Government of West Bengal
Irrigation & Waterways Department

NATIONAL COMPETITIVE BIDDING

Request for Expression of Interest (REOI) for Consultancy Services

For

ESTABLISHMENT OF INFLOW FORECAST, FLOOD FORECAST AND WARNING SYSTEM IN WEST BENGAL FOR KANGSABATI-KELIAGHAI-SHILABATI AND DWARAKESWAR SUB BASINS

Under

National Hydrology Project

March 2020

Executive Engineer
Burdwan Investigation & Planning Division
Irrigation & Waterways Directorate

Request for Expression of Interest
Consultancy services for

Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins

Memo No: 113/NHP-02/02 **Date: 26.03.2020**

EOI No: WBIW/NHP/NIQ-07 of 2019-20
Ref No: NHP-2019-2020-WBSW-731524

1. This Invitation For Bid follows the General Procurement Notice for this Project that appeared in Development Business on 9th March, 2017

2. The Government of India has received financing from the World Bank toward the cost of the National Hydrology Project, and intends to apply part of the proceeds for this consulting service.

3. Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India is implementing the National Hydrology Project (NHP) in almost entire India with the active technical and financial support of World Bank. Irrigation & Waterways Department, Government of West Bengal is the Implementing Agency responsible for development of Surface Water components in the state. The State Project Management Unit (SPMU) of I&W Department implementing the NHP project as Implementing Agency – Bengal(SW) is the agency requiring the Consultancy services for ***Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins.***

4. The consultancy services for Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins under National Hydrology Project broadly consist of the following:

   i. Develop, calibrate and operate comprehensive model/ suite of models for real time flood forecasting (level/ inflow/inundation/ peak water velocity/ time of peak flow maps) using hydro-meteorological data, meteorological forecast and other data with desired accuracy. This would include rainfall runoff modeling as well as 2D/ coupled 1D-2D hydrodynamic modeling. Integrate cross sections with DEM to improve model efficiency. To start with, the DEM would be free domain DEM as chosen by the consultant in consultation with the Department. Within 04 years the model may have to be upgraded by incorporating finer resolution DEM (DEM with 10 m / 1 m resolution prepared using ortho images or 0.5 m LiDAR DEM) for selected areas. While the DEM will be made available to the agency for free from the Department.

   ii. Integrate all processes for data management, forecast models and dissemination methodology etc., in a single system to run models and generate forecast in fully automatic mode for short term period (3 days or more) with desired accuracy.

iii. Create Inundation map library for various return periods of rainfall events/ flood events including different scenarios of embankment breach at identified vulnerable locations.

iv. Develop web based Integrated Flood Warning System with GIS tools for dissemination of forecast, inundation map, to the departmental officers through secured departmental website with flexibility to disseminate such information to other stakeholders as per decision of the department.

v. To develop a GUI-based dashboard for customizing model runs for the rainfall runoff and hydrodynamic models, viewing and analysis of model results.

vi. To develop web based and mobile based system for disseminating flood warnings, based on the envisaged extent of flooding

vii. Provide support for flood prediction and warning for a specified period after acceptance of the model.

viii. Training and Capacity Building

ix. The duration of the consultancy period will be for a period of 5.5 years with 1.5 years for development and acceptance of the system and 4 years for maintenance and support after acceptance.

x. ***A brief Draft Terms of Reference (ToR) is attached.***

5. The attention of interested Consultants is drawn to paragraph 1.9 of the World Bank's Guidelines: Selection and Employment of Consultants under IBRD Loans and IDA Credits& Grants by World Bank Borrowers dated January 2011 ("Consultant Guidelines") revised Jul 2014, setting forth the World Bank's policy on conflict of interest.

6. The Executive Engineer Burdwan Investigation & Planning Division I&W Department Govt. of West Bengal now invites eligible consultants to indicate their interest in providing the above required consultancy. Interested consultants must provide information indicating that they are qualified to perform the services (brochures, description of similar assignments, experience in similar conditions, availability of appropriate skills among staff, etc.)

7. Consultants may associate with other firms/ consultants to meet the necessary qualification criteria or enhance their capability. The EOI submitted by consultants in association should clearly indicate the nature of the association if it is a joint venture or a sub-consultancy. In case of Joint venture, the name of the lead firm should be clearly stated and the JV should not have more than three members including the lead.

8. **A consultant will be selected in accordance with the QCBS (Quality and Cost Based Selection)** procedures set out in the World Bank's "Guidelines: Selection and Employment of Consultants Under IBRD Loans and IDA Credits & Grants by World Bank Borrowers- Jan 2011, modified July 2014". The Guidelines are available at www.worldbank.org/procure

9. **The criteria for short listing of the Consulting firms shall be as follows:**

1. The firm should have been in consulting business in water resource / flood management sector for at least 5 years having experience of substantially completed (at least 70% complete) of one similar assignment (inflow forecast &/or flood forecast) in India/abroad of value 200 lakhs or two similar assignments each of value 125 lakhs or three similar assignments each of value 75 lakhs in the last five years.
   (The consultant should provide a brief description of the organization including ownership details date and place of incorporation of the firm, objective of the firm, and details of relevant/ similar assignments executed with customer name & address, contact details, order value and performance certificates)

   Total point under this criterion is **30 (Thirty),** the firm with experience of completion of maximum no of projects will get full marks, while marks of other firms will be assigned on pro-rata basis.

2. The firm shall be financially sound with an average annual turnover of more than INR 200.00 Lakhs during any two years in the last five years i.e. 2014-15, 2015-16, 2016-17, 2017-18 and 2018-19.

   Total point under this criterion is **15 (Fifteen),** and the firm with highest turnover will get full marks, while marks of other firms will be assigned on pro-rata basis.

3. The firm should have prior experience in development of different modeling assignments.

   Total point for this criterion is **30 (Thirty)**.

   The number of points to be assigned to the firm shall be determined considering the following sub criteria and relevant percentage weights

   (The consultant should provide details of relevant modeling work assignments executed with customer name & address, contact details, order value and performance certificates)

   a) Development of hydrology model for runoff computation (33.3%)
   b) Development of hydraulic model of rivers / canals (33.3%)
   c) Development of terrain model for flood inundation mapping (33.3%)

4. Availability of adequate key professionals having relevant advanced academic degree and experience in
   a) Team leader- Hydrology, Hydraulic and / or Water Resources engineering person with more than 18 yrs experience
   b) Hydrology/Hydraulic modeler with more than 10 yrs experience

   Total points for this criterion is **25 (Twenty five).**

   The number of points to be assigned to the firm shall be determined considering the following sub criteria and relevant percentage weights

   a. For Team Leader - (60%) – Firm having TL with maximum years of experience shall be given max marks, while marks of other firms will be assigned on pro-rata basis.

b) For Hydrology/Hydraulic modeler - (40%) - Firm having modeler with maximum years of experience shall be given max marks, while marks of other firms will be assigned on pro-rata basis

Total points for the four criteria : 100

The minimum score required to pass is*: 70*

10. Interested Consultants may obtain further information at the address given below from 10.00 – 17.00 hours (IST) on all working days.

Superintending Engineer, Investigation and Planning Circle II
Irrigation & Waterways Directorate, Govt of West Bengal
Jalasampad Bhavan, 5th Floor, Salt lake, Kolkata 91,
West Bengal, India
E mail: bengalsw@gmail.com

11. Expression of Interest with all relevant information and documents can be downloaded from https://wbtenders.gov.in / wbiwd.gov.in for "Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins" under National Hydrology Project from 27.03.2020 10.00 hrs. to 12.05.2020 15:00 hrs Server time. The last date/time of submission/uploading of REOI at https://wbtenders.gov.in is 12.05.2020 15.00 hrs Server time The Expression of Interests received till the appointed time and date shall be **opened on same day at 15.30 hrs**. Server time. In the event, this last date being declared as holiday by the Government, above EOI will be opened on the next working day at the same time.

12. **Pre-bid Meeting:** A pre-bid meeting will be held on 28.04.2020 at 12:00 hrs (IST) at the Office of the Superintending Engineer, Investigation and Planning Circle II, Irrigation & Waterways Directorate, Govt of West Bengal, Jalasampad Bhavan 5th Floor, Salt lake, Kolkata 91, West Bengal, India, to clarify the issues and to answer questions on any matter that may be raised at that stage**:**

13. The electronic bidding system will not allow any late submission of the REOIs after due date and time as per server time. Physical, Email, Telex, cable or facsimile submission of REOIs will be rejected as non-responsive. Intending Bidders are advised to visit website https://wbtenders.gov.in / wbiwd.gov.in prior to closing date of submission of REOI for any corrigendum / amendment

Executive Engineer
Burdwan Investigation & Planning Division
Irrigation & Waterways Directorate
Purta Bhawan, 3rd Floor
Purba Burdwan-713103, West Bengal
E mail: bengalsw@gmail.com / eebipd2012@gmail.com

Important Note: No proposals (technical or financial) are required now, On the basis of information provided by the interested consulting firms, the authority will prepare a shortlist of firms who will be provided with the RFP documents for submission of detailed offer.

Terms of Reference

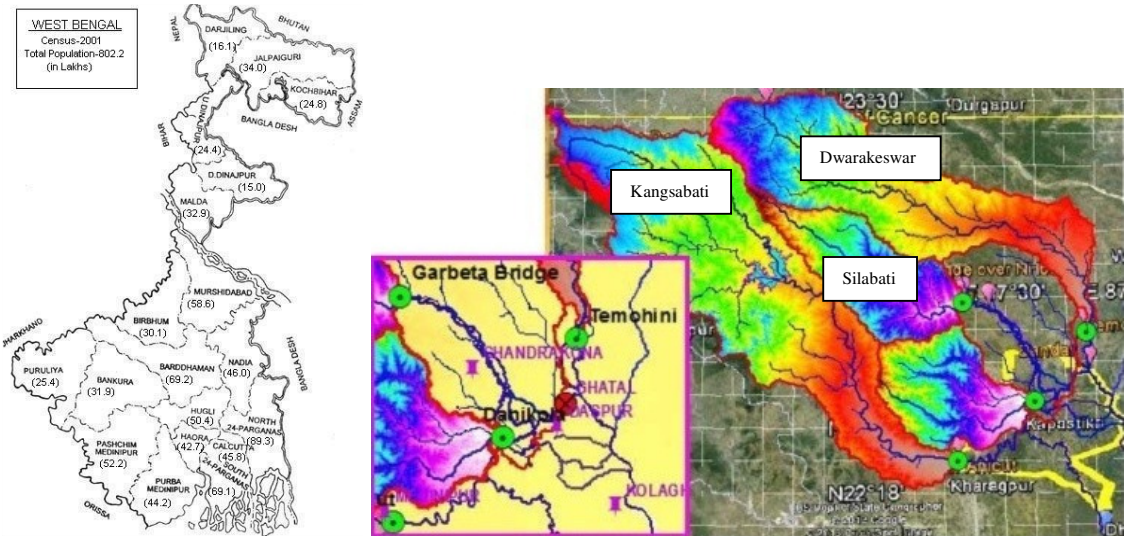
For

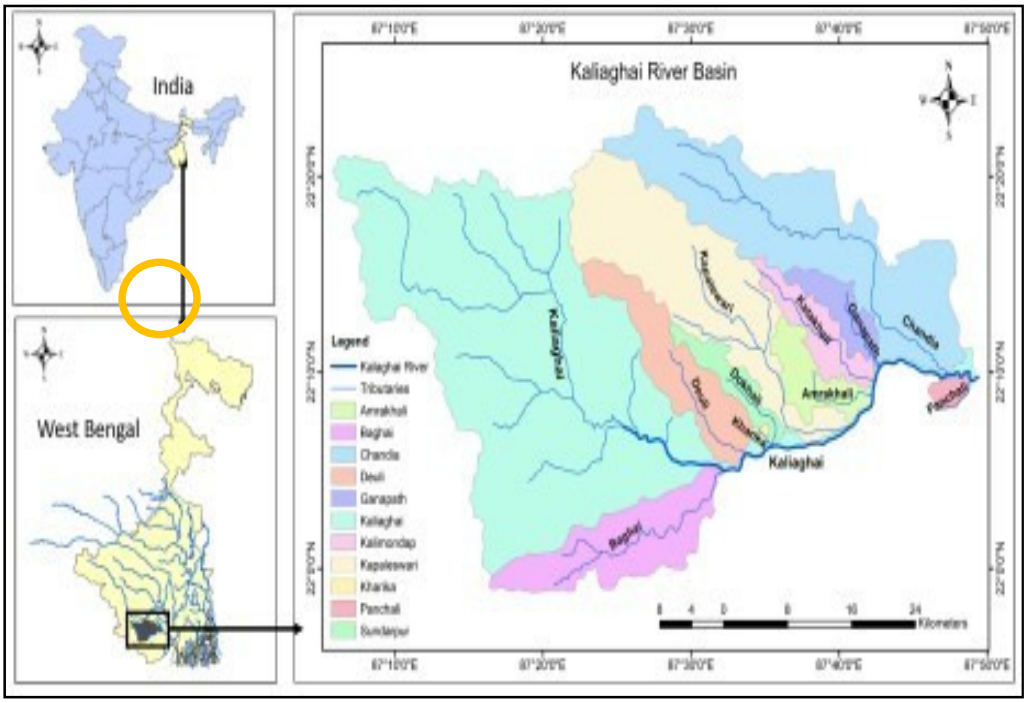
Establishment of inflow forecast, flood forecast and warning system in West Bengal for Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins.

INDEX

1. BACKGROUND

The state of West Bengal is one of the most flood prone states of India. More than 42 percent of its geographical area is identified as flood prone. Of the different regions of West Bengal which are flood prone, the district of Paschim and Purba Medinipur are one of the most vulnerable. Figure below shows the location of the state and the Kangsabati, Keliaghai, Silabati and Dwarekeswar basins and its overall location in respect of West Bengal.





Location of Kansabati, Silabati, Keliaghai and Dwarakeswar river basins

Rivers Kangsabati, Kaliaghai, Shilabati and Dwarakeswar regularly inundate large tracts of low-lying hinterland of southern West Bengal, causing immense damage to the natural and the built environment. The floodplains of these rivers, being extremely fertile, bear rich harvest of crops - often thrice a year. Being very fertile it is home to a large human population living in historically old villages and towns. However, untimely rain especially during the convectively active period in the monsoon season result in inundation of the agricultural fields adjoining the rivers, catch the farmers unaware - resulting in great loss of standing crops. Such recurring floods in the region have affected the economy of the area, lives of the inhabitants and also the development of the infrastructure. Therefore, need for effective steps to forecast and take suitable measures for better flood management has been felt.

It may be noted that the region drains the waters of the following important river systems: (a) Kangsabati (or Cossye); (b) Silabati (or Silai) (c) Dwarakeswar and d) Keliaghai. Within the region, the rivers, in turn, break up into further river sub-systems. For example:

Kangsabati, that is Cossye, divides into Old and New Cossye
Silabati divides into another channel named Ketia
Dwarakeswar divides into another channel named Jhumi
Old Cossye further divides into Durbachati and Palaspai
Ketia further divides into another channel named Katan

All the rivers finally drain into the Rupnarayan or the Hooghly which are under the influence of tide.

2. OBJECTIVES OF CONSULTANCY

The broad objective of this consultancy is:

a) To develop, calibrate and operate comprehensive model/suite of models for real time flood forecasting (level / inflow / inundation maps) of the Kangsabati-Keliaghai-Shilabati and Dwarakeswar sub basins to support effective flood management.

b) To create Inundation map library for various return periods of rainfall events/ flood events including different scenarios of embankment breach at identified vulnerable locations.

c) To develop a flood warning system based on the flood forecast utilizing the available hydrological, meteorological, and other data, which can at later stage be further refined to improve the Flood Forecast.

d) To integrate all processes for data management, forecast models and dissemination methodology etc., in a single system in GIS environment to run models and generate forecast in fully automatic mode for short term period (3 days or more) with desired accuracy.

e) To develop a dashboard for customizing model runs for the rainfall runoff and hydrodynamic models, viewing and analysis of model results.

f) To develop web based and mobile based system for disseminating flood warnings, based on the envisaged extent of flooding

g) Training and Capacity building.

3. SCOPE OF CONSULTANCY SERVICES

The following basins/sub basins are to be taken up for the development of the hydrologic - hydrodynamic models for Real Time Flood Forecasting coupled with available weather forecast from IMD / IITM or any other reliable sources.

Sl no	Name of River Basin	Catchment Area in sq Km	Length of river system in Km	Width of river (Av) in Mtr	Tributaries
1	Kangsabati	6528	525	500	Bhairabbaki, Tarafeni
2	Silabati	4086	350	100	Kubai, Tamal, Parang, Donai, Buri Ganga
3	Dwarakeswar	4252	320	250	Gandheswari
4	Keliaghai – Kapaleswari - Baghai	1875	275	75	Kapaleswari, Baghai, Deuli, Chandia
5	Rasulpur	1554	275	75	Kalaberia, Sadar.Itaberia, Deriadighi, Orissa Coast Canal
6	Pichabani	807	120	65	Negua, Contai nullah, Orissa Coast Canal

Note: Data given above may vary upto ± 15% during actual survey.
The brief description of these basins is as follows:

Kangsabati: The River Kangsabati originates from the Purulia District. After its confluence with river Kumari a dam has been constructed with a flood absorption capacity of 180.43 MCM. Two major tributaries the Tarafeni and Bhairabbanki meet the river at 12.8 km downstream of the dam. The river finally branches out into two different channels old Kasai and New Kasai. The New Kasai finally meets river Keliaghai to form river Haldi and finally outfalls into river Hooghly. The old Kasai further breaks to form the Kankikhal. The Kanki Khal finally drains into river Silabati. The Old Kasai further breaks into two channels called Palaspai and Durbachati to finally fall into river Rupnarayan.

Silabati: The River Silabati originating from the high land in Purulia District traverses through the districts of Bankura and West Midnapur and finally combines with the

Dwarakeswar river to form the River Rupnarayan. Main tributaries of the river being Buri Ganga Kubai Tamal and Donai. The river after meeting river Kanki a spill channel of river Kansabati finally meets Dwarakeswar.

Dwarakeswar: Originating from the upland in Purulia District and travelling through the districts of Bankura and Paschim Midnapur the river Dwarakeswar meet river Silabati to form the river Rupnarayan. The river has a major left bank tributary called Gandheswari falling into the Dwarakeswar just after Bankura town.

Keliaghai: The river system comprises of twelve major tributaries outfalling into the Kaliaghai river. Centrally aligned Kaliaghai river has one right-bank tributary (Baghai) whereas all other tributaries viz river Deuli, Kapaleswari, Kharika-khal, Sundarpurkhal, Aamrakhalikhal, Kalimandapkhal, Ganpat khal, Chandia join the river in its left bank from north-western high-land. The river Kaliaghai joins the river new Cossye at Dhewbhanga to form river Haldi which finally drain into the river Hooghly.

Other than the above rivers two small rivers viz **Rosulpur and Pichabani** flow through the southern area of the basin and outfall into the Hooghly.

The Scope of the Consultancy is broadly divided in two phases as follows:

Phase - I

a) To develop, calibrate and operate a comprehensive model / suite of models involving meteorological-Hydrological-Hydraulic models for real time flood forecasting (rainfall/runoff/Inflow/inundation maps) using hydro-meteorological data, meteorological forecast and other data with desired accuracy.

b) To develop a decision support system (DSS) for the operation of structures in order to help the department in risk-informed decision making, by way of predicting losses, gains and risks in case of alternative scenarios corresponding to different possible management decisions. It would help minimization of flood losses in the basin through exercise of controlled release from the dams, averting synchronization of runoff from uncontrolled catchment with upstream releases, while safeguarding the safety of the dam and future water uses in an optimal way.

c) To create Inundation maps for various rainfall/flood events including different scenarios of embankment breach at identified vulnerable locations.

d) To integrate all processes for data management, forecast models and dissemination methodology etc., in a single system in GIS environment to run models and generate forecast in fully automatic mode for short term period (3 days or more) with desired accuracy.

e) To develop a dashboard for customized model runs and analysis of results.

f) To develop web based Integrated Flood Warning System with GIS tool for dissemination of forecast, inundation map, to the departmental officers through secured departmental website with flexibility to disseminate such information to other stakeholders as per decision of the department.

g) To develop mobile based flood warning system that issues warnings to specified persons and public in general based on pre-defined flood magnitude classes.

Phase - II

Maintenance, updating and running of the model in real time during operational support period of 4 years.

NOTE: The consultant shall undertake the work/service in consultation with modeling unit of SPMU, NHP headed by Director, Advance Planning Project Evaluation & Monitoring Cell, I&W Directorate.

3.1. Key tasks in Phase - I

3.1.1. Review of Data availability

i) Identification of required data (hydro-meteorological, topographical, and other data required for modeling) for setting up of model, calibration, and validation.

ii) Review of available data and information with respect to minimum and optimum requirement for model development.

iii) Requirement of additional data, if any may also be recommended by the consultant for better performance of the model.

3.1.2. Identification of suitable software and hardware

i) The main frame of the modeling and flood forecasting system should preferably be based on license free or public domain suite of software. The consultant should identify other required software like GIS, remote sensing, database management, web hosting and data dissemination, data visualization. This ancillary software should be compatible with the proposed system or other modeling software as the case may be, and should preferably be license free / public domain software.

ii) The consultant should identify compatible hardware for real time flood forecasting, generation of inundation map, system for data assimilation (automated coupling of input data (HO, MET (station and gridded data in form of QPF and other various state of the art satellite/radar/ any other new technology products) and topography) and output dissemination (Including all necessary, software, hardware and web system) in real time.

iii) Procurement of all required hardware and software in consultation with client, if required, by the consultant during project period and to be handed over to the client after completion of the consultancy.

3.1.3. Data Collection and Validation

i) Collection of required data as and when required from various offices of the Irrigation Department Government of West Bengal or other agencies with prior intimation to the purchaser.

ii) Collection of details of structures across the river reaches that influence their hydraulic behaviour.

iii) Integration of cross sections with DEM to improve model efficiency. To start with, the DEM would be free domain DEM as chosen by the consultant in consultation with the Department. At later stage the model may have to be upgraded by incorporating finer resolution DEM (DEM with 10 m / 1 m resolution prepared using ortho images or 0.5 m LiDAR DEM) for selected areas. These would mainly include low lying areas suffering from recurring flooding problems. While the DEM will be made available to the agency for free. The tentative areas to be covered by such high resolution DEMs would be

(i) 2,892 km² by LiDAR DEM with a resolution of about 1 m.

(ii) 37,596 km² by DEM derived using satellite imageries as shown in the fig prepared by MoWR.

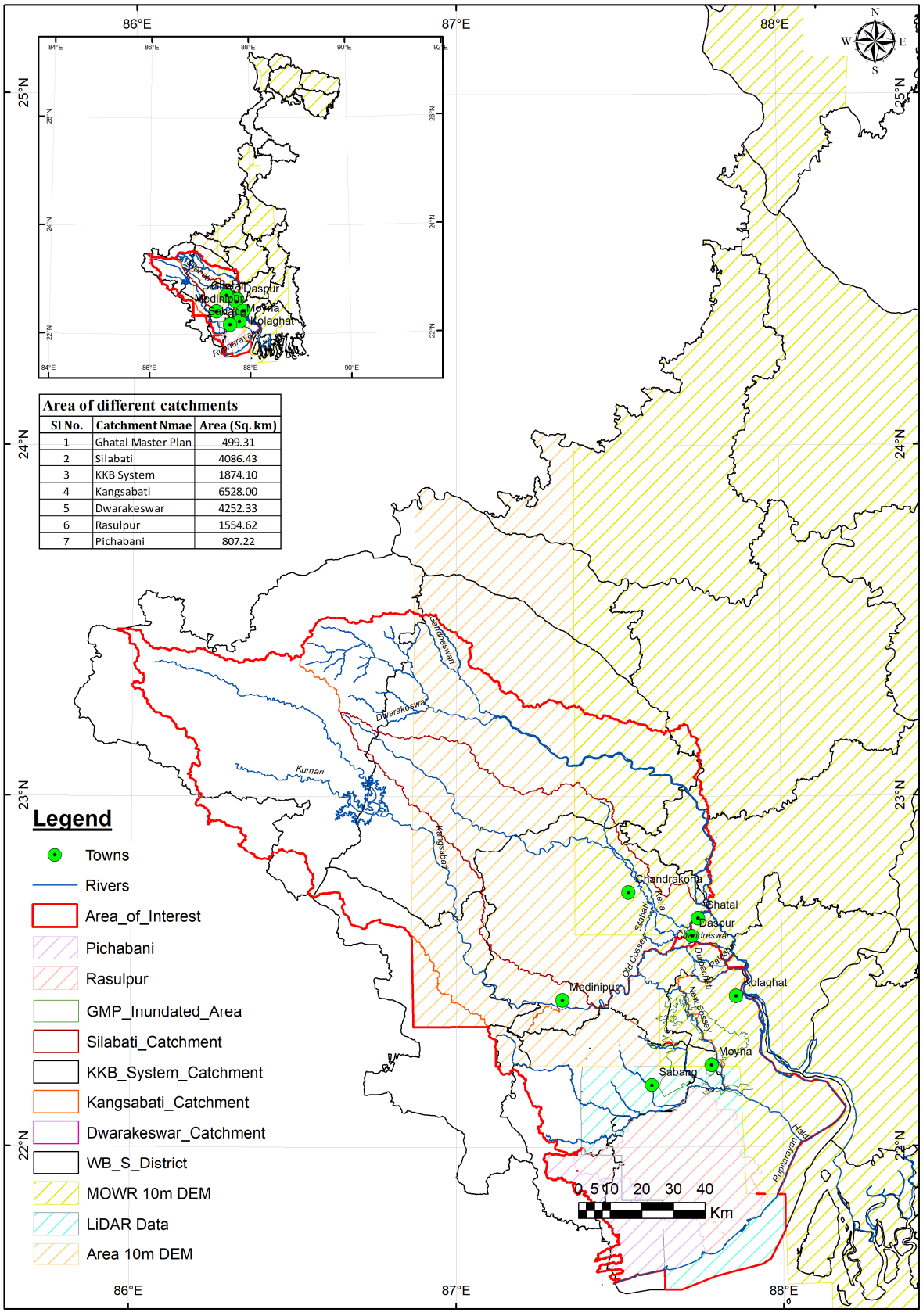
(iii) 10,066 km² by DEM with a resolution of about 3-5 m.

These are for assessment of required capacity of hardware/ software. However, the exact area to be covered by these DEMs and the date on which it would be made available to the agency will depend on receipt of the same by the Department, which is beyond the control of the Department, and may therefore, vary. A figure showing the coverage of the DEMs is shown below for reference.

iv) Collection of land use / land cover (LULC) data / map / imagery of suitable resolution available free in public domain.

v) Validation of input data for consistency.

vi) Correction and gap filling of data based on consistency check.



Area to be covered by DEMs with different resolutions

3.1.4 Development of forecast models

i) Delineation of sub-basins, river networks and extraction of basin/catchment parameters.

ii) Develop Hydrologic models for estimation of discharge and 2-D Hydrodynamic models for assessment of flooding extent and impact. A GUI – based dashboard should be developed to allow hassle-free running of the models without expert intervention. It should be able to read stored data and collect data through internet from specified websites, carry out hydrologic modeling, apply corrections, carry out hydro-dynamic modeling and present results in user-friendly manner in the form of maps, graphs and tables.

iii) The hydrologic model should also be capable of estimating runoff from rainfall data acquired through RTDAS system installed by the department. It should be calibrated to match with the observed gauge/discharge data and reservoir release.

iv) The proposed system should be able to dynamically generate real time forecast of river discharges and water levels at key locations at different times based on the available Quantitative Precipitation Forecast (QPF) of IMD/other agencies for 3 days or more where QPF is available for longer duration. This should consider the releases from the Kangsabati Reservoir Project, the only major dam in the area. The computations should be based on the latest available area-elevation-capacity curve for the reservoir [last bathymetric survey was carried out in 2012] and the existing operating policy rules governing the reservoir releases.

v) Perform bias correction of using satellite based rainfall data products/forecasted rainfall, using long term historical data. For this purpose, consultant should obtain point rainfall data from ground measurements by the department and satellite rainfall / forecast of same period and perform bias correction for at least 4 recent years.

vi) Model is to be calibrated for minimum 4 recent years including all major peaks to the accuracy satisfactory to the department. Inundation model is to be prepared using DEM and the cross sections as mentioned earlier. The validation of inundation depth is to be done through ground survey.

vii) Model calibration up to desired accuracy. (Level forecast ± 0.05m, inflow forecast ± 10% of flood volume) at 20 gauge stations (to be specified by the Department at a later stage), with a lead time of 12 hours or more. For extent of flooding, the inundation forecast maps should be accurate to± 5% of the

observed inundation extent. The arrival time of flood peak should be accurate to half an hour or less. The spatial distribution of peak flood velocity should also be forecast for planning evacuation.

viii) A prime focus of the modeling exercise is to ensure zero death due to flooding in the region considered, and minimize damage to properties to the extent feasible through the issue of forecast. Therefore, a critical element in the contract is to establish thresholds of flood depth for each flood prone locality that would call for activation of evacuation plan, and issue forecast well in advance to ensure its implementation in a proper way. The forecast of extent and severity of flooding within a tolerable limit of acceptance is of crucial importance as the errors on either side are undesirable. While under prediction may lead to death and extensive damage that is totally unacceptable, over prediction beyond certain margins would speak against the credibility and make grounds for non-compliance to future flood warnings.

ix) Generate real time flood inundation maps showing extent, depth, arrival time, duration and peak velocity. Inundation extent with depths should be validated with high resolution DEM later and periodic updating of model is to be done.

x) Prepare Flood inundation map library corresponding to different return period of rainfall (2, 5, 10, 25, 50, 75, 100, 200 and 500 Years).

xi) Run the models for the river basin using precipitation estimates generated, observed input data and update the model at every 3 hours.

xii) Model should be capable of updating the state parameters using observed data and capable of generating short term / medium term ensemble forecast (using forecast products from different agencies) and Probabilistic forecast for longer lead times.

xiii) Based on the pre-defined thresholds of flood category in terms of flood depth and extent, automatic generation of alerts to concerned Executive Engineer/ Chief Engineer/ Secretary of the I&WD/ Block/ District Administration/ Police /State Disaster Management Authority / National Disaster Management Authority/ any other concerned Department as may be identified by the Department/ residents of the area through mobile as WhatsApp and SMS messages is a requirement. The critical thresholds are to be jointly decided in consultation with the Department.

xiv) Model is to be vetted by a premier institute of India like NIH / IIT / IISc etc. (Expenditure to be incurred for this purpose will be borne by the consultant)

3.1.5 Input data assimilation and processing precipitation / level / inundation estimates

i) Consultant will develop work flow for each process to automate collection, validation and management of observed input data (H.O data, releases from control structures, Rainfall (satellite/radar/ rain gage values (including AWS/ARG) /any other new products [in optimum combination]) flow to model.

ii) Automate real-time acquisition of QPF from IMD/RTDAS to be updated at 3 hour interval (or at specified interval, as decided by the Department).

iii) The whole process of acquiring input data (from various sources like websites, ftp folders etc); processing the data in required format, gap filling and quality check, providing the data as inputs to models, generation of outputs in form of GIS vector layers, raster, maps and tables, updating of outputs on website and databases etc. should be automated and should not require any human intervention at any of the mentioned stages.

3.1.6 Development of Integrated Flood Warning System

i) Develop Integrated Flood Warning System with Graphical User Interface (GUI) for real time dissemination of model output in the form of levels, discharge, inundation extent, depth, arrival time and duration etc.

ii) System should be capable of map and graphical displays, and alerts, for providing:

a. Access to both predicted and present water level/discharge at monitoring station notified location.

b. Access to forecasted inundation maps with Inundation extent and inundation depth and peak velocity of water flow.

c. System should have capability for generating results (quarry based) for level, discharge, inundation extent, inundation depth, inundation duration, peak velocity of water flow, population/area affected upto village level due to flooding.

d. System should have capability of generating flood forecast report, flood bulletins, text messages, animations, flood summary report, report in reply to user defined queries etc.

e. Development of interface for real-time display of results of flood warning system on departmental website as well as mobile alerts based on envisaged criticality of the event.

3.1.7 Key Deliverables and Reporting

The consultant shall also provide following deliverables for this work:

- **Inception Report**: consultant shall provide an "inception report" clearly indicating how consultant has planned to achieve the assigned objectives of this consultancy. The inception report shall include detailed work plan along with time schedule, selection of database, and finalization of models, data requirement, review of available data and data gaps, if any. The inception report shall indicate the time schedule represented by weekly Gantt chart showing major milestones, task deliverables, completion dates and any interdependencies.

- **Draft Model Development Report**: The consultant will submit the draft model development report within the stipulated time to the client. The report should include broadly the following chapters-
    1. Objective
    2. Study area
    3. Methodology for model development
    4. Data used
    5. Approach for model development
    6. Different forms of model output
    7. Confidence limit in result prediction
    8. Model parameters considered and their Sensitivity Analysis
    9. Uncertainty in model development
    10. Shortcomings in the models
    11. Discussion, Conclusion & Future Recommendation.

- **Final Report:** Consultant shall submit the final report to the client in hard (10 set) and soft copy. Consultant will prepare a paper based on results of the modeling in consultation with the Department for presentation at national and international forums.

- **Operational Training:** Training departmental staff to enable independent handling of the model along with receipt and viewing of output data.

- **Records and Metadata:**

    - ✓ The consultant shall consolidate all data used in development of the mathematical model and data formats as decided in consultation with Engineer-in-Charge.

    - ✓ The metadata records shall be delivered free of errors in both content and format.

- ✓ The consultant shall deliver all data and data products, metadata records which detail datum, re-projections, re-sampling algorithms, processing steps, field records, and any other pertinent information etc.

- ✓ ***Geospatial data***- in the form of shape files. The consultant is required to submit a file geo database or shape files listing all the geospatial files, with their respective attributes. All the geo-spatial and time series data should be properly catalogued, including basin, sub-basin and other station IDs as provided by the client; and should be consistent with nomenclature used by client.

- ✓ ***Cross section*** - it shall include the hydraulic model cross-sections used to develop the inundation mapping. This will allow the modeling to be archived for future applications and updates to the inundation mapping.

- ✓ Development of technical, operational, user manuals, online help, training presentations and other training material. Provide 5 copies of user manuals (software design, operation and troubleshooting tips) in hard copy and electronic form.

3.2 The key tasks in Phase II include

3.2.1 Maintenance, updating and Running of the model in real time during operational support period of 4 years after acceptance of the Final Report:

i. Maintenance of the model including updating of software used for the models

ii. Develop scripts for automatic alert (via email, WhatsApp and SMS) to developers / modelers / programmers/ concerned officers in case the system malfunctions due to inability to download data, unavailability of servers, error in data etc. The consultant should develop an automated system for alert so that appropriate actions could be taken with minimum delay.

iii. Maintenance of the auxiliary systems for coupling real time HO and Met data with the model and data dissemination portal.

iv. Review of model and updating of parameters based on the model performance and improving model results.

v. Incorporation of changes in model in case data from new station/sources are accepted by the department, and further calibration. The recalibration may be required for at least 2 times a year, depending on the data situation and accuracy of results.

vi. Updating inundation map libraries and improvising the technology for real time inundation forecast and dissemination.

vii. Generate real time forecast for identified forecast locations for 3 days or more, depending on availability of forecasted rainfall data.

viii. Generate real time flood inundation maps for reaches/locations identified by the Department to predict inundation extent, depth, arrival time, peak velocity of flow and flooding duration at any location in the basin. Inundation extent with depths should be validated with high resolution satellite later and periodic updating of model is to be done.

ix. Run the models using precipitation estimates generated, observed input data and update the model at every 3 hour.

x. Training field staff to enable independent handling and minor modification/up gradation of the system as data availability increases (e.g. high resolution DEM, observed rainfall from more stations and finer resolution predicted rainfall grids) in near future.

xi. Conducting workshops/conferences addressing the issues faced during real time forecasting and dissemination.

3.2.2 Key Deliverables

- **Half yearly progress report:** Consultant shall provide half yearly progress report of the work carried out by them in the period positively by 10th of the next month clearly indicating achievements, problems faced, likely solutions proposed, and bottlenecks if any in carrying out the task as per TOR.

- **Flood forecasting report:** Consultant shall generate flood forecasting report on real time basis during the monsoon period i.e. June to October every year, giving details of FF sites, observed water levels, forecasted water levels, spatial forecast of inundation area etc. in mutually agreed format, to put it on web.

- **Flood Report:** A flood report is to be generated after the end of each monsoon season. The report will have all the details i.e. methodology, deviation in forecast and actual observed parameters, bottlenecks/limitations, sensitivity detail of model results, all graphical details, performance of real time data transmission system, quality of received data vis-à-vis objectives etc. The consultant will make

presentation in the Department organized Flood Appraisal workshop to deliberate these experiences and outputs in this workshop.

- **Comparison of results:** At the end of each monsoon period, the consultant should prepare a detailed comparison report for observed and predicted flow/ levels; and analyze the reasons for discrepancy (if any) and incorporate the changes in the model for improving accuracy during next season. The comparison should also be made for forecasted rainfall vs point observation of rainfall data, and bias correction be updated every year before and after monsoon season.

4. SCHEDULE FOR COMPLETION OF TASKS

A. Phase I:

Sl No	Deliverables	Description	Period	Remarks
1.	Advance against Bank Guarantee	Signing of contract		
2.	Inception Report and Data Collection Report	I. Analysis of data availability and data quality, Review of International experience, Identification of possible models suitable to each river basin, Conceptual design of flood II. Monitoring system, Methodology for the development of model, Identification of data inputs for the model, Outputs expected, Methodology for the calibration and validation of model, and fortnightly schedule of implementation work plan. III. Collection of Required data (hydro-meteorological, topographical, GIS layers including DEM and other data required for modeling)	T+2 months	To be reviewed and approved by a committee constituted by the Department
3.	Model Development Report	Detailed report of flood modeling stating objective, study area, methodology, data used, model parameters, different approaches, shortcomings etc as per TOR.	T+8 months	-do-
4.	Development of Integrated Flood Warning System and submission of Draft Final	i) Detail report on Development of GIS based flood warning system including dissemination of Model output in form of levels, discharge, inundation extents and inundation depths etc.	T+15 months	-do-

	Report based on preliminary DEM data	ii) Development of interface for real-time display of results of flood warning system on departmental site for disseminating the forecast/inundation maps. iii) Development of Dashboard for query based generation flood warning/flood inundation maps for the department and display of same on departmental/other website for dissemination as per decision of the client. iv) Dissemination system of flood alerts through web and mobile phones (SMS, email and WhatsApp), based on pre-defined flood thresholds and corresponding dissemination list. v) Demonstration of complete system vi) Draft Final report with outputs of all tasks		
5.	Final Report based on preliminary DEM data	Objective confirming to all task described in the TOR Operational training of the full system and dissemination workshop.	T+18 months	-do-

B. Phase II

Activities of Phase II will start after acceptance of final report and successful completion of operational training of the full system. Time period of phase II will be 4 years.

Sl No	Deliverables	Description	Period	Acceptance
1.	Maintenance Period	Maintenance and running of the model. Up gradation and refinement of model if required, provide training to departmental staff and submission of Half yearly progress report, Flood forecasting report, Flood report, and Comparison of results as provided in TOR.	4 years	To be reviewed and approved by a committee constituted by the Department

2.	Final report based on LiDAR Data	Final report after up gradation of model based on LiDAR data received from MOWR. .	Within 4 years	-do-

5. DATA SERVICES & FACILITIES TO BE PROVIDED BY THE CLIENT:

The following amenities will be provided by the Client:

- DEM and cross-section data if available (if not available, consultant have to make do with SRTM data or other suitable data)
- Nominate counterpart officers to facilitate in implementing and operation of flood forecast and inundation model.
- Consultant has to collect available historic and current data on hydrometeorology, hydrology and hydraulics; available thematic data. The client will facilitate the process in the form of permissions, letters etc.

6. RESPONSIBILITIES OF CONSULTANT

- Conduct and complete the consultancy as per the agreed TOR and scope of the consultancy.
- Establish a full-fledged office at Kolkata with all infrastructures and office-establishment etc., where the team leader along with his staff will be stationed. The model will be developed and implemented in State Data Centre at Kolkata and operationally run for consultancy period, along with I&WD counterpart team.
- Collect data as needed for modeling from concerned agencies. The consultants will have to acquire real time data from different agencies/networks if required for the Modeling work. Consultant has to bear all expenses on data collection.
- Conduct field visits as required for data collection or to verify model results.
- Undertake digitization / data conversion of source data as needed for modeling.
- Presence of key staffs in departmental premises during operational, maintenance and support period should be ensured.

- Consultant should use appropriate modeling software for satisfactory results. Requirement of all input data for the model, consistency of data, primary or secondary validation should be analyzed well in advance. At later stages, any gap in input data shall not be taken as a reason for poor performance of the model.

- Consultant has to provide all software, data, and source code of all applications after the completion of the consultancy to the client.

7. HANDLING RESTRICTED DATA

The Consultants, their sub-consultants, and the personnel of either of them shall not, either during the term or even after the expiration of this contract, disclose any proprietary or confidential information related to the Project, the services, this contact, or the Client's business or operations without the prior written consent of the Client. Certain data (such as topographic maps in 1:50,000 / 1:15000 scale with heights and contour information, hydro-meteorological data for river system and DEM with 50 cm contour interval) which may be used in development and operation of flood models may be considered “restricted” as per Ministry of Defense and Ministry of Water Resources guidelines. Keeping in view security guidelines for data secrecy and to provide optimum functionality and to enable sharing data with the consultants, a secure data handling environment has been proposed.

8. CONSULTANT AND THEIR KEY TEAM QUALIFICATION

The lead organization for the project will meet the following criteria

- Minimum five years of experience in providing consultancy services in the water sector, with particular emphasis and a track record of successfully delivering major analytical projects that directly interface with water resources policy or management.

- Demonstrated experience in Hydrological modeling, flood forecasting at basin scale in the last five years. Consultant with experience in flood inundation forecast is desirable.

- Ability to quickly deploy a team (professionals with relevant experience and qualifications) either from the lead organization or through sub-contracting arrangements.

Sl. No.	Position	No of persons	Required Qualification	Duration (Total man-months)
1	Team Leader	1	Relevant advanced academic degree in Hydraulics / Hydrology/ Water Resources with 18 years of work experience in water resource sector. Preferably has the knowledge of hydrologic and hydraulic modelling tools used in flood forecasting.	18
2	Deputy Team Leader	1	Relevant academic degree in Water Resources with 12 years of work experience in water resource sector. Preferably has having field level experience in water sector & having executed government projects and knowledge of modelling tools used in hydrology / hydraulics.	24 (18+6)
3	Senior Hydrologist	1	Post-Graduation in Hydrology, Hydraulics and/or Water Resources engineering with at least 10 years' experience in hydrologic analysis in flood modelling. Should have a very good experience with rainfall-run-off modelling. Should have extensive knowledge of hydrological and hydrodynamic modelling in flood forecasting. Preference to be given to those with flood modelling experience on Indian river basins.	24 (18+6)
4	Junior Hydrologist	2	Graduation in Hydrology, Hydraulics and/or Water Resources engineering with at least 5 years' experience in hydrologic analysis in flood modelling. Knowledge of hydrological and hydrodynamic modelling in flood forecasting.	84 (2x18+1x48)
5	GIS Specialist	1	Post Graduate in Geoinformatics/Equivalent Degree with 5 years' experience in RS/GIS applications for resource mapping, preparation and integration of GIS datasets including processing of DEMs. Preferably has the experience in hydrologic applications, 3D analysis and customization and experience in flood inundation mapping.	24 (18+6)
6	IT /Database Specialist	1	Must be a MCA holder or BE / B Tech in Computer Science with at least 5 years' experience in database projects; with at least one full project implementation, involving GIS/RS/Database preferably with Oracle spatial / Oracle environment.	24 (18+6)
7	Other Technical Support Staff	1	Engineering Graduate; good command over Microsoft Office components; Experience in similar role preferred	66 (18+48)
8	Support Staff	2	Basic Degree. For the data collection and Liaison services	66 (18+48)

9. SCHEDULE OF PAYMENT

Schedule of payment shall be as follows

Sl No	Deliverables	Payment schedule	Period
1.	Advance against Bank Guarantee	10% of accepted value	
2.	On acceptance of Inception Report and Data Collection Report	5% of accepted value	T+2 months
3.	On acceptance of Model Development Report	10% of accepted value	T+8 months
4.	On acceptance of Draft Final Report based on preliminary DEM data	5% of accepted value	T+15 months
5.	On acceptance of Final Report based on preliminary DEM data	20% of accepted value	T+18 months
6.	On satisfactory performance during Maintenance Period	5% of accepted value on half yearly basis for 4 years (5 x 2 x 4 = 40%)	4 years
7.	On acceptance of Final report based on LiDAR Data	10% of accepted value	Within 4 years

10. DURATION OF CONSULTANCY

18 months for model development + 4 years (Operational Support, up gradation, refinement, recalibration)