the short term expert input, as provided in the TOR, has been used for model development activities rather than the envisaged, more user-oriented support tasks. However, the CAT understands that FPCO has approved this change.

Regional FMM Based on NCRM

The extent of FMM activity on NCRM development was discussed with FAP 25 and SWMC. The FMM team has made some necessary additional developments of the NCRM (quasi 2-dimensional flood plain description) in order to arrive at a suitable regional FMM for demonstration purposes. Discussions have been held with respect to possible assistance from the FMM to the FAP 3.1 modelling for which the FMM capabilities would be

required. The CAT stresses that the FMM team may assist the FAP 3.1 modelling team by demonstration and training in the FMM software within the resources available, but that the modelling as such should be carried out by the FAP 3.1 consultant.

GIS Software

In terms of appropriateness of the chosen GIS technology, considering the limitations of the hydrodynamic data and modelling, the CAT agrees to the choice of the UNIX-based ArcInfo. The CAT realizes that this software is more sophisticated than required for the FMM (only some 20% of its capabilities are being utilized), and that caution is required by the user. However, more simple GIS technologies, such as the PC-ArcInfo, may impose undesirable constraints.

One limitation inherent in the choice of the UNIX-based ArcInfo is that the FMM for the time being is constrained to a Work Station environment which is more expensive and less robust than a PC-486 environment. However, with the rapid developments in EDP technology, it is expected that the present limitations may be of little significance in a few years. For users of FMM end products (such as flood maps) results may be transferred on files which can be further processed and analyzed by the user on PCs in a MS-DOS-environment.

The CAT understands that financial arrangements are being negotiated for the use and dissemination of the dedicated ArcInfo uses within FMM for Bangladesh so that the FMM products can be distributed to users at reasonable costs. It is *stressed* that such arrangements need to finalized soon, before the ArcInfo-based development has advanced to an irreversible stage.

FMM for Impact Assessment

The FMM is being developed as an instrument to be used for various purposes by different sectors - and at national, regional and compartment levels - each with their own characteristics and requirements. The mode of collaboration between the users and the FMM providers will be developed and tested in the application phase to come. By providing a detailed description of flooding patterns in time and space as output from the FMM, the concerned sectors are given the basic data for impact assessment or forecasting of floods.

Impact assessment may be carried out manually, or by superimposing overlays within the GIS structure to be combined with the flooding pattern for calculation of damages or other impacts. The *CAT stresses* that the interpretation and analysis of such sectoral data and information should be made by the concerned sector specialists who have the required background for assessment of economic, social and environmental consequences of floo-

ding events (such as cropping patterns and agricultural damages, effects of floods on inland water fisheries etc.). Hence the FMM becomes a tool, and the FMM modellers facilitators, to assist in this process.

Off-line and On-line Application

The *CAT stresses* that the FMM in the present stage is to be developed as an analytical tool to be used off-line. Based on such analyses simple relationships will be developed for application in real time (i.e. on-line). Examples of this are simple guidelines for manual operation of structures by farmers (compartment level), or simplified representations of flooded areas and volumes as a function of river stage to be used for flood forecasting (regional or national level). The ultimate on-line use of FMM tools during floods are envisaged to come later.

Reporting and CAT visits

The FMM project is due to finish by the end of October 1994 with a Final Report. An Interim Report II is planned for May 1994.

Originally the Interim Report II was planned to coincide with the completion of Reference Manuals. However, with the Reference Manual for the MIKE 11-GIS advanced to the present Interim Report I there is no natural milestone for a major report in May 1994. As a result of discussions with the FMM team and FPCO the *CAT consequently proposes* a more operational reporting schedule as follows:

- a brief Progress Report (still named Interim Report II) in April-May 1994 to serve as basis for a visit by two CAT members to discuss progress and strategies for the application phase;

- advancement of the Draft Final Report to July-August 1994 to serve as the basis for a second visit by two CAT members to discuss the results achieved and advise on activities in the remaining three months of the project, including completion of the Final Report;

- discussion of the final outcome of FAP 25 and the future of the FMM during the last full CAT Mission in October 1994.

4.4 Institutionalization of the FMM

The FMM is a modelling and software tool to be used by a variety of government agencies and consultants. It will be developed and demonstrated at the national, regional and compartment level in FAP 25. After the completion of the FAP 25 project the FMM will be documented and made ready for application by interested users.

Like the surface water models at SWMC the FMM is a 'living tool', to be maintained, improved and upgraded over time as a result of user experiences and demands, as well as new and improved modelling, software and hardware technologies. Users need introductory training before applying the tool, and often some support and assistance during the application will be required. Experiences generated by users should be documented and fed back to the custodians of the FMM in order for subsequent users to benefit from them.

The CAT believes that the FMM development in FAP 25, associated with a high level of 'outreach' activity in the form of workshops and training sessions has generated considerable local expertise for the continuation of FMM activities in Bangladesh. However, for the sustainability of the FMM it is essential that a proper institutional framework exists for this expertise to be retained and further developed. Otherwise future maintenance and operation of the FMM as discussed above will not be possible, and the FAP 25 efforts may ultimately be wasted.

The *CAT finds* that the logical institutional host for the FMM after completion of FAP 25 is the SWMC which maintains, distributes, supports and improves models in the same way as required for the FMM. Developed by interfacing the MIKE 11 with DEM and GIS, the FMM is linked to the SWMC technology, and most users of the SWMC models are expected to use the FMM for pre- and post-processing of data and results. The SWMC is basically a service and consulting organisation capable of assisting many different users, as also required for the FMM. The SWMC is likely in the future to rely on charging users for the provision of models and services (both public and private); the FMM is a logical addition to the products of the SWMC and one which in the long run may contribute significantly to its financial sustainability.

The FMM hardware and software, as well as some of the key technical staff of FAP 25, can in principle easily be accommodated by SWMC. However, for the SWMC to assume this new responsibility some short term support will be required to absorb the FMM, both in terms of facilities and additional training of key staff.

The question of sustainability and future institutional framework for the SWMC and the FMM has been discussed throughout the FAP 25 preparation and implementation. A small group of senior GOB officials is now (as part of FAP 26) reviewing the general institutional structure of the water sector in Bangladesh, and no firm proposals have as yet been made. However, it appears to the CAT that regardless of the overall structure to be adopted, the SWMC will continue as an entity, located in Dhaka. The recommendation by the CAT of placing the FMM with the SWMC is made under this assumption.

The *CAT stresses* that time is short. FAP 25 will be completed in less than a year (i.e. in October 1994), and decisions on its future need to be taken in time for a proper handover to the host institution, i.e. hopefully the

SWMC. The additional support required for that institution to absorb the FMM may need external donor financing. Such arrangements take time and need to be initiated soon to avoid a vacuum between the end of FAP 25 and the future FMM operation.

4.5 Second FMM Workshop

The second FMM Workshop was held on 14 November 1993 after the end of the development stage of the project. Participants from various GOB, NGO and FAP organisations were present. A CAT member also participated

The main objectives of the second FMM Workshop were:-

- to present the FMM features developed so far to relevant GOB authorities, consultants and other potential users
- to obtain feedback for improvement

Presentations were made on the following topics:-

- development of the MIKE 11 - GIS interface
- features of inputs to MIKE 11 - GIS
- features of outputs from MIKE 11 - GIS
- changes to the MIKE 11 - NAM interface

Presentations were also made on i) Land Classification and Flood Mapping in the Atrai Basin by FAP 19 and ii) the Institutional Issues of FMM

The presentations were generally well received and useful discussion and debate took place in all sessions. The main points which emerged were:-

- FAP 25 is predominantly concerned with the development of new and useful user friendly techniques relating to the nature of flood events both spatial and temporal
- Subsequent usage of the techniques fall outside the scope of FAP 25
- The natural institutional home for the FMM is in the SWMC because of the close linkages with straightforward MIKE 11 modelling

5. MORPHOLOGICAL AND INTER-REGIONAL STUDY

In May 1991, on their second mission, the CAT raised the question of the "missing component" in FAP, namely a study to look at the overall morphological and hydrological effects of proposed and potential FAP projects.

The third CAT mission in December 1991 proposed a river morphology study as a key component of this (missing) inter-regional study. The CAT further proposed that a mission of international experts should be assembled in Dhaka to formulate the study.

The fourth CAT mission in December 1992 reiterated the request for the mission suggesting that it would carry out a preliminary morphological study to be followed by a more comprehensive study, identified by the mission, within the inter-regional study. Outline Terms of Reference for the mission were formulated and were included as an appendix to the fourth CAT report dated April 1993.

In line with the CAT recommendations and following the International Workshop on the Morphological Behaviour of the Major Rivers in Bangladesh held at the Sheraton Hotel, Dhaka, on 6 and 8 November 1993, FPCO has announced the formulation of a new study entitled "Morphological Study of the Major Rivers in Bangladesh". A first draft of the Terms of Reference for this study was being developed by GOB and preliminary comments were requested from the CAT.

The formulation of detailed Terms of Reference for a morphological study does not fall within the remit of the CAT. However, in view of previous CAT involvement in advocating a study of this nature, the following general comments are made:

a) River morphology is a complex and difficult subject which needs a multi-disciplinary approach and the involvement of top experts in the field. The CAT therefore suggests that the study should be formulated, monitored and supervised by a small group of international experts who would advise on the direction of the study and who would have a key role in the interpretation of results. This group would form part of the study team and would visit Bangladesh at key stages during the execution of the project;

b) The study should be self contained and should not venture into those issues which are best dealt with by Regional Studies. Hence the study should be concerned with only two environmental issues namely morphology and hydrology/hydraulics. It should look at:

   * the morphology of the major rivers (including large regional rivers), with and without man-made interventions and considering both short and long term development;

* changes in hydrology/hydraulics associated with morphological changes;

* institutional aspects concerning future morphological study and monitoring activities in Bangladesh;

The results from the study would feed through to Regional Studies which would include social, economic, environmental and other aspects;

c) It is recommended that the study should be carried out in two phases:

* Phase 1 would involve an overview of available studies and information, the identification of data and the formulation of the methods to be used in the study. The morphological study methods should include all relevant aspects including geology, river regime and erosion/sedimentation processes. The international experts would be heavily involved in this phase and would help to identify and prioritise those activities to be carried out in phase 2. A report would be issued at the end of this phase.

  Phase 1 could be accomplished by a formulation mission as originally proposed by the CAT in 1991. However, continuity between phases 1 and 2 is essential and the use of the same, common pool of international experts is a pre-requisite of this study;

* Phase 2 would involve data collection, field investigations, reviews of historical information, assessments of changes occurring external to Bangladesh, analytical studies, modelling and reporting. Priority should be given in this phase to those items in the work programme which will yield early results of relevance to FAP proposals and other riverine developments.

d) A large proportion of the flows in the major rivers in Bangladesh originates from outside the country. The morphological development of these rivers in Bangladesh is thus continually influenced by developments in India and Nepal and also the more general aspects of climate change. The study will have to use public domain information on developments in these countries to assess the likely magnitude of changes in flows and/or sediment loads. Appropriate sensitivity analyses will have to be carried out during the study to provide a range of results with varying probabilities;

e) The study should involve a minimal amount of field data collection. Any in-river field measurements should be carried out by the River Survey Project (FAP 24) - extended or adapted. Some terrestrial measurements may be necessary as part of the study if the geological tectonic aspects demand it;

f) As far as possible the study should use a wide range of existing technologies. Development of new and untried technologies should be avoided;

The CAT urges rapid processing of these proposals for the morphological and hydrological study because of its importance and urgency. The CAT further advises careful scheduling of the work such that preliminary results relating to FAP projects and other riverine works will be available at an early stage. The CAT emphasises the need for a study team which includes international experts in this specialised and difficult field of study.

6. MODELLING TECHNOLOGY

Reports on the MIKE 11 modelling technology were given in the first four CAT reports. With time the need for these comments has diminished (i) because many of the difficulties experienced by users have been sorted out either by SWMC or DHI and (ii) more and more of the Regional Consultants have successfully completed their modelling activities. In this fifth CAT report comments are minimal.

6.1 Structures in MIKE 11

During 1993 FAP 5, 6 and 20 reported some difficulties with structures. The problems were partly due to inexperience on the part of the users and partly due to software errors. In general, these were attended to satisfactorily by SWMC and DHI.

DHI is currently working on the structures module within MIKE 11 for FAP 25 and a separate check is being carried out by the SWMC. A new release version of the module is promised for early in 1994.

It was agreed with SWMC that when changes to the coding within MIKE 11 are made by SWMC and the new version is issued to a Regional Study team then other users within Bangladesh should be notified. This will be done by newsletter. All users in Bangladesh will be provided with new release versions of the software as and when these are issued by DHI.

6.2 Shallow Flows and Drying Channels

Stability problems remain with shallow flows in drying channels. In MIKE 11 these problems are addressed by introducing a narrow artificial slot in the cross section. Following the problems faced by FAP 5 and FAP 6 DHI is working on an improvement of the slot description and it is expected that this modification will be introduced in the next MIKE 11 release.

6.3 MIKE 11 "Morphological" Modelling

SWMC has continued to carry out "morphological" modelling of some major rivers using MIKE 11 and the results were presented at the International Workshop on the Morphological Behaviour of the Major Rivers in Bangladesh.

As stated in previous CAT reports it is generally agreed that so called one dimensional morphological modelling gives some insight into the future behaviour of rivers but it is limited in its scope of application. This is particularly so in wide sand bed channels which are inherently two-dimensional and dynamic. The CAT feels that further discussion of this topic is not relevant within FAP 25.

6.4 Models Developed by FAP Consultants

It was agreed some time ago that the FAP consultants would return any models that they had developed to the SWMC. From the completed FAPs all models have been returned except those developed by FAP 3 and FAP 3.1.

The committee report "Development of a Uniform Methodology on the Issue of Data and Models" advocates that SWMC would archive the models returned by consultants assuming adequate resources. SWMC would briefly check the models before archiving them. The models would not be updated and would remain available to future users at no charge. The CAT endorses this policy

7. MODELLING RELATED ACTIVITIES IN FAP COMPONENTS

7.1 Timing of Model Supply and Use

Since the Fourth CAT Mission the model development schedule in the SWMC has suffered some further delay, but without any significant effect for the FAP. Of the Regional Studies only FAP 5 and FAP 6 have carried out modelling in 1993. The updated SERM has been available to FAP 5 from January 1993 while the full NERM was delivered to FAP 6 in May 1993, a one month delay as compared to the envisaged schedule in the Fourth CAT Mission Report.

At the end of SWSMP-II all regional models have been developed to the full model stage. Calibration and verification periods appear from Table 7.1. It is noted that there is a change in terminology at the SWMC. During model development the SWMC has operated with three model stages (pilot, full and verified). In the draft final report of SWSMP-II this has been reduced to two, the pilot stage and the full stage, the latter being calibrated for one period (corresponding to the previous full model stage) and verified for another period (corresponding to the previous verified stage).

The SWMC claims that the full model stage for all regional models represents a significant improvement over the pilot stage model and also that the six regional models are of more or less equal quality. This statement is based on a visual comparison of simulated and observed water levels and hydrographs. FAP 5, the only Regional Consultant who has used a full, verified model (SERM) for feasibility studies, claims that the model accuracy has been satisfactory for their purpose and finds that the model has a sound potential for engineering, agricultural and fishery/environmental analyses.

The SWMC is still not making a statistical analysis of model performance as done by FAP 25 in the FHS. This has been discussed with the SWMC and it has been agreed that a minimum of statistical analysis may be useful in connection with the annual model verification and possible updating. Such analysis should be confined to a limited number of stations in each region, where observation records are expected to be particularly reliable.

7.2 Regional Studies

FAP 5: South East Region Water Resources Development Programme

In 1993 FAP 5 has carried out feasibility studies for Gumti Phase II and Noakhali North Drainage and Irrigation project. Two submodels, one of each of the project areas, have been established based the SERM. The FAP 5 consultant has closely followed the recommended modelling approach of FAP 25, including 25-year simulations of present conditions and finally selected development plan.

Model	Type	Calibration Period(s)	Verification Period	Model Development Status	Full Model Report
GM	NAM	Based on Regional NAM Models	Based on Regional NAM Models	Completed	Dec 1993*
	HD	Jan 1986 to Mar 1991	Apr 1991 Mar 1992	Completed	Dec 1993*
SERM	NAM	Apr 1986 to Dec 1991	Jan 1992 to Oct 1992	Completed	Published
	HD	Jul 1986 to Oct 1988	Monsoons 1990, 1991 1992	Completed	Nov 1993*
SWRM	NAM	Apr 1986 to Mar 1992	Apr 1992 to Mar 1993	Completed	Nov 1993
	HD	May, Jun, Aug, 1990; Mar, Aug 1991	Apr 1992 to Mar 1993#	Completed	Published
NWRM	NAM	Jan 1990 to Dec 1992	Jan 1986 to Dec 1986	Completed	Nov 1993
	HD	Apr 1990 to Oct 1991	Nov 1991 to Mar 1993	Verification in progress#	Published
NCRM	NAM	Apr 1986 to Mar 1992	Apr 1992 to Mar 1993	Completed	Nov 1993
	HD	Apr 1990 to Mar 1992#	Apr 1992 to Mar 1993	Verification in progress	Nov 1993
SCRM	NAM	Apr 1986 to Mar 1992	Apr 1992 to Dec 1992	Completed	Nov 1993
	HD	Mar, Aug, Sep 1991	Apr 1992 to Mar 1993#	Verification in progress#	Dec 1993#
NERM	NAM	Apr 1986 to Dec 1992	Jan 1993 to Jul 1993	Completed	Nov 1993
	HD	Apr 1991 to Mar 1993	Apr 1993 to Jul 1993	Verification in progress	Nov 1993

Table 7.1 Data Periods used for SWMC Full Model Development

* Model Update Report

\# Uses the Combined SWRM/SCRM

FAP 5 has developed their own post-processing facilities allowing model output (water level and discharges) to be used not only for engineering analyses, but also for agricultural and fishery/environmental analyses of effects of considered development options. The experience of FAP 5 in this respect could be very valuable for the continued development of the Flood Management Model under FAP 25.

In the fourth CAT report the problems with the exact gauge datum at Daulat Khan was mentioned. This was solved in the spring of 1993. Improved cross section information in Lower Meghna and revision of chainage of the Daulat Khan station now suggest that the needed adjustment of gauge datum is only +0.12m instead of +0.75m. This correction has been confirmed by SOB.

Also FAP 5 has faced some problems with the structures module of MIKE 11, more specifically with the culvert description. This was overcome by using the control structure (undershot gate) instead, which anyway is a better representation of the actual conditions. FAP 5 has also reported problems with instabilities for drying channels, see Chapter 6.

FAP 6: Northeast Regional Water Management Project

Since the last CAT mission the cooperation between FAP 6 and the SWMC on modelling has taken place to the satisfaction of both parties.

The late availability of the full NERM has of course been a major concern for FAP 6. However, the model has proven to be a useful tool in analyzing the effects of the proposed Regional Development Plan on water levels and discharges in the rivers of the region.

Three scenarios have been modelled for the 1991 water year: the present condition, the future with no intervention, and the future with the options proposed in the Regional Development Plan.

FAP 6 is presently considering the possibility of carrying out long term simulations (25 years) as recommended by the FHS. The major constraint to this is establishment of boundary conditions through NAM rainfall runoff modelling because of limited rainfall data from India.

In applying the NERM FAP 6 has faced various problems in model setup, model use and in the MIKE 11 source code. problems which have all been solved in cooperation with SWMC, see also Chapter 6.

7.3 Other FAP Studies

FAP 10: Flood Forecasting and Early Warning

As mentioned in the last CAT report the FAP 10 project terminated by 30 November, 1992. Following various modifications modified TOR were approved in the Technical Committee in June 1993. The proposed project consists of four modules:

* coordination and monitoring to ensure integration of external hydrometric information and relevant FAP outputs into the Flood Forecasting and Warning System;

* expansion of flood forecasting system through updated and improved regional modelling;

* development and improvement of forecast outputs and dissemination emphasising appropriate warning systems at the grass root level;

* installation and development of telemetry system;

Danida has been requested to fund the first three modules and an appraisal mission has taken place in December, 1993 after the visit of the CAT.

As stated in the fourth CAT report there is a need for a close cooperation between FAP 10, FAP 25 developing Flood Management Models and the SWMC. The envisaged modelling activities under FAP 10 would no doubt benefit from the ongoing development of FMM under FAP 25 and the CAT understands that this has been considered by the FAP 10 appraisal mission and that unnecessary duplication of modelling activities in FAP 10, FAP 25 and the SWMC will not take place.

FAP 19: Geographic Information System

FAP 19 officially terminated on 31 October, 1993. A continuation of the project has just been agreed.

During 1993 FAP 19, among other activities initiated a pilot project on the use of satellite images from the new Earth Resources Satellite (ERS-1). The study area is part of the NC and NW region.

The ERS-1 has radar facilities which may allow areas of inundation to be determined and also measurement of water surface elevation (accuracy unknown). Potentially, such images may prove to be very valuable for verification of flood plain flooding as simulated with a Flood Management Model, not least because the radar can penetrate the clouds that block conventional satellite operational width.

Ground truth information have been collected by cooperating FAP components during two passages on 31 July and 28 August 1993. FAP 19 has just received the data from ESA and expects to finalize the pilot study in early 1994.

If the technique is proven it would be an excellent opportunity for FAP 25 to verify their FMM for the Tangail area and part of the NC region during the 1994 application stage. With passages every 4-5 weeks approximately five images from the coming 1994 monsoon season could be utilized in such exercise. The CAT recommends that FAP 25 and FAP 19 jointly work out a proposal to acquire 1994 ERS-monsoon data for verification of the FMM. Present funding may however not adequate.

FAP 20: Compartmentalization Pilot Project

Since the last CAT visit FAP 20 has setup a model for the Sirajganj compartment in addition to the model already established for the Tangail compartment. The modelling activities for the Sirajganj compartment are reported in the Sirajganj CPP Interim Report, Annex 2 from June 1993. The model provides enough detail to simulate peripheral control and control up to the level of subcompartment of which the model contains a total of nine.

The model has been calibrated for the period May - November 1992 using observed water levels at six different locations. Model performance is generally reported to be satisfactory. However, as other FAP consultants also FAP 20 has reported problems with the use of the MIKE 11 structures module.

Various development options with and without an embankment along the Ichamati river have been analysed with respect to improvement of flooding and drainage conditions in the compartment, also for the 1992 monsoon season. External impacts of the compartment on up- and downstream maximum water levels have been analysed based on data from 1970 (five year return period) and 1990 (year when a breach occurred in the Brahmaputra Right Embankment). FAP 20 plans to undertake 25-years simulations as proposed in the FHS.

Modelling in the Tangail compartment has been improved and refined in connection with the FMM modelling under FAP 25. Improved performance of NAM has been achieved using the irrigation module. Model verification for the 1992 monsoon, which was very dry, has demonstrated the need of refining the flood description on the flood plain by means of flood cells (pseudo 2-dimensional description). This work is in progress.

FAP 24: River Survey Programme

FAP 24 has reported the first phase of a Hydrological Study (June 1993) undertaken with the overall objective to improve the understanding of the

hydrological characteristics of the main river system. As such it builds very much on the Flood Hydrology Study under FAP 25.

The CAT endorses the views of the Model Coordinator of FAP 25, previously communicated to FPCO, on the findings and recommendations of FAP 24.

In particular, the CAT recommends that FPCO and BWDB Hydrology take the necessary action to implement in practice the FAP 24 guidelines for checking of water level observations, establishment of rating curves and trend analyses of long time series of water levels and discharges.

Furthermore, the FAP 24 analysis of Bahadurabad discharge time series after 1988-flood indicate a dramatic shift in Q/h measurements, which according to FAP 24 most likely is due to a systematic error (overestimate) in discharge measurements. This is explained by possible changes in planforms, channel pattern and cross section resulting in a velocity distribution which is more skewed than before the 1988 flood.

The CAT recommends that BWDB Hydrology and FAP 24 as quickly as possible, and following analysis of 1993 monsoon data, agree to a firm conclusion on this issue. The CAT notes that the ongoing updating of the GM at the SWMC would depend hereon and thus also FAP projects using the GM.

8. FLOOD HYDROLOGY STUDY

8.1 General

The Flood Hydrology Study has been completed and has submitted its Final Report in three volumes:

* Flood Hydrology Study, volume 1, Main Report, June 1992;

* Flood Hydrology Study, volume 2, Annex 1, June 1992;

* Flood Hydrology Study, volume 3, Annex 2, February 1993;

All volumes have been submitted in draft and comments from FPCO have been incorporated in the Final Report. Official approval of the report by the Technical Committee is still pending.

8.2 Updating of the Flood Hydrology Study

As recommended by the Fourth CAT Mission the hydrological basis of the engineering design criteria along the major rivers as established by the Flood Hydrology Study (FHS) may be updated during the course of the FAP. Such possible updating would depend on the availability of more exact information on actual flood control options and their likely combination and on further improvement in the performance of the General Model (GM). It was also mentioned that the next update of the GM could provide the basis for such updating of the FHS within the frame of FAP 25, but that subsequent updating(s) may need to be carried out by SWMC.

SWMC is in the process of updating the General Model (GM) based on the period 1986-92. The updated GM is benefitting from i) improvements in the regional models with respect to location of cross sections and gauges, ii) new cross sections in the Lower Meghna and corresponding revised datum correction in observed mean daily water levels at Daulat Khan (+0.75 to +0.12 m), and iv) improved boundary discharges in Brahmaputra and Ganges based on the recommendations of FAP 24, cf section 7.3. The updated General Model will be verified for the period 1986-92.

The CAT recommends that once the updated GM is released FAP 25 undertake 25-year simulation (period 1965-89) with the model and compare the performance with Run 6 of the FHS. If the updated GM performs significantly better FAP 25 should update the FHS with respect to design peak water levels and peak discharge for existing conditions, cf. Tables 1 and 2 in the Executive Summary of the Main Report and still considering the agreed original 25-year period.

The CAT finds that any later updating of the FHS due to implementation of new structures or further improved performance of the GM may logically be carried out by SWMC.

9. COORDINATION ACTIVITIES

9.1 General Coordination

The coordination activities under FAP 25 have as foreseen in the last CAT report been decreasing through 1993, because many FAP projects have come to an end.

Accordingly, there have been no informal meetings of FAP hydro-modelers and hydrologists in 1993. The day-to-day, or ad-hoc bilateral contacts to SWMC, FPCO, BWDB Hydrology and FAP projects have also decreased.

Two meetings have been held in the FAP Model Coordination Committee (FAPMCC), the 6th meeting on 10 May, 1993 and the 7th meeting on 10 November, 1993 during the visit of the CAT. The most important issues on the agenda of these meetings have been that of data rather than of modelling technology, cf. section 9.2. With the transfer of the SWMC to RRI, the Director General of RRI is now the Chairman of the FAPMCC.

The Model Coordinator had three visits over the last year, December 1992, May 1993 and November 1993 to support the day-to-day coordination of the Hydraulic Modelling Engineer and assist the CAT.

The CAT finds that the present coordination structure with the Hydraulic Modelling Engineer, responsible for the day-to-day coordination but also Deputy Team Leader for the FMM development, and supported by the Model Coordinator as and when required, offers a flexibility in coordination capacity, which would suit the requirements up to the completion of the project. These requirements will depend on the extent to which new FAP activities are initiated, e.g. feasibility studies growing out of the regional FAPs.

9.2 Specific Coordination Issues

Over the last three years a number of specific coordination issues have dealt with data more than with models. While some progress has been observed none of the data issues have yet been finally resolved. In the previous reports the CAT has stressed the importance of these issues and has little to add except reiterating their importance and recommending them to be addressed by or through FPCO. The progress on the issues since the last CAT report is briefly summarized in the following.

Provision of Data and Models

On 8 May, 1993 the Committee on Data and Model Exchange within the FAP submitted its draft report to MIWDFC. The report (with the title

"Development of Uniform Methodology on Issue of Data and Model") recommends that procurement of data and models follows the proposal of the Model Coordinator, cf. Fourth CAT Mission Report.

The report also recommends that 5% of data costs be borne by the donor agency as a direct reproduction cost. This appears reasonable and easy to administrate. To the extent that a FAP consultant can collect his data with another FAP consultant, as allowed in the prescribed procedures this 5% charge will of course not become effective.

The official approval from the Ministry is still pending, but expected soon. To which extent FAPs have been reimbursed the payment made for data over the last three years is not known.

Data-base Harmonization

Following cancellation of two previously called meetings, the first meeting to follow up on the Inter-Agency report on Data Improvement was held on 24 May, 1993. It was decided during the meeting that a working group should update the report and include the recommendations of the Committee on Data and Model Exchange within the FAP. The update report should be available by end of August, 1993.

The working group has held two meetings by now but no substantial progress has been made.

Release of Updated Datum of SOB/FINNMAP and its Use by BWDB Hydrology

In early 1992 SOB prior to their own field checking made a conditional release of FINNMAP survey data for the benefit of the FAP and other users. However, the official SOB approval of FINNMAP data is still pending for which reason BWDB Hydrology cannot adjust datum of the 50-60 BWDB temporary benchmarks, which were included in the FINNMAP survey. The inherent risk in the present situation is of course a lack of consistency in topographic and hydrometric data used by the individual FAPs in the areas concerned.

The issue was discussed at the 7th FAPMCC meeting. The SOB has through field checking confirmed the observations of FINNMAP but official approval may still take some time. The outcome of the meeting was that SOB agreed to issue a letter giving provisional approval of FINNMAP data, hopefully allowing BWDB to make the necessary adjustments of temporary benchmarks.

Model Updating Procedures

Some confusion did remain with respect to updating procedures for SWMC models after the Fourth CAT Mission. The Model Coordinator discussed the issue with FPCO and SWMC during his May 1993 visit and the CAT understands that a common understanding has now been reached along the following lines:

Comprehensive updating will not be done every year. The procedure will include an annual verification based on the data from the preceding year. Updating will only be undertaken if this verification provides unsatisfactory results, or in the case of implementation of major new schemes, which could affect river flow and inundation patterns.

10. FUTURE ROLE AND ACTIVITIES OF THE CAT

As an integral part of the FAP 25 project the CAT has had four main activities since the first mission in October 1990:

- the coordination of FAP modelling activities;
- the Flood Hydrology Study (FHS);
- the Flood Management Model (FMM);
- recommendations for the overall coordination of morphological and hydrological aspects of the FAP.

The model coordination activities of the CAT are becoming less important as the SWMC models have all reached the full verified stage, and coordination increasingly will rest with the SWMC itself. The remaining coordination requirements of FAP 25 will be handled by the Model Coordinator (MC) and the Hydraulic Modelling Engineer (HME) who will continue their activities through October 1994. The MC will have two visits to Bangladesh, and the HME work on a part time basis (ref. Chapter 9 above).

The FHS is completed. The updating of the FHS will require little input from the CAT in the future (ref. Chapter 7 above)

The FMM will be the most important CAT activity in the remaining period of FAP 25. The CAT will assist and provide overall guidance of the FMM development through 1994 as indicated in Chapter 4 above, i.e:

* visit by two CAT members in April-May 1994 to discuss progress and strategies for the application phase (time of Interim Report II)
* visit by two CAT members in August 1994 to discuss the results achieved and advise on activities in the remaining three months of the project (time of Draft Final Report)
* discussion of the final outcome of FAP 25 and the future of the FMM during the last full CAT Mission tentatively scheduled for mid October 1994 (around the issue of the Final Report).

With respect to the overall morphological and hydrological aspects of the FAP the CAT has made recommendations for an overall study in the three previous Mission Reports. The CAT has made a number of general observations and recommendations to the recent proposal by FPCO for such a study as presented on 9 November 1993 (entitled a "First Attempt on TOR for the Morphological Modelling of the Main River System in Bangladesh", see Chapter 5 above).

Participation in the preparation and execution of the overall morphological and hydrological study is obviously beyond the present TOR and resources of the CAT.

The planned activities of the sixth CAT mission are outlined in Appendix 4.

APPENDIX-1

Terms of Reference

for

Fifth Mission of Short-term Experts on the Coordination Advisory Team (CAT)

1. BACKGROUND

Component 25 of the Bangladesh Flood Action Plan (FAP 25), Flood Modelling and Management consists of the following three components:

i) A Coordination Advisory Team (CAT)

ii) A Flood Hydrology Study (FHS)

iii) A Flood Management Model (FMM)

The project is executed by the Flood Plan Coordination Organization (FPCO), with the Danish Ministry of Foreign Affairs (Danida) as the lead donor. The donor agencies of France, the Netherlands and the United Kingdom also contribute to the project.

The CAT component has been ongoing since October 1990, while the FHS was completed in December 1992. The FMM, the last component, started in mid October 1992 and is expected to continue to mid October 1994.

The Team of Short Term Experts of the CAT held their first meeting in Bangladesh in October 1990, producing an Inception Report dated November 1990. The following visits of the team took place in May 1991, December 1991 and December 1992. During the fourth visit, it was decided that the fifth visit of the team should take place in October 1993.

2. OBJECTIVES

The overall objectives of the CAT, as stated in the detailed Terms of Reference of the FAP 25, are:

i) To achieve consistency, compatibility and continuity in all related modelling activities;

ii) To coordinate the supply of models as tools to the various FAP projects and the feedback of relevant data and information from

various FAP projects to the Surface Water Modelling Centre (SWMC)

The specific objectives of the Fifth CAT Mission are:

- review draft First Interim FMM Report under FAP 25 and advise on the proposed work programme for the remaining period of the project;

- review follow-up on recommendations of the Fourth CAT Mission report, notably on the key issues related to a proposed Expert Mission on River Morphology, the proposed Inter-regional Study, and harmonization of data formats, data bases and processing software;

- advice to FPCO on any necessary steps to be taken in the continued coordination of modelling activities under the FAP;

3. ACTIVITIES

In pursuance of the provisions of clause 4.1 of the Terms of Reference of FAP 25, the work of the team will include the following activities:

a) Liaise with FPCO, SWMC and the POE on the general progress and development of modelling activities within the FAP;

b) Attend a meeting of the FAP Modelling Coordination Committee (FAPMCC);

c) Review actions taken by FPCO, the Model Coordinator/Hydraulic Modelling Engineer, SWMC and the FAP components in the light of the report of the Fourth CAT Mission (draft from December 1992 and final report from April 1993);

d) Review recommendations made under FAP 24 and by BWDB Hydrology with respect to methods and systems for verification of new hydrological data;

e) Review of the updating of the Flood Hydrology Study;

f) Participate in November 6-9 Morphology Seminar under FAP 24 (some members);

g) Review actions taken in response to the recommendations of the Fourth CAT Mission, notably with respect to:

   * river morphology considering also the recommendations of the said seminar;

* the proposed Inter-regional Study, and

* harmonization of data formats, data bases and processing software;

h) Participate in November 13-14 FMM workshop under FAP 25 (some members);

i) Review the general progress of the FMM including the draft First Interim FMM Report and propose any necessary adjustments for the remaining part of the FMM;

j) Make recommendations on the institutional responsibility for maintenance, updating and operation of Flood Management Models considering possible developments and recommendations of FAP 26 - the Institutional Development Programme;

k) On the basis of the above findings, make recommendations for the future coordination activities of modelling activities in the FAP by the Hydraulic Modelling Engineer, the Model Coordinator, the SWMC and the CAT.

l) Report to FPCO.

4. COMPOSITION OF THE TEAM

The expatriate advisory Team of Short-Term Experts will be composed as follows:

- Dr. Rodney White (the United Kingdom)

- Mr. Johan Grijsen (the Netherlands)

- Dr. Jean Cunge (France)

- Dr. Torkil Jonch-Clausen, Team Leader (Denmark)

The Team will be supported by the Hydraulic Modelling Engineer, Mr. Emaduddin Ahmad and the Model Coordinator, Mr. Jorn Rasmussen of FAP 25 throughout their visit.

5. PROGRAMME OF THE VISIT

The team will work in Bangladesh in the period November 5-15, 1993 with the exception of Dr. Cunge whose schedule in Bangladesh will be November 2-9, 1993. The Model Coordinator will be present in Bangladesh in the period November 2-15, 1993.

Prior to leaving for Bangladesh, the Team will study available recent FAP reports of relevance for the CAT activities, notably the First Interim FMM Report if available. The Team will work closely with FPCO and hold discussions with the relevant government agencies, FAP consultants and donor agencies.

The Team will present its findings to FPCO, the POE and the local donor representatives before its departure from Bangladesh.

6. REPORTING

The Team will submit a draft report before November 25, 1993. The final report will be submitted to FPCO, with copies to the World Bank and the donor agencies of Denmark, France, the Netherlands and the U.K. before December 31, 1993.

Programme of the Fifth CAT Mission

Monday	1 Nov	1645	One CAT member arrives
Tuesday	2 Nov	1230	Model Coordinator arrives
		1500	Model Coordinator's review
Wednesday	3 Nov	0830	FPCO initial meeting
		1000	Danida
		1330	SWMC
Thursday	4 Nov	0900	FAP 6
		1400	FAP 25 - FMM Demonstration
Friday	5 Nov	1700	Two CAT members arrive
Saturday	6 Nov	0900	Morphology Seminar
Sunday	7 Nov	0730	Field trip (one CAT member)
		0830	FAP 25 - FMM Review
		1100	Danida
		1300	SWMC
Monday	8 Nov	0900	Morphology Seminar
Tuesday	9 Nov	0900	Morphology Seminar - concluding session
		2100	One CAT member leaves
Wednesday	10 Nov	0830	FPCO briefing
		1030	7th FAPMCC meeting
		1230	RRI
Thursday	11 Nov	0800	World Bank
		1300	FAP 5
		1400	Donor debriefing
Friday	12 Nov	0830	CAT Internal
		2100	One CAT member leaves
Saturday	13 Nov	0900	CAT Internal
		1300	SWMC
Sunday	14 Nov	0900	FAP 25 - FMM Workshop
Monday	15 Nov	0900	FPCO debriefing
		1400	Model Coordinator leaves
		2100	One CAT Member leaves

APPENDIX-3

List of Key Persons Consulted

FPCO
Mr. M.H. Siddiqi, Chief Engineer
Mr. Ashfaqui Azam, Superintending Engineer

Panel of Experts
Mr. Md. Nurul Huda, Chairman
Prof. Jahiruddin Chowdhury

RRI
Mr. Anwar Yusuf, Director General

SWMC
Mr. A.S.M. Abdul Khaleque, Superintending Engineer
Dr. Ranjit Galappatti, Team Leader
Mr. Terry van Kalken, Computational Hydraulic Engineer
Mr. Alessandro Lasarte, Computational Engineer
Mr. Jesper Kjelds, Morphologist

BWDB
Mr. A.B.M. Habibullah, Director - SWH-I
Mr. A.N.H. Akhtar Hussain, Executive Engineer - SWH-I

Royal Danish Embassy
Mr. K. Kjaer Nielsen, Chargé d'Affaires
Mr. P.E. Christensen, Counsellor

Caisse Francaise de Developpement (CFD)
Mr. A. van den Abele, First Secretary
Mr. Khawajah Ahmad,

British High Commission
Dr. Harry Potter, First Secretary, Natural Resources

Royal Netherland Embassy
Mr. Bert Diphoorn, First Secretary Development (Water Sector)

World Bank
Mr. Ross Wallace, Resident FAP Coordinator

FAP 5
Mr. Michael Pollitzer, Team Leader

FAP 6
Mr. Larry Bodnaruk, Modelling Specialist
Mr. Saifuddin Ahmed, Modeller

FAP 19
Mr. Timothy Martin, Team Leader

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FAP 25
Dr. Guna Paudyal, Team Leader
Mr. Bill Syme, Computational Hydraulic Engineer
Mr. David Milton, FCD Engineer (I)

Planned Activities

for

Sixth Mission of Short-term Experts on the Coordination Advisory Team (CAT)

1. BACKGROUND

Component 25 of the Bangladesh Flood Action Plan (FAP 25), Flood Modelling and Management consists of the following three components:

i) A Coordination Advisory Team (CAT)

ii) A Flood Hydrology Study (FHS)

iii) A Flood Management Model (FMM)

The project is executed by the Flood Plan Coordination Organisation (FPCO), with the Danish Ministry of Foreign Affairs (Danida) as the lead donor. The donor agencies of France, the Netherlands and the United Kingdom also contribute to the project.

The CAT component has been ongoing since October 1990, while the FHS was completed in December 1992. The FMM, the last component, started in mid October, 1992 and is expected to continue to mid October 1994.

The Team of Short-term Experts of the CAT held their first meeting in Bangladesh in October 1990, producing an Inception Report dated November 1990. The following visits of the team took place in May 1991, December 1991, December 1992 and November 1993. During the fifth visit, it was decided that the sixth visit of the team should take place in late October/ early November, 1994.

2. OBJECTIVES

The overall objectives of the CAT, as stated in the detailed Terms of Reference for FAP 25, are:

i) to achieve consistency, compatibility and continuity in all related modelling activities;

ii) to coordinate the supply of models as tools to the various FAP projects and the feedback of relevant data and information from various FAP projects to the Surface Water Modelling Centre (SWMC)

The specific objectives of the Sixth CAT Mission are:

- review of the final outcome of FAP 25 in general and the future of the FMM in particular;

- review follow-up on recommendations of the Fifth CAT Mission report;

- advice to FPCO on any necessary steps to be taken in the continued coordination of modelling activities under the FAP;

3. ACTIVITIES

In pursuance of the provisions of clause 4.1 of the Terms of Reference of FAP 25, the work of the team will include the following activities:

a) Liaise with FPCO, SWMC and the PoE on the general progress and development of modelling activities within the FAP;

b) Attend a meeting of the FAP Modelling Coordination Committee (FAPMCC);

c) Review actions taken by FPCO, the Model Coordinator/Hydraulic Modelling Engineer, SWMC and the FAP components in the light of the report of the Fifth CAT Mission;

d) Participate in Third FMM workshop under FAP 25;

e) Review the general outcome of the FMM development and make recommendations for possible further development and applications;

f) Prepare a summary of all previous CAT recommendations and follow-ups;

g) Review actions taken on the institutional responsibility for maintenance, updating and operation of Flood Management Models considering possible developments and recommendations of FAP 26 - the Institutional Development Programme;

h) Report to FPCO.

4. COMPOSITION OF THE TEAM

The expatriate advisory Team of Short-Term Experts will be composed as follows:

- Dr. Rodney White (the United Kingdom)
- Mr. Johan Grijsen (the Netherlands)
- Dr. Jean Cunge (France)
- Dr. Torkil Jønch-Clausen, Team Leader (Denmark)

The Team will be supported by the Hydraulic Modelling Engineer, Mr. Emaduddin Ahmad and the Model Coordinator, Mr. Jørn Rasmussen of FAP 25 throughout their visit.

5. PROGRAMME OF THE VISIT

The team will work in Bangladesh in a 10-day period tentatively scheduled for mid October 1994 (around the issue of the Final Report).

Prior to leaving for Bangladesh, the Team will study available recent FAP reports of relevance for the CAT activities, notably the Final FMM Report if available. The Team will work closely with FPCO and hold discussions with the relevant government agencies, FAP consultants and donor agencies.

The Team will present its findings to FPCO, the PoE and the local donor representatives before its departure from Bangladesh.

6. REPORTING

The Team will submit a draft report within two weeks after their departure. The final report will be submitted to FPCO, with copies to the World Bank and the donor agencies of Denmark, France, the Netherlands and the U.K. before December 31, 1994.