ANNEX 1: TERMS OF REFERENCE

Package: GEF-CPMU-CS-QCBS-02: Mekong River Delta Flood and Inundation Simulation System

Project: the Viet Nam mekong delta integrated climate resilience and sustainable livelihoods project (gef-icrsl)

(Attached to Decision No 389/QD-CPO-TD dated 26 November, 2021 of General Driector of CPO)

I. INTRODUCTION

1. The Government of Vietnam received a credit proceedings from International Development Association (IDA), a member of the World Bank Group to finance Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project (MD-ICRSL project). The Project commenced in Quarter III 2016 with development objectives of "Enhance the tools to make plans for climate change impacts adaptation, improve climate resilience in management and use of land and water resources in some selected provinces of Mekong river delta (MKD)

2. The Technical Assistance Project for Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project (GEF-ICRSL) was approved by the Ministry of Agriculture and Rural Development (MARD) in Decision No. 4694/QD-BNN-HTQT dated November 16, 2017 used the grant of Global Environment Facility (GEF) through WB to enhance research and innovation capacity for research institutions to develop and apply natural resource management, agriculture, forestry and fishery practices adapt climate change in selected provinces in MD including: upper delta (An Giang, Dong Thap); delta estuary (Ben Tre, Tra Vinh, Vinh Long, Soc Trang) and peninsula (Ca Mau, Bac Lieu, Kien Giang) to enhance the effectiveness of ICRSL Project. The total project fund is 6,237,281 USD in which 6,090,831 USD from the GEF grant and 146,450 USD from the Government counterpart fund. The project took effect in October 2018 and ended in December 2022. The project was designed in accordance with the ICRSL Project Components to support respectively including 05 components:

Component 1: Strengthen Monitoring, Analysis and Information Data Base (1,540,831 USD)

Component 2: Managing Floods in Upper Delta (1,450,000 USD)

Component 3: Adapting to Salinity Transitions in Delta Estuary (1,450,000 USD):

Component 4: Protecting Coastal Areas in Delta Peninsula (1,450,000 USD)

Component 5: Project Management and Implementation Support (346,450 USD)

In order to complement the ICRSL Project, these components focus on research and innovation activities to improve the quality and effectiveness of flood prevention and protection, migration solutions and, in particular, solutions for ensuring child safety during the flood season in the Mekong Delta through inundation and flood simulation system.

3. The important strategies for the upstream floodplain are to enhance (or maintain to the current minimum level) water retention capacity by dike systems, thereby creating favorable conditions for three-crop rice production in the direction of flood-based production with better climate resillience, adaptation and optimization of water conditions in the dry and flood seasons. Flood management in the upstream floodplains of the delta is important to protect and/or get the benefits of flood control and diversion measures while increasing rural incomes and protecting high-value assets. Over the past decades, the landscape of these areas has significantly changed because of the agriculture and aquaculture intensification. High dykes have been built around the rice fields to control flooding and allow the third rice crop to be grown every year. An important strategy for developing resilience is the application of flood-based agriculture and flood management. From that achieving a balance between flood control, land use, water adaptation, and rehabilitation of flood retention capacity as well as ecosystem connectivity.

4. The main research scope of this package is the areas affected by floods and inundation such as the areas of Dong Thap Muoi and the Long Xuyen Quadrangle in the provinces of An Giang, Dong Thap, Long An and Kien Giang. The main activities of this component include: (i) Collecting baseline data; (ii) Developing a modeling system to simulate flood and inundation in the Mekong Delta (MD); (iii) Developing flood maps according to disaster risk scenarios; and (iv) Developing a decision support system for flood and inundation management in the MD.

5. Implementation arrangement

The Central Project Office (CPO) of MARD is the Project Owner. The CPO is a Client of consulting services under this Term of Reference. The CPO will sign the contract, monitor the performance of the contract and the output of the consulting services.

During implementation of service, the consultant shall report to CPO and Vietnam Disaster Management Authority under MARD regularly in order to promptly address difficulties and issues. The main report/deliverables shall be consulted and agreed by CPO/VDMA before carrying out next steps or acceptance

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II. OBJECTIVE OF CONSULTING SERVICE

6. The main objective of consulting service is to develop a system to simulate flood and inundation for the areas affected by flood disaster risk in the deeply inundated areas of the MD in order to improve early warning of natural disasters and to support the decision-making in disaster prevention and control by the Vietnam Disaster Management Authority (VNDMA), local steering committees for natural disaster prevention and control, as well

as community in the project area. Therefore, the quality and effectiveness of flood prevention and protection, evacuation solutions will be improved.

The specific objective:

1. Establishing the modeling systems to simulate flood and inundation in order to meet the necessary requirements for accuracy and reliability to calculate flood and inundation for the study area.
2. Developing a set of inundation maps according to disaster risk scenarios as the basis for relevant ministries, sectors and provinces in the Mekong Delta, especially in deeply inundated areas, to review and complete flood response options according to the provisions of the Law on Natural Disaster Prevention and Control, creating conditions for sustainable socio-economic development in the areas affected by floods and inundation.
3. Establishing the system to simulation flood and inundation in the Mekong Delta for early warning of natural disasters and the decision-making support in order to:
   - Improve leadership capacity for flood and inundation prevention and control;
   - Strengthen adaptive flood risk management, minimizing loss of life and property of the government and the people.
   - Raise awareness and capacity of local governments, communities and people at Mekong Delta in preventing flood disaster risk, especially in deeply inundated areas, by the way of providing online flood and inundation information that visually displays calculation results for static and dynamic scenarios in the form of WebGIS inundation maps, time-process charts and statistical reporting tables.

III. SCOPE OF CONSULTING SERVICE

7. The main research scope of this package is the flood hazard areas affected by floods and inundation such as the areas of Dong Thap Muoi and the Long Xuyen Quadrangle in the provinces of An Giang, Dong Thap, Long An and Kien Giang.

8. Scope of consulting service: The Consultant will consult with the VNDMA and localities to perform the tasks of collecting information and data; establishing numerical models to simulate flood and inundation; developing flood maps according to disaster risk scenarios; establishing the automatic simulation system; training and transferring products to the VNDMA and localities. Consulting activities must comply with the Government of Vietnam (GOV) regulations and the WB requirements.

IV. SPECIFIC TASK OF CONSULTING SERVICE

9. The Consultant is required to perform the following specific tasks, without limitation:

Task 1: Inception and overview

The Consultant will study all project-related and consulting service-related documents including reports, maps and data that have been studied in previous and ongoing projects. Overall assessment of flood and inundation situation from 2000 to present and response options of localities (province, district, commune) will be done. The Consultant must review the following documents, without limitation:

- Water resources plan of the Mekong Delta in the period of 2012 - 2020 and the vision to 2050 of MARD according to the Decision No.1397/QĐ-TTg dated September 25, 2012.
- The integrated program of sustainable agricultural development in response to climate change in the Mekong Delta until 2030 with a vision to 2045 of MARD approved by the Prime Minister according to Decision No. 324/QĐ-TTg dated March 2, 2020.
- Project "Modernization of hydraulic systems to facilitate transformation and sustainable agricultural development of ecological sub-regions in the Mekong Delta" of Directorate of Water Resources - MARD according to Decision No. 633/ QĐ -TTg dated May 12, 2020, approved by the Prime Minister on the orientation for the development of hydraulic works in the periods of 2030, 2050 and 2100.
- The Mekong Delta Integrated Regional Plan (MDIRP) for the period 2021-2030 with a vision to 2050 is being prepared by MPI within the framework of WB9

Coordinating with the Projecr owner and implementing agencies of subprojects 1.4 and 1.5 in sharing the available data and proposing mechanisms, methods and protocols to share data and output between subprojects and proposed projects after these projects have been completed.

Proposing methods and detailed plans for research implementation.

Preparing the Inception Report, which includes: explanation of the approach and methodology; detailed work plan, operation schedule and staff mobilization plan; requirements for the specialists and human resources to perform the service. The product delivery plan (report) must also be detailed. Initial research based on a review of existing documents will also form a chapter of the inception report

The outputs of this Task include:

1. The Inception Report, and

2. The overall assessment report on floods, inundation situation and response options of localities .

Task 2: Data collection and additional survey

Collecting data to establish numerical models and flood maps according to disaster risk scenarios. The Consultant will carry out comprehensive collection, survey, assessment and analysis of available data and information on key areas related to flooding and inundation in the study area, then establishing a database to hand over to the Client upon completion of the service. This task includes activities of collecting and evaluating available data and documents, measuring, surveying and adding data.

1) Collecting available documents and data:

The Consultant should review documentation and identify issues as described below:

- Collecting data, hydraulic models, basic documents on flood, inundation and climate change
- Collecting basic documents and data on topography, digital elevation model DEM, cross-section river, canals for the establishment of numerical models and inundation maps.
- Collecting basic documents and data on meteorology (hourly rainfall, daily rainfall), hydrology (water level, measured discharge, flood extraction) updated to 2021 for the purpose of setting up, calibrating and verificating the numerical models.
- Collecting documents and data on hydraulic works, canal networks, dikes, embankments, flood control works.
- Collecting documents and data on construction works, especially traffic routes and their elevations.
- Collecting basic maps and databases to create flood maps according to disaster risk scenarios.
- Collecting documents, data on the history of flood disaster events and damage from 2000 to present; living conditions, economy, natural disaster prevention and control works, respond options to natural disasters, infrastructure, land use, etc. in the study area.
- Reviewing the available documents and data; proposing a plan for additional measurement and survey of necessary data based on the analysis and evaluation of the collected data; then proposing and discussing with the Project Management Unit.
- Carrying out additional measurements and surveys of cross-sectional data of rivers, canals; monitoring along dike routes; necessary hydrological data for the establishment, calibration and verification of hydraulic models.

The Consultant will coordinate closely with other agencies, departments and stakeholders (such as the VNDMA, Departments of Agriculture and Rural Development, Departments of Natural Resources and Environment, Departments of Construction,

meteorological and hydrological stations, sub-projects 1.4, 1.5, etc.) to collect available data and documents. The list of available data is refered to Table 1.

Table 1: List of required figures (for direction)

No.	Type of data	Purpose of use	Place of collection (for direction)
1	Geographic database map at scale 1:50,000 (the whole area), 1:5,000 (provinces), 1:2,000 (cities)	To develop flood maps (base maps) with different scales (for size 2A0, A0 and A3)	Departments of Natural Resources and Environment; Sub-projects 1.4, 1.5
2	Topographic map, DEM scale 1:50,000 (area), 1:5,000 (provinces), 1:2,000 (cities)	To derive 2-D meshes in inundation modelling	Departments of Natural Resources and Environment; Sub-projects 1.4, 1.5
3	Topographic map of the river bed, cross-section of rivers, canals	To develop river network in the hydrodynamic model and 2-D meshes in inundation modelling	The Hydraulic Departments; Provincial Departments of natural resources and environment; Subproject 1.5; Southern Institute of Water Resources Planning; Southern Institute of Water Resources Research
4	Coordinates and elevations of geodetic marks class III, IV	To serve the additional survey: survey of road elevations, embankment route, additional cross-sectional	The Hydraulic Departments; Provincial Departments of natural resources and environment; Subproject 1.5
5	Data of river dikes and embankments (vertical and horizontal alignment)	To derive 2-D meshes in inundation modelling for areas	The Provincial Hydraulic Departments; Subproject 1.5; Southern Institute of Water Resources Planning; Southern Institute of Water Resources Research
6	Data of hydraulic works: location/coordinates, size, elevation of sluices, spillways on rivers and canals; operation procedures; monitored data	To develop river network in the 1-D hydrodynamic model and 2-D meshes in inundation modelling for areas	The Provincial Hydraulic Departments; Subproject 1.5; Southern Institute of Water Resources Planning; Southern Institute of Water Resources Research

No.	Type of data	Purpose of use	Place of collection (for direction)
7	Data of disaster prevention and control works: location/coordinates, altitude, scale of works (location, safe houses for disaster prevention; evacuation and migration areas;)	To update options of preventing, avoiding and responding to natural disasters	The Provincial Hydraulic Departments; Subproject 1.5; Southern Institute of Water Resources Planning; Southern Institute of Water Resources Research
8	Data of historical flood and inundation events: time, location/coordinates, flood level elevation, inundation depth, extent of damage	To check the calculation results and update options of preventing, avoiding and responding to natural disasters	The Provincial Hydraulic Departments; Subproject 1.5; Southern Institute of Water Resources Planning; Southern Institute of Water Resources Research
9	Traffic route data: vertical and horizontal alignment (position, length, elevation and width) of traffic routes (position, length, elevation and width)	To derive 2-D meshes in inundation modelling for areas	Provincial Departments of Transport
10	Data of construction works: location/coordinates, size, elevation of sluices, traffic bridges on rivers and canals	To develop river network in the 1-D hydrodynamic model and 2-D meshes in inundation modelling for areas	Provincial Departments of Transport
11	Hydro-Meteorological data at stations managed by Vietnam Meteorological and Hydrological Administration and specialized stations: position/coordinates of measuring station, elevation of station; hourly rainfall,	To calibrate and verify 1-D hydrodynamic model and 2-D meshes in inundation modelling for areas	The Southern Region Hydro-Meteorological Centre, Provincial Hydro-Meteorological Stations; The Provincial Hydraulic Departments; Provincial Departments of natural resources and environment

No.	Type of data	Purpose of use	Place of collection (for direction)
	daily rainfall, hourly water level, flood extraction data		

Table 2: List of hydrological stations used to calibrate and verify models (for direction)

No.	Station	River	Province	Observations	Station grade
1	Tân Châu	Tiền	An Giang	H, Q, WQ	1
2	Châu Đốc	Hậu	An Giang	H, Q, WQ	1
3	Chợ Mới	Ông Chưởng	An Giang	H	3
4	Vàm Nao	Vàm Nao	An Giang	H, Q, WQ	1
5	Long Xuyên	Hậu	An Giang	H	3
6	Xuân Tô	TGLX	An Giang	H	3
7	Tri Tôn	TGLX	An Giang	H	3
8	Cao Lãnh	Tiền	Đồng Tháp	H	3
9	Trường Xuân	DTM	Đồng Tháp	H	3
10	Mỹ Thuận	Tiền	Vinh Long	H, Q, WQ	1
11	Mỹ Tho	Mỹ Tho	Tiền Giang	H, S	3
12	Hoà Bình	Cửa Tiểu	Tiền Giang	H, S	3
13	Vàm Kênh	Cửa Tiểu	Tiền Giang	H, S	3
14	Bình Đại	Cửa Đại	Bến Tre	H, S	3
15	Chợ Lách	Hàm Luông	Bến Tre	H	3
16	Mỹ Hóa	Hàm Luông	Bến Tre	H, S	3
17	An Thuận	Cửa Hàm Luông	Bến Tre	H, S	3
18	Bến Trại	Cửa Cổ Chiên	Bến Tre	H, S	3
19	Cần Thơ	Hậu	Cần Thơ	H, Q, WQ	1
20	Trà Vinh	Cổ Chiên	Trà Vinh	H, S	3
21	Trần Đề	Cửa Trần Đề	Sóc Trăng	H, S	3
22	Đại Ngãi	Hậu	Sóc Trăng	H, S	3

No.	Station	River	Province	Observations	Station grade
23	Mộc Hoá	Vàm Cỏ Tây	Long An	H	3
24	Tuyên Nhơn	Vàm Cỏ Tây	Long An	H, S	3
25	Tân An	Vàm Cỏ Tây	Long An	H, S	3
26	Bến Lức	Vàm Cỏ Đông	Long An	H, S	3
27	Kiến Bình	DTM	Long An	H	3
28	Cai Lậy	ĐTM	Tiền Giang	H	3
29	Long Định	ĐTM	Tiền Giang	H	3
30	Phước Hoà	Sông Bé	Bình Dương	H, Q, WQ	1
31	Phú Hiệp	La Ngà	Đồng Nai	H, Q, WQ	1
32	Tà Lài	Đồng Nai	Đồng Nai	H, Q, WQ	1
33	Trị An	Đồng Nai	Đồng Nai	H	3
34	Biên Hoà	Đồng Nai	Đồng Nai	H	3
35	Dầu Tiếng	Sài Gòn	Bình Dương	H	3
36	Thủ Dầu Một	Sài Gòn	Bình Dương	H	3
37	Phú An	Sài Gòn	TP HCM	H	3
38	Nhà Bè	Nhà Bè	TP HCM	H, S	3
39	Gò Dầu Hạ	Vàm Cỏ Đông	Tây Ninh	H	3
40	Cần Đăng	Bến Đá	Tây Ninh	H,Q	2
41	Tân Hiệp	TGLX	Kiên Giang	H	3
42	Rạch Giá	TGLX	Kiên Giang	H, S	3
43	Phung Hiệp	TSH	Hậu Giang	H	3
44	Vị Thanh	TSH	Hậu Giang	H	3
45	Phước Long	TSH	Bạc Liêu	H	3
46	Xẻo Rô	Cái Lớn	Kiên Giang	H, S	3
47	Sông Đốc	Sông Đốc	Cà Mau	H, S	3
48	Cà Mau	Gành Hào	Cà Mau	H, S	3
49	Gành Hào	Gành Hào	Bạc Liêu	H, S	3
50	Năm Căn	Cái Lớn	Cà Mau	H, S	3

Notes: H = water level, Q = flow discharge, S = salnity, WQ = water quality.

2) Investigating, measuring, carrying out additional survey:

The objective of the investigation, measurement and additional survey is to supplement the necessary information and data for the development of computational models and inundation mapping in order to obtain the most realistic calculation results. Tasks to be performed include:

- Measuring and surveying additionally cross-sections of rivers and canals that are missing or too old;

- Measuring and surveying additionally vertical alignment of dike and embankment that have no data;

- Measuring and surveying additionally vertical alignment of borders that have no data;

- Measuring and surveying additionally hydrological data for calibration and verification of models;

- Investigating additionally flood and inundation situation.

(The additional survey volume is listed in Appendix)

During the implementation process, the volume of additional measurement and survey must be based on the available or collected documents by the Consultant from available studies. The additional measurement and survey of data should be planned and discussed with the PMU before implementation. Any selected subcontractors for additional surveying work will be contracted and paid for by the Consultant.

The overview analysis and evaluation of the collected data and additional data will be presented in the Report on additional data collection, measurement and survey.

The outputs of this task include:

- The set of data and documents collected from previous projects.

- The set of data additionally investigated, measured and surveyed.

- The report on additional data collection, measurement and survey.

Task 3: Developing a set of numerical models for simulating flood and inundation in the Mekong Delta (MD)

Flooding and inundation at the MD is affected by both flow processes in rivers, canals, and flood plains. Therefore, a comprehensive flood model of the MD needs to be established to preliminarily calculate the evolution of floods and inundations on the overall scale of the MD and to provide boundary conditions for inundation modelling by downscaling approach. The flood model will best calculate both water level and flow volume, then provide these results as input data boundary conditions for deriving 2-D meshes in inundation modelling for areas.

The overall flood model for MD will be established including 2-D meshes in inundation modelling integrated with 1-D hydrodynamic model of the main river and canal network for the whole region MD.

Updating 1-D hydraulic model of the main river and canal network for the whole region MD.

1-D hydrodynamic model of the main river and canal network for the whole region MD is a very complex model, requiring a huge amount of data and effort to establish, calibrate and verify the model. This process can take many years. So the establishment of a new 1-D hydraulic model of the main river and canal network for the whole Mekong Delta cannot be done within the timeframe and budget of this project. Therefore, the Consultant needs to collect and inherit the existing 1-D hydraulic model for the MD. This model has a computational domain extent from Kratie station on the main Mekong river to the East Sea and the Gulf of Thailand, including all major branches and important canals (Tien River tributaries, Hau River tributaries, Vam Co, Giang Thanh, Cai Lon, Cai Be, Ong Doc, Bay Hap, Cua Lon, My Thanh,...) and hydraulic works such as sluices and dams mainly on the MD. Within the framework of the project, the Consultant only updates, re-calibrates and verifies the model with the data collected for recent years.

1) Developing 2-D meshes hydrodynamic model for the MD

The 2-D meshes hydraulic model needs to be establish to simulate overflow flood in flood and inundated areas for the MD. The model with grid cells is established for all deep and shallow inundated areas of the MD with a grid cell number of about 20000 – 40000 elements, representing different flood levels of the area with the main topographical features.

2) Calibrating and verifying the overall flood model for MD

The evaluation of the accuracy of the overall flood model for the MD needs to be done during model calibration and verification. The model calibration and verification can be carried out with a number of floods that have occurred in history with data at hydrological stations. The model calibration and verification need to be performed separately for different floods. The accuracy is evaluated by the most widely used quantitative statistics such as Nash-Sutcliffe, RMSE, BIAS...

It is possible to adjust the performance of the constructions accordingly in the model with different floods, corresponding to different infrastructure conditions of road and dike.

The output of this task includes:

- The set of the overall flood models for the MD.
- The report on establishment of the overall flood models for the MD.

- Set of the overall flood models for the MD includes data files of model configuration, grids, initial conditions, boundary conditions and model parameters after calibration and verification.

- The report on establishment of the overall flood model for the MD should show detailed addition, update, process and results of model calibration and verification.

Task 4: Developing detailed flooding models for each areas in MD

The overall flood model for the MD has a wide scope, so it only provides preliminary flood calculation results. It is necessary to establish detailed flooding models for each area in the Mekong delta, especially the deeply flooded regions, with higher grid resolution and more detailed description of topographical features, especially dike constructions, roads, canals, small ditches and other hydraulic, traffic and construction works. These detailed flooding models use output results from the MD's overall flood model as boundary conditions using the downscaling approach.

The system of established models will be used to simulate and develope the inundation maps according to disaster risk scenarios (static scenarios) and be used as the core component of the flood simulation system, in order to give early warning and assist in disaster prevention and control by the Vietnam Disaster Management Authority (VNDMA), the local steering committees for natural disaster prevention and control, and people in the project area according to forecast bulletins and real disaster situations (dynamic scenarios).

Specific activities of this task include:

1) Analyzing data, determining computational domains for models

The domain division of detailed flooding models should be based on the analysis of natural features, dikes, canals, roads and inundation characteristics of each region. The different computational domains are divided based on the relatively clear separation of the actual flood flow characteristics.

2) Data processing, generating detailed grids for models

Data processing of embankments, dikes, roads and riverbanks, canals creates two-dimensional grids. The grid needs to clearly show these characteristics and describe in detail the changes of topography and features in the calculated region such as dikes, roads, canals, hydraulic works, traffic, constructions .etc. The number of grid cells per domain ranges from 20000 to 40000 elements so that the models can run on normal PCs.

3) Data processing, generating bathymetry for detailed models

Topographic data processing, DEM digital elevation maps leads to interpolate into two-dimensional grids. The coordinate system used between the grid, topography and flood

map needs to be consistent. Conversion between coordinate systems will likely have to be done using the conversion functions of GIS data processing tools. Note that the printed flood maps for localities need to use VN-2000 coordinate system for each one as in regulations, while these results are shown on the WebGIS digital flood map that needs to be returned to a unified coordinate system supported by WebGIS software such as EPSG:4326, EPSG:3857.

4) Simulating the hydraulic and traffic works

Simulating the embankments, dikes, traffic routes, hydraulic works in the model. The dikes, embankments, and roads can be simulated using broard-crested spillways.

5) Connecting detaied models and the overall models

Connecting the detailed 2-D flood model with the overall flood model for the MD through boundary conditions. The flood calculation results from the overall flood model for the MD need to be extracted at the boundary positions of each detailed flood model, then using as initial boundary conditions for these models. The Consultant should develop a tool to connect these ones automatically as part of the flood and inundation simulation system described in Task 6.

6) Validating models

In case there are measured, investigated and surveyed data such as flood tracks and historical inundation depth, the Consultant should compare the results of the models with these data in order to assess and improve the reliability of the models.

The output of this task includes:

- The set of detailed 2-D flooding model for inundated areas in the study area.

- The report on establishment of detailed 2-D flooding models for areas.

Set of detailed 2-D flooding models for inundated areas in the study area includes data files for model configurations, meshes, initial conditions, boundary conditions, and model parameters.

Task 5: Establisment of flood map corresponding to disaster risk levels

1) Consulting and identifying disaster risk scenarios

The Consultant need to coordinate with localities and VNDMA to identify and unify calculation scenarios for developing flood maps for each locality and specific area. Disaster scenarios can be based on disaster risk levels such as Decision No. 18/2021/QD-TTg dated on April 22, 2021 of the Prime Minister and design flood frequencies, flood alarm levels, local rainfall; scenarios on tides, storm surges, sea level rise; dike and dam failure scenarios at the upstream; climate change scenarios; land subsidence and urban development planning for the future (as by 2050), flood control options.

The estimated number of calculation scenarios is 05 scenarios. The Consultant need to discuss with each locality and VNDMA on specific scenarios to calculate and develope flood maps for each locality.

2) Simulating disaster risk scenarios

The calculation and establishment of flood maps according to disaster risk scenarios must use the established models in Task 3 and Task 4. The Consultant needs to process the data and create boundary conditions for calculation corresponding to each specific scenario for these models, then run the model and extract the results from the models to develop a flood map.

3) Developing flood maps according to disaster risk scenarios

The set of flood map according to disaster risk scenarios needs to show the spatial extent and flood level, etc., based on topographic maps for inundated areas, and for each province, each district and to each commune in the deeply inundated area.

It is necessary to show on the map the subjects affected by flood and inundation including road infrastructure, hydraulic works, construction works, safe areas for migration.

In order for the calculation results best suited to the reality, the Consultant needs to present the flood calculation results on the map according to the disaster risk scenarios including the extent of inundation, the depth of inundation. At the same time, the workshop and consultations with localities on the reasonableness of the calculation results may be conducted.

4) Supporting the locality to update the response options

In case localities need to update flood response options according to disaster risk scenarios, the Consultant should assist localities in updating response options on the flood map. The consultant may need to organize a technical workshop to finalize flood response plans for the provinces/cities in the MD and related sectors according to disaster risk levels.

The outputs of this task include:

- The set of flood maps according to disaster risk scenarios for the whole region, province, district and commune level printed in color on paper sizes 2A0, A0 and A3

- The report on developing flood maps according to disaster risk scenarios.

The flood maps according to disaster risk scenarios need to be approved by the competent authorities before handing over to agencies including VNDMA and the steering committees for natural disaster prevention and control at provincial, district and commune levels of localities in the project area.

Task 6: Development of flood and inundation simulation system for the MD

Flood and inundation simulation system for the MD is a Spatial Decision Support System - SDSS including: hydraulic models (1-D and 2-D); database and interface for managing input and output of calculation scenarios (including attribute data, time series and map); modeling and data processing tools; early warning tools; tools to visualize and query information and results; reporting tools; management tools and user authorization and management. This system is the core of the flood early warning system and the decision-making support system in response to flood disaster risk at the MD.

Flood and inundation simulation system for the MD needs to be set up to run automatically including: automatically creating boundary conditions and input data files according to the dynamic scenarios; automatically running the overall flood model for the MD; automatically extracting results from overall flood model for the MD to detailed one for each area; automatically creating boundary conditions and input data files for detailed flood models for areas; automatically running detailed flood models for areas; automatically extracting the results and developing digital flood maps to visualize on the WebGIS interface. The provision of dynamic calculation scenarios, the layout of the PCs for running the model, and the lookup of the results are all done remotely through the interface of the web portal and WebGIS.

1) Building tools to collect and process input data for the overall flood model for the MD

Flood and inundation simulation system for the MD needs to be connected to use forecast bulletins from Sub-project 1.5 and other forecasting information sources such as rainfall forecast, flood forecast from National Centre for Hydro-Meteorological Forecasting, Mekong River Commission, The Southern Region Hydro-Meteorological Centre, Provincial Hydro-Meteorological Stations in the project area. Depending on the sources of information and data, the connection can be made automatically through internet connections or by manually entering forecast information through the interface of the portal. Forecasting sea level can use tidal forecasting methods based on harmonic constants or use forecast results from other modeling sources. In addition to forecast information, measured data from existing databases of VNDMA and Sub-projects 1.5 and 1.4 also need to be exploited, collected and processed as input to the models.

2) Building tools to extract results from the overall model for the MD

Preliminary flood calculation results of the overall model for the MD need to be automatically extracted for detailed flood models and visualized on the WebGIS interface of the portal for monitoring and inspection purposes.

3) Building tools to process input data for detailed flood models

Preliminary flood calculation results of the overall model for the MD according to forecast bulletins need to be extracted to create input boundary conditions for detailed flood

models. In addition, some situations in operation and other dynamic scenarios need to be automatically represented in the input data files of the models.

4) Building tools to extract the results of detailed flood models

The calculation results from detailed flood models for regions need to be automatically extracted for early warning systems and for lookup on the WebGIS interface of the portal. The results extracted from the models include: maximum flood extent; maximum flooding depth; or retention time of flood levels. In addition, this tool also needs to allow the extraction of time-series hydographs of flooding at specific locations defined by the user on the WebGIS interface.

5) Designing and developing the interface of early warning system on the portal

In addition to the information, calculation results, flood forecasts that are visualized on the web portal and WebGIS interface, the flood calculation results from the models are also transferred to the early warning system for flood disaster risk. This early warning system uses calculation results from the model as well as the geodatabase and other databases to provide early warning of natural disaster risk.

The warning information not only visualized on the portal can also be sent via email addresses, messages (if possible) with established addresses and applications on the mobile phone.

6) Researching available web portal systems and designing integrated flood and inundation simulation system with current systems

The Vietnam Disaster Management Authority (VNDMA) now has several portals for serving different tasks. The Consultant needs to coordinate with VNDMA to find out the available web portals and design an integrated flood and inundation simulation system with one of these existing systems.

The portal interface and early warning software must be accessible using internet browsers on PCs or handheld devices (mobile phones, tablets...).

7) Designing, building attribute database and integrating with available databases

The Consultant needs to carry out the design and building of the attribute database that manages the input data and the outputs of the mathematical models. It needs to be integrated with the existing databases of the VNDMA.

8) Designing, developing map database and integrating with available databases

The Consultant needs to design and develop a map database to manage spatial data and flood calculation results for visualize and lookup on the WebGIS interface. The design and developing of the map database needs to be integrated with the existing databases of VNDMA .

9) ***Researching the available WebGIS interface, designing and developing WebGIS interface for visualize and inquery the information on the web portal and integrating with available WebGIS interface***

The Consultant needs to conduct research on the available WebGIS interface on VNDMA's web portal. Based on this existing one, the Consultant will design, develope and integrate on the WebGIS interface with the functions to visualize and query flood map information under static and dynamic scenarios.

The WebGIS digital map interface of the web portal must be able to visualize flood maps according to disaster risk scenarios (static scenarios) and inundation results as well as possible scenarios in reality. This interface must allow the visualize of information about inundation extent, depth, duration of each flood or calculation scenarios based on topographic maps, traffic maps, satellite image background... like Google Maps. This interface should also allow to query inundation depth, processing time of inundation at locations required by the user.

The WebGIS interface should also allow to query the latest location and status at rain gauges, water level stations, sluice gates and pumping stations as well as process in the form of time series graphs at these locations in order to support the decision-making process for the operation of hydraulic works and water control systems in each region.

In case there is enough topographic data and detailed data of construction works and infrastructure, it is possible to present a three-dimensional (3D) visualization of the detailed flooding process.

10) ***Researching, designing, developing and integrating user authorization with management module***

The Consultant needs to research, design and develop management module and user authorization, then integrating with the available modules on the web portal. User roles can be classified as a system administrators and users. The administrators may have the rights to setup, turn on/off functions and user management. The users who are technical experts have the right to set up dynamic calculation scenarios and select PC workstations for calculation scenarios. The users who are managers have the right to view sensitive disaster risk information and approve publicly available information. The regular users who have signed up for an access account and can set preferences about geographical areas and warning information that they want to receive from the system. The public users can view certain public information approved for publication without logging in.

11) ***Designing, developing interface to manage simulation scenarios and integrating with current system***

The Consultant needs to research, design and develope an interface to manage flood simulation scenarios on the portal and integrate with the existing system.

The portal interface must allow remote operation to set up calculation scenarios, operational plans for flood protection works, automatically queue and run simulation model on workstations according to the settings.

12) Designing and developing module to monitor remotely via the internet

The Consultant needs to design and develope application software modules and remotely monitor the operation of the system via the internet. This module automatically sends emails or messages when there are data errors or problems in operation.

The outputs of this task include:

- The software of flood and inundation simulation system for the MD is installed in VNDMA

- The set of flood maps according to disaster risk scenarios in digital form is visualized on the WebGIS interface of the software.

- The report on developing flood and inundation simulation system for the MD.

The software of flood and inundation simulation system for the MD needs to be tested and operationally checked before handing over.

The Consultant is required to have a warranty period, fixing bugs and maintain support for VNDMA during the operation and use of the software for a minimum period of 3 years. They also coordinate with the DMA to upgrade and update the system if required.

Task 7: Guidance and technology transfer

The Consultant needs to carry out the technology transfer and guide the team of experts to exploit, use and operate the system at the VNDMA and localities. The operation of the Mekong Delta flood and inundation simulation system requires the necessary hardware and software systems. These hardware and software will be invested and equipped at the VNDMA through a procurement and equipment package using another source of capital. The Consultant should provide the requirements of minimum technical specifications for the hardware and software of the system.

Documentation and training courses on the system operation need to be organized for different user groups. The main focus can be on the use and exploitation of the system for the regular and the public user group; instructions on system management and operation for user groups of VNDMA.

The training on how to use and exploit the system can be conducted in the form of workshops, seminars, and training courses.

In addition to two workshops, Workshop 1: Kick-off and Summary Workshop were jointly organized for the provinces; the Consultant needs to conduct 03 separate workshops for each province, including:

Workshop 2: Consultation on the disaster risk scenario;

Workshop 3: The report on consulting on flood map results and supporting to update response options;

Workshop 4: The report on flood map results according to risk scenarios.

In addition to technical reports, the Consultant needs to compose a Summary Report summarizing the performed work and results. The Final Report will also include an Overall Summary for the policymakers, Conclusion and Recommendation (including ongoing problems and recommendations for further in-depth research). The Final Report will be submitted within one month after the final workshop draft.

The outputs of this task include:

- The user manual of flood and inundation simulation system for the MD
- The final report

V. DELIVERABLE REQUIREMENTS

10. The Consultant has to submit deliverables for Client as shown in Table 1 below. The deliverables are written in both Vietnamese and English in PDF and printed form (color printing, book form, thick cover), meeting the requirements mentioned in part 9 above. All tasks will be considered completed if they are accepted by the CPO (Client). The durations and expected deadlines are refered to Table 3.

Table 3: Timeline of deliverables

No.	Deliverables	Quantity		Duration (from the date of signing contract)
		VN	EN	
1	Inception report	03		1 month
2	Report on disaster assessment and response	03		2 months
3	Report on data collection and recommendations for additional measurements and surveys	03		3 months
4	Set of data and documents collected from previous projects	03		3 months
5	Report on additional data survey and measurement	01		4 months
6	Set of data additionally investigated, measured and surveyed	01		4 months

No.	Deliverables	Quantity		Duration (from the date of signing contract)
		VN	EN	
7	Report on establishing the overall flood and inundation model for the Mekong Delta	03		5 months
8	Set of overall flood and inundation model for the Mekong Delta	01		5 months
9	Report on establishing flood and inundation model for detailed regions	03		6 months
10	Set of detailed 2-D flood and inundation models for the regions	01		6 months
11	Report on developing flood maps according to disaster risk scenarios	03		8 months
12	Set of flood maps according to disaster risk scenarios for the whole region, provinces, districts and communes printed on paper	01		9 months
13	Report on developing flood and inundation simulation system	03		9 months
14	Software to calculate and simulate flood and inundation in the Mekong Delta	01		10 months
15	Set of flood maps according to disaster risk scenarios in digital form visualized on the WebGIS interface of the software	01		10 months
16	User manual for the flood and inundation simulation system for the Mekong Delta	03		10 months
	Final report	03	02	10 months

VI. REQUIREMENTS FOR CONSULTANT

The service contract is awarded to a consultant which has full legal status, financial autonomy, and at least 10 years of experience in the field of hydraulic and water resources; experiences in implementing research and design projects in the field of water resources, especially projects in the field of natural disaster prevention and control sponsored by international agencies or co-financing of bilateral donors; experiences in implementing projects in MD region is an advantage. The consultant has a team of experts to perform the service that meets the requirements for qualifications and experience.

International consulting firms are encouraged to form joint ventures or alliances with Vietnamese companies to provide the necessary skills and professionalism to ensure the overall success of their research and achieve project objectives.

State-owned enterprises, institutes, universities or government organizations should carefully studied their eligibility to participate in the World Bank Procurement Regulations for IPF Borrowers published in July 2016 .

The following experience and competence of Consultant is considered as an advantage:

- Have a business license for the following activities: Technology transfer consulting; Consulting and services in the field of hydrology and environment; Developing research, demonstration models for scientific research; Developing mathematical models, experimental hydraulic models of works; Management, exploitation and protection of hydraulic works; Consulting, training, providing information on the environment field; Hydrometeorological activities; Cartographic survey; Topographic survey; Preparing a plan to prevent floods downstream of the reservoir; Planning for natural disaster prevention and control; Construction planning for traffic, hydraulic and construction works; Natural disasters, climate change, prevention and adaptation measures; Participating in activities on prevention of inundation, drought, saltwater intrusion, storm and flood, disaster reduction, desertification;

- Have a license for surveying and cartographic activities and a certificate of competence in construction activities in the agricultural and rural development sector that meets the requirements to perform the service;

- Have experiences in developing flood maps for inter-provincial projects approved/appraisal by government authority;

- Have experience in the similar service; has set up the system real-time calculation using simulation models for the water system. . Consultant has to provide supporting documentation including website of these systems

- Preferably, Have studied on calculation of the hydrological and overall hydraulic network of the river and canal system in the Mekong Delta

- The technical requirements of the hydraulic modeling software are as follows:

+ Have ability to solve one-dimension hydraulic problems in complex river and canal systems with the influence of upstream floods and tides;

+ Having ability to simulate flood plain flow using flexible 2-D mesh combined with 1-D river and canal network to preserve the volume and momentum of the flow;

+ Having ability to simulate hydraulic works, dykes, embankments and roads.

Table 2: Requirement of expert team

No.	Position	Requirements	Tasks	man-months (*)
I	Key experts			
1	Team Leader / Specialist on Disaster Prevention and Control (01 person)	Have a Master's degree in water resources engineering, disaster prevention, control or other related fields ; A higher degree is an advantage; Have at least 20 (twenty) years of working experience in the field of consulting for hydraulics construction or natural disaster prevention and control; Participated in at least 03 (five) consulting services on developing flood maps in the position of Team Leader; Participated in at least 05 (five) projects of international or multilateral donor organizations; (Having working experience for projects of WB, ADB is an advantage); Proficient in writing reports and communication in English.	Take charge of managing and leading all research activities, maintaining close relationships with CPO, VNDMA /MARD, donors, local (provincial) agencies and other stakeholders to ensure coordination and cooperation between the parties; Take charge of the outputs and manage the inputs, activities and reports of all experts including thematic reports and concept designs; Take charge of and participate directly in the assessment of water resources and water demand, analyze water transport route options, propose technical solutions including nature-based solutions; Monitor progress against service delivery and coordinate the preparation and submission of inception report, semi-annual and annual reports, thematic reports and other research reports; Write research reports including thematic reports.	10
2	Deputy Team Leader / System Simulation Specialist (1 person)	Have a Master's degree in hydrology or other related fields; A higher degree is an advantage; Have at least 20 (twenty) years of working experience in the field of hydrology, hydraulics,	Support Team Leader in managing and directing all research activities, maintaining close relationships with CPO, VNDMA/MARD, donors, local (provincial) agencies and other stakeholders other	10

No.	Position	Requirements	Tasks	man-months (*)
		simulation modeling, system control and operation, IT application in the field of water resources; Participated in developing at least 03 (three) real-time calculation systems using simulation models for water source systems and have at least 2 times assigned as the Deputy Team Leader or higher position; Participated in at least 03 (three) consulting services on developing flood maps in Vietnam and have at least 02 (two) times assigned as the Deputy Team Leader or higher position; Participated in at least 03 (three) projects of international or multilateral donor organizations (Working for project of WB, ADB is an advantage); Proficient in writing reports and communication in English.	stakeholders to ensure coordination and collaboration between the parties; Support Team Leader for all outputs and managing the inputs, activities and outputs of all specialists including thematic research report and concept design; Guide the team to ensure the quality of work meets current standards, compliance with national laws, policies and strategies, as well as World Bank guidelines and requirements; Coordinate the task of data collection, data processing, developing of models, flood maps, automatic calculation system and e-portal; operation system testing, training and transferring; Paticipate in tasks of setting models, developing flood maps and simulation systems; Write research reports including thematic reports and review all reports.	
3	Hydrological and Hydraulic Modeling Specialists (01 people) (Leader of Hydrological and Hydraulic Modeling group)	Have a Master's degree in hydrology or other related fields; A higher degree is an advantage; Have at least 15 years of working experience in hydrological and hydraulic modeling, proficiency in the use of 1D and 2D hydraulic modeling ;	Define input data requirements for mathematical modeling; Determine the domain of the models; Take charge of developing, updating models; model calibration and verification processes; Apply the model	10

No.	Position	Requirements	Tasks	man-months (*)
		Participated in at least 03 (three) consulting services of applying 1D and 2D simulation modeling in flood and inundation calculations in Vietnam as the same position or higher; Participated in at least (03) flood mapping tasks in Vietnam at the same or higher position; Proficient in writing reports and communication in English.	to solve problems in the project; Coordinate with the localities in evaluating the calculation results to establish the flood maps; Take charge of thematic reports on developing mathematical models and creating flood maps; Take charge of guiding the use of simulation models	
4	Specialist on Flood, Inundation and Early Warning (1 person)	Have a Master's degree in hydrology or other related fields; A higher degree is an advantage; Have at least 15 (fifteen) years of working experience in flood early warning, flood control, flood inundation, flood and training to raise awareness on flood disasters; Participated in at least 03 (three) tasks on flood early warning, flood control and flooding in Vietnam at the same or higher position; Participated in at least 03 (three) consulting services on flood map developing in the same or higher position; Proficient in writing reports and communication in English.	Determine input data requirements for early warning; Coordinate with other in sharing information, standardizing data exchange formats and methods; Design structures and components of an early warning system; Design standard of output information of early warning system and information transmission method; Design the structure and components of the decision support system.	10
5	Database Specialist (1 person)	Have a Master's degree in information technology, database or other related fields; A higher degree is an advantage; Have at least 15 (fifteen) years of working experience in	Take charge of coordinating and sharing attribute data with Sub-projects 1.5 and 1.4; Take charge of data standardization design	10

No.	Position	Requirements	Tasks	man-months (*)
		developing databases, software, and portals; Have experience in developing Microsoft SQL Server, My SQL databases; experience in developing software using C#, JavaScript, HTML5 & CSS3, ASP.NET, Entity Framework; experience in developing Web servers: IIS, Apache; Participated in the development of at least three (03) real-time calculation systems for water systems using simulation models; Have good command of English language.	Take charge of designing database Take charge of setting up data servers' Take charge of processing and converting the collected data into the database; Participate in the guidance, technology transfer and system exploitation and operation.	
II	Non key experts			
6	Specialist on Hydrological and Hydraulic Modeling (07 people)	Have a Master's degree in hydrology or other related fields; A higher degree is an advantage; Have at least 15 years of working experience in hydrological and hydraulic modeling, proficiency in the use of 1D and 2D hydraulic modeling ; Participated in at least 03 (three) consulting services of applying 1D and 2D simulation modeling in flood and inundation calculations in Vietnam as the same position or higher; Participated in at least (03) flood mapping tasks in Vietnam at the same or higher position; Have good command of English language.	Define input data requirements for mathematical modeling; Determine the domain of the models; Take charge of developing, updating models; model calibration and verification processes; Apply the model to solve problems in the project; Coordinate with the localities in evaluating the calculation results to establish the flood maps; Take charge of thematic reports on developing mathematical models and creating flood maps; Take charge of guiding the use of simulation models	56

No.	Position	Requirements	Tasks	man-months (*)
7	Specialist on Flood and Infrastructure Investigation (2 people)	Have a master's degree in water resouces or other related fields; A higher degree is an advantage; Have at least 15 years of experience in design consultancy, construction supervision of hydraulic works and disaster prevention. Participated in at least three (03) tasks of design consultancy, construction supervision of hydraulic and disaster prevention works in Vietnam at the same or higher position. Have good command of English language.	Define data collection requirements, data collection scope; Set the data format to be collected, the standard data fields of the attribute database; Take charge of collecting data on meteorology, hydrology, hydraulic works, flood status, infrastructure; Take charge of handling the collected data on meteorology, hydrology, hydraulic works, flood events, infrastructure.	16
8	Climate Change Specialist (1 person)	Have a Master's degree in hydrology, water resources management or other related fields; A higher degree is an advantage; Have at least 10 (ten) years of consulting experience in the fields of climate change, water resources, and disaster risk; Participated in at least 03 (three) consulting services related climate change in the field of water resources, disaster risk in Vietnam at the same or higher position; Have good command of English language.	Coordinate with localities to establish disaster risk scenarios related to climate change; Collaborate with hydrological and mathematical modeling specialists in calculating and determining boundary conditions for disaster risk scenarios related to climate change; Coordinate with hydrological and mathematical modeling specialists and localities in calibrating and vadidating the calculation results and flood maps according to disaster risk scenarios related to climate change.	6
9	Specialist on Food Disaster Risk (02 people)	Have a master's degree in disaster risk assessment and management or other related	Coordinate with localities to establish disaster risk scenarios due to floods, in-field rains, upstream dam	16

No.	Position	Requirements	Tasks	man-months (*)
		fields; A higher degree is an advantage; Have at least 15 (fifteen) years of working experience in research and problem solving related to hydrological and hydraulic modeling, vulnerability assessment and disaster risk; Participated at least 03 (three) consulting services related to disaster risks due to flood, inundation, dam failure at the same or higher position; Have good command of English language.	failure scenarios, and embankment failure scenarios; Collaborate with hydrological and mathematical modeling experts in calculating and determining boundary conditions for disaster risk scenarios; Coordinate with hydrological and mathematical modeling specialists and localities in calibrating and vadidating the calculation results and flood maps according to disaster risk scenarios.	
10	Software Development Specialist (01 people)	Have a Master's degree in information technology, software engineering or other related fields; A higher degree is an advantage; Have at least 15 (fifteen) years of working experience in developing software, databases, portals, and mobile applications; Have experience in developing software using ASP.NET, Entity Framework, HTML5 & CSS3, JavaScript; experience in developing Web servers: IIS, Apache/Tomcat; experience in developing Microsoft SQL Server, My SQL databases; Participated in the developing at least three (03) real-time calculation systems for water systems using simulation models; Have good command of English language.	Take charge of developing software to collect and process data, creating inputs for models and extracting outputs; Take charge of developing softwares that connect to the components of the computing system; Take charge of developing mobile software; Prepare thematic reports, guidance for technology transfer and operation of the system.	16

No.	Position	Requirements	Tasks	man-months (*)
11	Information System Specialist (1 person)	Have a Master's degree in information systems; A higher degree is an advantage; Have at least 10 (ten) years of working experience in developing information systems, databases, and portals; Have experience in developing information systems using ASP.NET, Entity Framework, HTML5 & CSS3, JavaScript, TCP/IP, UDP, Socket protocols; experience working with Web servers: IIS, Apache and Microsoft SQL Server, My SQL databases; Participated in the developing at least three (03) real-time calculation systems for water systems using simulation models; Have good command of English language.	Design structural of information systems and its components; Take in charge of setting up the web server. Take charge of the development of the web portal; security modules, user management; generate report Prepare thematic reports, guidance for technology transfer and operation of the system.	8
12	WebGIS Specialist (01 person)	Have a Master's degree in information technology or other related fields; A higher degree is an advantage; Have at least 10 (ten) years of working experience in developing information systems and portals using WebGIS; Have experience in developing information systems using OpenLayers, Leaflet, Google Map API, HTML5 & CSS3, JavaScript, ASP.NET, Entity Framework. Experience working with databases and servers: Geoserver, IIS, Apache, Microsoft SQL Server, My SQL;	Take charge of coordinating and sharing map data with Sub-projects 1.5 and 1.4 Design structure, normalize map data Take charge of setting up map servers; Take charge of converting the collected data format into the map database; Design WebGIS interface of the system; Take charge of developing WebGIS interactive interface, e- portal; Prepare thematic reports, guidance for technology	8

No.	Position	Requirements	Tasks	man-months (*)
		Participated in the developing at least 03 (three) WebGIS systems in the water sector; natural disaster evacuation and prevention at the same or higher position. Have good command of English language.	transfer and operation of the system.	
13	Specialist on Cartography, Geographic Information System (2 people)	Have a Master's degree in geodesy, cartography, geographic information systems, hydrology, environment, water resources; A higher degree is an advantage; Have at least 10 (ten) years of working experience in measuring, surveying, processing topographic data, establishing topographic maps, flood maps, and disaster prevention and control maps; Have proficiency in using QGIS, ArcGIS, Mapinfo, AutoCAD, MicroStation software; Participated in at least 02 (two) tasks of measuring, surveying, processing topographic data, making topographic maps, creating flood maps in Vietnam at the same or higher position. Have good command of English language.	Take charge of the collection, additional survey of topographic data, cross-section; Participate in designing structural, normalizing map data; Converse format of the collected data into the map database; Prepare thematic reports, guidance for technology transfer and operation of the system.	16
14	Training Specialist (2 people)	Have a Master's degree in hydrological engineering, water resources engineering, disaster management or other related fields; A higher degree is an advantage;	Take charge of training for capacity building on disaster prevention; Design training programs of capacity building; Prepare training materials;	6

No.	Position	Requirements	Tasks	man-months (*)
		Have at least 15 (fifteen) years of working experience in training, capacity building in disaster revention, construction safety; Participated in at least 03 (three) tasks of training capacity building for disaster prevention and control, construction safety, flood map in Vietnam and in the region in the same or higher position. Have good command of English language.	Coordinate specialists for training workshops and capacity building process; Organize technology transfer, guide system exploitation and operation .	
15	Specialist on Sociology and Gender (01 person)	Have a Master's degree in sociology or other related fields; A higher degree is an advantage; Have at least 10 (ten) years of experience in consulting services related to the social sector, resettlement in agricultural and rural development projects; Participated in at least 03 (three) similar consulting services in this position; Have working experience in projects of international or multilateral donor organizations (Having working experience for projects of WB, ADB is an advantage); Have good command of English language.	Carry out investigation and surveys to collect socio-economic data; Advice and assess issues related to society, ethnic, gender and child during project lifetime; Consult and coordinate with private localities to evaluate plans for natural disaster prevention and control; Assist and advise localities in raising awareness of the community; Participate in the preparation of thematic reports.	6
16	Technicals supporting staff	University degree in consultancy and have less than 5 years of experience in consultancy.	Assisting experts in all project activities: data collection, additional surveys, data processing, document preparation, map processing,	120

No.	Position	Requirements	Tasks	man-months (*)
		Recent relevant experience with similar projects in Vietnam.	model calculation domain, result extraction, database development for Web-GIS, cost - efficiency calculation and processing	

(*) The estimated staff time inputs are indicative for the Consultant's reference, the Consultant is encouraged to propose their own staffing plan which best helps to ensure satisfactory completion of the assignment

VII. INFORMATION FOR CONSULTANTS

11. Consultant will be selected by QCBS (Quality Cost- Based Selection) method, in accordance with the World Bank Procurement Regulations for IPF Borrowers published in July 2016 .

12. The estimated time to perform consulting services is 10 months from the date of signing the contract with the estimated total number of man-months for the main expert at 204 man- months and for the support staff at 120 man- months.

13. The type of contract to be applied is a lump-sum contract with the contract amount including all related costs to perform the service: salary, per diem, travel, survey, conference, office rooms, office supplies, computers and all related equipment.

Appendix: Volume additional survey

Table 1: Volume of hydrological and hydraulic survey

No	Content	Unit	Volume	Note
I	**Additional survey and measurement of hydrological factors**			
1	Water level measurement (04 stations x 15 days, measuring mode 24 times per day)	times	1440	
2	Discharge measurement (02 stations x 15 days, measuring mode 24 times per day)	times	720	

Table 2: Topographic survey

No.	Code	Activities	Unit	Weight
1		**Control of ground and altitude**		
1.1	CK.01104	Measurement of horizontal control network grade 4 (in case of not using target). Terrestrial grade IV	point	12
1.2	CL.01104	Measurement of horizontal control network grade 4 (in case of not using target). Terrestrial grade IV	km	6
1.3	CK.04304	Polygonometry grade 2, terrestrial grade IV	point	10
1.4	CL.03104	Technical levelling, terrestrial grade IV	km	2
1.5	CO.01404	Measurement and draw of underwater cross-sections	100 m	20
2		**Expenses for field trip and hiring underwater surveying vehicles**		
2.1		Field trip for topographic survey	trip	1
2.2		Hiring underwater surveying vehicles	day	7

Table 3: The embankment and road survey

No.	Code	Activities	Unit	Weight
1		**Control of ground and altitude**		
1.1	CK.01104	Measurement of horizontal control network grade 4 (in case of not using target). Terrestrial grade IV	point	10
1.2	CL.01104	Measurement of horizontal control network grade 4 (in case of not using target). Terrestrial grade IV	km	6
1.3	CK.04304	Polygonometry grade 2, terrestrial grade IV	point	10
1.4	CL.03104	Technical levelling, terrestrial grade IV	km	3
1.5	CO.01104	Measure and draw the longitudinal section of the route on land	100 m	20
2		**Field trip for the embankment and road survey**	**Trip**	**1**