Term of Reference
for
selection of consultant for
"Consultancy services for Management Support to the Mathematical Modelling Centre (MMC) Under Water Resources Department, Government of Bihar"

1. BACKGROUND

Water Resources Department, Government of Bihar has established a Mathematical Modelling Centre (MMC) at Patna. The MMC has been created to provide high-quality services in the field of Hydrological Modelling, Computational Hydraulics, River Engineering & related sciences for improved integrated Water Resources Planning and Management in the State of Bihar.

Presently, the Mathematical Modelling Centre carry out flood forecast and other types of modelling work in different river basin of Bihar.

The MMC, under a regular capacity building program, develop a self-sustainable and intensive on the job training to be able to produce reliable outputs. However, it is the need of WRD, Bihar to have immediate usable outputs from this Centre. Thus, a Managing Consultant is required not only to manage the MMC and help in its operational and functional activities, but also to take over the responsibilities of the immediate modelling tasks assigned to the Centre by the Department.

2. OBJECTIVES

The overall objective of the proposed Consultancy Services is to run successfully & perform operational functions of MMC, Flood Management Improvement Support Centre (FMISC), Water Resources Department, Government of Bihar. The Consultant has to develop sustainable capacity in the MMC, WRD to independently carry out mathematical modelling for various facets of water resource development including flood and sediment management and erosion management of Ganga basin and rivers of Bihar like Kosi, Bagmati, Mahananda, Sone, Gandak etc.

The Managing Consultant will be required to manage the MMC and help in its operational and functional activities and will be fully responsible for the flood forecasting of the rivers of the Bihar and other modelling tasks (like erosion prediction, river morphological studies, sediment transport modelling and inundation prediction tools etc.) assigned by the department to the centre.

Immediate Objectives: -

I. Evaluate the existing flood forecasting models, and other operational models developed till current monsoon 2024 in this centre and making it operational in monsoon 2024.

II. Ensure timely delivery of high-quality outputs that meets client's satisfaction.

III. Effectively support the operation and maintenance of the established MMC in accordance with latest practices to keep the Centre's infrastructure in optimal working condition.

IV. Deploy the experts to support in initial setup of organization processes, create job roles and determine requisite qualifications and expertise for manpower. He will be responsible for determining the compliances that are to be met i.e. IT guidelines, audit compliances and to introduce sound management practices in keeping with the future plans for running of the MMC as Centre of Excellence (COE).

V. Identify the gaps in human resources capacity and provide training as per requirement to create human resource to run MMC efficiently.

Medium term objective:

I. Develop SOP protocols and a roadmap for the maintenance, operation, and upgrade of models. Propose suitable formats, content, and dissemination protocols for Flood Alert disseminations. It should be properly documented consisting of detailed protocol for maintenance of all types like preventive, perfective (accuracy), enhancements etc.

II. Update and calibrate the existing models at the centre with the latest available data, incorporating cross-section, topography, LiDAR, and other structural information. Subsequently, ensure validation of the models up to the most recent monsoon hydrology with proper documentation.

III. Expansion of the domain of existing models as per requirement of the Department incorporating latest technology such as AI/ML and other paradigm.

IV. Conduct hands-on training, hand holding, capacity building and training material for WRD officials, collaborating closely with modelling experts to develop internal trainers and essential training toolkits. This is aimed at preparing new modellers who will be assigned or recruited into the MMC.

V. Assist in the planning of new projects related to flood protection, anti-erosion, river interlinking, flood and sediment management, irrigation engineering, and similar initiatives under the purview of WRD, Bihar.

VI. Development of mathematical models other than existing model in centre as per requirement of Department.

3. SCOPE OF WORK

I. Provide an overview of global experience and current national approaches to flood forecasting, inundation mapping and early warning systems.

II. Evaluate existing flood forecast and inundation mapping in the river basin, and identify possible improvements to forecast parameters, accuracy and lead-time including statistical correlation, soft computing techniques like fuzzy logic, SVM, ANN, stochastic models, and conceptual hydrological/hydraulic models based on current and likely available topographic, hydrologic and hydraulic data in the basin. Identify possible suite of appropriate models for improvement in forecast with regard to output parameters, lead-time and accuracy. Advantages /disadvantages and strengths / weaknesses of each option shall be elaborated.

III. To review the existing flood forecasting models, and other models already developed and is in operation for last monsoon and other existing task-based models (1D, 2D, 1D-2D linked, river interlinking model etc.), and suggest further improvements.

IV. To work and assist the Water Resources Department, Government of Bihar with the following studies and activities:
- River Basin Management
- Flood Forecasting/ Flood Management
- River Erosion/ Sediment Management
- Water Resources Management/ Irrigation Management
- Investigating and determining solutions to particular problems that arise and assist the Department in designing river infrastructure and projects
- Policy formulation, strategies and action plans, based on the most advanced available knowledge, data and analysis
- Dissemination, explaining and discussions of knowledge at the levels of the public, the government and private sectors, NGOs, academic institutions and civil society
- Becoming (in the longer term) a self-sustaining institution by imparting on job training to the WRD officials and specialists.

V. Provide support for planning of new projects for flood protection works & anti-erosion, and river interlinking works, flood and sediment management and irrigation engineering under WRD, Bihar.

VI. Update and calibrate all existing models established at center with latest available data such as cross-section, topography, LiDAR, sediment data and other structural data, and then validate the model till latest monsoon hydrology.

VII.   Develop mathematical model for the Rivers other than existing models in center incorporating reservoirs and structures, including inundation mapping tool. And also conduct water balance studies for the same.

VIII.   Introduction of AI/ML as a cutting-edge technology for model creation and other applications, for existing models and upcoming developed models in MMC.

IX.   Catchment sediment Budget modelling: To understand the sediment generation phenomenon, sediment transport mechanism, morphological characteristics of the rivers, sediment deposition mechanism in respect of identified river, identify critical and other vulnerable locations in the catchment/ reaches in the river, suggest suitable catchment treatment/ river training works for restoration of critical locations/ reaches depending on site conditions.

X.   Formulating mitigation plan, though modelling options, for efficient channelization of flow and sediment load through desiltation, channel linking, structural interventional and natural adaptation etc.

XI.   Develop a tool for identification of Critical reaches for erosion and sedimentation with major causative physiographic parameters of the catchment and bed like erosion area, LULC and its change, soil type, erosion length of the river, flow velocity, change in riverbed gradient etc. along with identification of the most suitable sedimentation/ morphological modelling model under the Indian conditions of topography, geology, meteorology and data availability.

XII.   Adapt to the 1D and 2D modelling software required for hydrodynamic modelling, sediment transport, flood modelling, morphological analysis and modelling, erosion modelling and other facets of water resources development for the activities.

XIII.   Flood Risk Vulnerability assessment in Bihar for river basin depending on availability of required topographic data using MIKE FLOOD, HEC-RAS model or any latest tool/software.

XIV.   Create a precise flood mapping tool that identifies critical flood-prone areas, ensuring self-sufficiency for MMC officials and staff through technology transfer and in-house customization.

XV.   Ensure timely delivery of high-quality outputs to the satisfaction of the Client.

XVI.   Create a tool for accessing the optimal forecast among various forecast products produced worldwide by different agencies, tailored for use within this center.

XVII.   To create a unified interface enabling access to all information and data pertaining to MMC.

XVIII.   To run, operation and maintain the established MMC supported by latest practices, for keeping the infrastructure of the Centre in full working order throughout.

XIX.   Propose protocols and road map for model maintenance, operation and upgradation to expand the domain of existing flood forecast model as per requirement of Department.

XX.   Recommend appropriate format and content and dissemination protocols for the Flood Alert.

XXI.   Development and continues updation of web-enabled Windows application on server-client architecture. It shall integrate the knowledge base of hydrologic/hydraulic/topographic data, and after configuration should run automatically. Based on a dynamic front-end module, it shall be possible to modify model inputs, recalibrate and validate when improved data becomes available and disseminate model results.

XXII.   Training and capacity building within WRD officials under hand in hand direct work from modelling expert and developing internal trainers and necessary training tool kits (Manual/video tutorials/ presentation etc.) for training new modellers who would be posted/recruited in MMC.

The overall scope of work divided in four components: -

Component 1

Evaluate the global expertise in water resource management with emphasis on flood management and recent advancements in the sector to ascertain their suitability within the context of Bihar state.

Assess the existing tools available with Mathematical Modelling Centre (MMC) with respect to the global study and experience.

Implement the improvements in existing tools by way of changes in existing models or introduction of new tools & technology to achieve or surpass the global standards.

The outcome from this component should include

a) Report on evaluation of global expertise and management practices followed in the leading water resource management projects with respect to scope of adaptation for implementation within the state of Bihar.

b) Work plan for implementation of global best practices or any other suggestions for improvement of the existing tools. This will include assessment of existing models and tools present in the MMC and identification of shortfalls with respect to the nature or the availability of the tools.

c) Training and training toolkit.

Component 2

To assess the WRD's activities in water resource management, flood control, and river basin management, including their role in investigating and resolving specific issues, as well as aiding in the design of river infrastructure and projects.

These activities could entail,

- Creating mathematical models for rivers beyond those currently available.
- Enhancing the already existing models by integrating reservoirs and structures,
- Developing an inundation mapping tool, identification of critical reaches etc.

Additionally, they may involve conducting catchment sediment budget modelling and other related tasks.

Assist in crafting tools, policies, and strategies to enhance Water Resources Department (WRD) activities in water resource management, flood control, and river basin management. This involves identifying and addressing challenges, supporting river infrastructure design, and developing policies based on advanced insights. Additionally, facilitate knowledge dissemination across sectors and ensure sustainability through training programs for WRD officials and specialists.

Creation of unified interface enabling access to all information and data pertaining to MMC.

To run, operation and maintain the established MMC supported by latest practices, for keeping the infrastructure of the Centre in full working order throughout.

Training and training toolkit.

Component 3

Creation of Sound, Scientific and management framework for carrying out the day-to-day activities of FMISC/MMC and making it self-sustaining institution by creation and implementation of suitable potential within the organization.

Organize the existing or the newly developed systems and maintaining their performance at the highest level of accuracy by incorporating latest database, calibration or other strategies that might be required to do so. This is to ensure that the system provide actionable outputs for enhancing department reediness towards flood risk assessment, monitoring and mitigation during monsoon season or as required.

Making unified interface fully functional.

Component 4

Introduce automation to reduce the turnaround time for generation of knowledge products. Create a DSS framework for help in making suitable decisions and selection of most appropriate input from

the available inputs datasets to the model like meteorological products and dissemination of most appropriate outputs from several forecasting models to the stakeholders.

Preparation of CatLog for all the model developed/updated by consultant; data procured and collected and training toolkit.

4. Duration of Consultancy- 24 Month
5. DELIVERABLES

SL. NO.	DELIVERABLES
1.	Inception Report The report will contain the following: (i) An assessment of the available existing models at the MMC. (ii) Data Assessment Report – an examination and quality evaluation of the data utilized in the model, including acquired information and future action recommendations, (iii) A staff assessment report- An assessment of the staff at FMISC/MMC. (iv) An assessment of the immediate modelling needs of FMISC/WRD and accordingly time frame plan to be provide. (v) A work plan for Deployment of Expert. (vi) A work plan for in-house training of FMISC/MMC, WRD officials. (vii) A work plan for execution of activity mentioned in scope of work.
2.	Quarterly Progress reports (QPR): – Quarterly Progress report includes the: (i) Details of activity mentioned in work plan including the recommendations for improving performance with reference to the previous report. (ii) Progress and status of training of FMISC/MMC, WRD officials including training tool kit, methodology, manuals and log files. (iii) Progress and status of new projects assigned by water resources department.
3.	Interim Report includes: (i) Demonstration of the activities carried out in component 1,2,3 and 4. (ii) Overview of the work done in last 12 months including the status of upgradation of models. (iii) Recommendations including a management plan and institutional structure for the future MMC. (iv) Recommendations on future suggestive measures for betterment of MMC. (v) Report on enhancement of model performance fort the existing models and state of development of require models and tools as identified in work plan.
4.	Draft Final Report - This report will include: (i) This report will include the complete Reports of all assignments mentioned in the Scope of Work. (ii) The report will contain the, management framework for carrying out the day-to-day activities of MMC/FMISC and making it self-sustaining institution. (iii) Outcome of implementation of the recommendation made in Interim Report (iv) Reports of DSS framework for help in making suitable decisions. (v) Fully functional DSS software with necessary source code and licences, training, maintenance and operational manual. (vi) This report will also include QPR-8. Reports on performance of models, development of tools and policies.

5.	Final Report includes:
	(i) This report will include the complete Reports for all assignments mentioned in the Scope of Work.
	(ii) The report will contain the, management framework for carrying out the day-to-day activities of MMC/FMISC and making it self-sustaining institutions.
	(iii) Outcome of implementation of the recommendation made in Interim Report.
	(iv) Reports of DSS framework for help in making suitable decisions.
	(v) Fully functional DSS software with necessary source code and licences, training, maintenance and operational manual.
	(vi) Reports on performance of models, development of tools and policies.
	(vii) Compliance of any other recommendations and suggestions by SRC.

6. Chronology of Report Submission:

S.No	Submission timeline	Report
1	Within first 45 days from agreement	Inception Report
2	Within 15 days of the end of first quarter of the agreement.	QPR 1
3	Within 15 Days of the end of reporting quarter.	QPR 2 onwards
4	Within 15 days of completion of the first year.	Interim report (including QPR-4)
5	45 days before the completion of Consultancy.	Draft Final Report
6	15 days after approval of Draft Final Report.	Final Report

The reports shall be submitted three hard copies and a soft copy (Word & PDF) to the MMC. Five hard copies of the finally approved report by the Standing Review Committee shall also be submitted for record.

7. Approval Committees and The Review Procedure:
The Inception Report, Quarterly Progress reports, Interim Reports, Draft Final Report and Final Report will be reviewed, accepted and approved by the Standing Review Committee (SRC) constituted for this assignment by Water Resources Department, Government of Bihar within 15 days after their submission by the consultant. The Consultants will be required to incorporate the suggestions/Observations advised by the SRC for modification of the reports/ and other activities associated with MMC.

8. Payment Schedule:
Payments to the consultants will be based on the (08) Eight invoices each raised corresponding to **quarterly submission of reports, Interim report, Final report**. The time–based remuneration costs of consultant staff will be invoiced on the basis of the individual time sheets based on deployment of staff duly approved by the client and the reimbursement of expenditure and scheduled costs will be made on the submission of appropriate documents. The payment for the quarter will be released after approval of corresponding reports by SRC

 The consultant shall submit to the client itemized statements at time interval of every quarter.

9. Obligations of the Consultant

- The consultant shall follow the tasks and activities defined in the Terms of Reference and also adhere to the concept outline for the MMC.
- The consultant will undertake to deliver the outputs described in the scope of work - The assignments and schedules of deliverables resulting from the scope of work will be specified in the Inception Report.
- The consultant will undertake in collaboration with MMC, the preparation of the tasks to be included in the work plan following up on the completion of the immediate objectives.
- The consultant would also conduct extensive dialogues with stakeholders for preparing recommendations for the longer-term institutional plan for MMC – including its relationship with its parent body Water Resources Department.
- Consultant will ensure synchronization of the two viz. Mathematical Modeling Center and Physical Modelling Centre (PMC) for joint research and other projects.
- The consultant will ensure the successful run of flood forecasting models daily, generate and disseminate alerts and result based on the outputs of these models, on the FMISC/MMC systems during the monsoon period.
- The consultant will prepare performance evaluation of the model on daily basis for the whole monsoon period or as if required.
- The consultant will run/modify and run the models on scenario based like for inundation/travel time/discharge etc. of flood in the basin as per requirement of the department.
- The consultant will also ensure deployment of experts throughout monsoon period.
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10. CLIENT'S OBLIGATIONS

- The Client will only facilitate in collecting the data.
- The FMISC would participate in all committees that are set up for discussing and monitoring the progress and processes for the work programme of MMC.
- WRD/FMISC and the Management Consultant will jointly decide the course correction every quarter based upon process documentation and monitoring.

11. SUGGESTED KEY STAFF

The consultant will engage the key experts with minimum required qualifications and experience as detailed below. Consultant shall make his own assessment for the requirement of any additional key or non-key experts/staff, which he feels is required for the successful and satisfactory completion of the services. Consultant shall quote accordingly payment schedule.

SUGGESTED KEY STAFF

S. No.	POSITION	QUALIFICATIONS AND EXPERIENCE	Suggested Person months	ROLES AND RESPONSIBILITIES
1.	Team Leader cum Hydraulic Modeller	• Doctoral degree in hydrology or related subject/topic with Master's degree in Hydrology/Water Resources/Hydraulic Modelling • Overall, 15 years' experience in Water Resources with at least 10 years' experience in river flood modelling, sediment transport and water quality, Flood control and river training works	24	He/she will be responsible for setting up (as well as accepting transfers of existing models) and quality control of all hydrological and hydrodynamic models; Training and Advising Modellers and at all levels; Managing the entire team of consultants and ensuring timely outputs - communicating with the Head of MMC/ FMISC.

S. No.	POSITION	QUALIFICATIONS AND EXPERIENCE	Suggested Person months	ROLES AND RESPONSIBILITIES
		• Desirable experience in Technology Transfer and institutional reform		
2.	River Morphologist cum Flood modeller	• At least a Master's degree in Hydrology/Water Resources/Hydraulic Modelling • 10 years' experience in hydraulics of heavily sediment laden rivers, and erosion control • 10 years' experience with computational hydraulics including 2-D river modelling and morphology	12	He/she will be responsible for setting up (as well as accepting transfers of existing models) and quality control of all sediment transport models - as well as schematising the related hydrodynamic models; Training and Advising Modellers at all levels; Supervising sediment sampling and analysis. In the absence of the Team Leader managing the entire team of consultants and communicating with the Head of MMC, Head of FMISC
3.	Hydrologist/ Flood Modeller	• At least Master's degree in Hydrology/ Hydraulic / Water Resources engineering • Total 10 years' experience • 5 years working experience in hydrologic analysis and models • 5 years' Experience in designing hydrologic network and HIS • Desirable: experience in application Software Development / design in Water resources sector.	12	He/she shall assist Team Leader in review of all the survey and other data. He/she shall assist Team leader in finding the gaps of available data and support in collection of missing data required for Model development etc. He/she shall assist Team Leader in technical studies of the expected outputs of assignment
4.	DSS Expert/ Software Engineer/ IT Expert	• Master's degree in engineering/technology or Computer Sciences/Information technology/Software Development • professional qualifications in software engineering • Experience in development of DSS systems for applied water resources / hydrology / hydrologic science	24	He/she will be responsible for setting up Decision Support Systems, Data Acquisition Systems, and links with other databases and asset management systems; Writing the necessary software and liaising with the modelling expert's teams on getting the correct conditioning of model results suitable for DSS applications and real time DSS.
5.	Institutional & Management Expert	• At least a Master's Degree in Water Resources and Research Management • Expertise in Institutional Development and Analysis • 5 years of relevant experience	6	His/her main responsibility will be to assist and analyse management strategies and other operation techniques for the MMC. At the end of Phase I he/she will be responsible for creating a report of recommendations for the next Phase.
6.	Mid-level flood forecasting/ Warning Dissemination Expert	• At least a Master's degree in Water Resources or related fields with minimum 5 years professional experience in river flood modelling/ flood forecasting/ Water Resources/Hydraulic Modelling.	24	His/her main responsibility will be to assist the flood modeller and River morphologist to analyse the hydrological modelling, and other modelling related tasks assigned by team leader and other operation for the MMC.
7.	Remote Sensing/ GIS Expert	• At least a Bachler's Degree in geology,	24	Perform GIS database development, qualitative/quantitative analysis, mapping, collect and handle data, provide mapping services, perform

S. No.	POSITION	QUALIFICATIONS AND EXPERIENCE	Suggested Person months	ROLES AND RESPONSIBILITIES
		geoinformatics, Geographic Information Systems, or remote sensing. • At least 5 years' experience in GIS and proficiency in GIS softwares.		technical research and analysis. Others tasks decided by the team leader and as per requirement for operation of MMC.
8.	a). Junior Hydrological Modeller	• At least a Master's degree in Water Resources or related fields with minimum 5 years professional experience. • Specialist experience in one of several fields of work dealt with at MMC, including River engineering design, information technology, image data processing, database management etc.	24	His/her main responsibility will be to assist the flood modeller and River morphologist to analyse the hydrological, image data processing, database management and other operation for the MMC.
9.	b) Junior Hydraulic Modeller	• At least a Master's degree in Water Resources or related fields with minimum 5 years professional experience. • Specialist experience in one of several fields of work dealt with at MMC, including River engineering design, information technology, image data processing, database management etc.	24	His/her main responsibility will be to assist the flood modeller and River morphologist to analyse the hydrological, image data processing, database management and other operation for the MMC.