United Nations Industrial Development Organization

TERMS OF REFERENCE (TOR)

Assessment of Suitable Flood Mitigation Measures (based on Dukniskhevi River Extreme Flood Analysis)

in Tbilisi, Georgia,

CTCN REFERENCE NUMBER: 2016000043

1 BACKGROUND INFORMATION

The Climate Technology Centre and Network (CTCN) is the operational arm of the United Nations Framework Convention on Climate Change (UNFCCC) Technology Mechanism and co-hosted by the United Nations Environmental Programme (UNEP) in collaboration with the United Nations Industrial Development Organization (UNIDO) and supported by 11 partner institutions with expertise in climate technologies. The mission of the CTCN is to promote accelerated development and transfer of climate technologies at the request of developing countries for energy-efficient, low-carbon and climate-resilient development.

These requests for Technical Assistance (TA) are being submitted to the CTCN by the National Designated Entity (NDE) of the respective country. The scope of services under these Terms of Reference shall be executed based on a restricted solicitation process, where only accepted Members of the CTC Network, are eligible to submit proposals. Should the bidder partner with another institution to deliver a minor part of the services described in these Terms of Reference, it is expected that the partner institution also joins the CTC Network.

In case you are not a CTCN network member yet, you may bid for implementation of the technical assistance, subject to the condition that you submit your completed application for CTCN Network membership before the last date of the bid closure and the same is acknowledged by the CTCN. Furthermore, the contract award – should your bid be selected – is conditional to your network membership application having been successfully approved by the Director of CTCN.

The maximum estimated budget for this contract with the range of 150,000 USD to 250,000USD.

2 PROJECT CONTEXT

In the past, the City of Tbilisi was crossed by a number of small rivers and temporary streams. Currently the majority of these streams flow through artificial tunnels, culverts and pipes. The land above these buried river beds is densely populated, occupied by residential houses and other infrastructure. The River Tsavkisistskali (other given names- Leghvtakhevi, Dabakhana) is located in Tbilisi. The River originates from the south-eastern slopes of the Udzo mountain of the Mtatsminda ridge at 1,200 m above sea level. From the left side the River Tsavkisistskali has several small tributaries and two wet gorges. The river banks are low. In the advanced section of the valley is cultivated botanic garden, 175 years old. In the

area of botanic garden the River Tsavkisistskali has generated a deep and narrow gorge (several ten meters). The River Tsavkisistskali enters the Mtkvari River by concrete pipe from the right side at 395 m above sea level at the East end of Sololaki hill. Based on this data, the drop in elevation of the Tsavkisiskhevi (the difference between its source and junction points) exceeds 800 m. The River runs through the ravine and inclination of the slopes is very steep. The length of the river Tsavkisistskali is 9 km, the catchment area is 27 km2. The river is fed by rain, snow, and underground waters. The river is characterized by spring floods and strong flash floods, while hydraulic capacity of the piped and closed river sections is insufficient to carry flood discharges. The annual water discharge makes 0.11 m3 / s, runoff layer is 150 mm, and the module is equal to 4.8 l / km2.

Flash floods and mudflows occurring on these small rivers as a result of heavy rains have hit different parts of Tbilisi, causing heavy damages or even catastrophes with number of victims and big material losses. Such disasters occurred in 1903 and 1955, in which flash floods in the Tsavkisistskali River destroyed large parts of Abanotubani, a district of Tbilisi. More recently, the Vere River flash flood in June 2015 had disastrous consequences. This issue is accelerated due to climate change and due to rapid and improper land development not taking into account natural phenomena of flood hazard.

Technology for flood modelling and mapping is essential to flood prevention and management. With proper suitable technology and specialized flood modelling software it is possible to simulate flood processes and to decide for adequate land development planning, flood prevention, mitigation and adaptation actions based, on flood modelling results.

The National Environmental Agency of Georgia has educated staff with theoretical knowledge in meteorology, hydrology and hydraulics, but with limited access to flood modelling and mapping technology and little practical experience with use of flood modelling software. Previous flood mapping efforts in Georgia were on rivers Rioni and Alazani, but in forms of drawings, based on estimations, historical experience and expert judgement, suffering from lack of technology and know-how.

Therefore, the government of Georgia has requested technical assistance from the CTCN.

3 AIM OF THE CONTRACT

All these necessary actions regarding management of flood disasters in Dukniskhevi River basin, as well as evaluation of climate change impacts on extreme flood regime by the governmental order is the competence of the Hydrometeorological Department (National Hydrometeorological Service (NMHS) of the National Environmental Agency (NEA) of Georgia.

The technology and methodology proposed in the CTCN assistance will set the National Environmental Agency (NEA) of Georgia to a higher level. The proposed activities in the project implementation in Georgia represent an unprecedented work on single river catchment from hydrological modelling, hydraulic modelling, to flood mapping and proposal of flood mitigation and adaptation measures.

The specific objectives for this assistance are as follows:

- In short term, the results of assistance will enable appropriate contingency planning for extreme flood events, based on actual flood hazard maps,
- In close future, measures for extreme flood adaptation could be planned in detail and put in place,
- In long term, proper spatial and land development planning, based on flooding maps, should mitigate flood risk,
- Transferred technology (modelling software) and modelling technique skills of trained personnel will enable effective management of flood risk and modelling of various flood scenarios and land development scenarios in future, building local capacity to respond and readiness for flood events.

The expected outcomes from this assistance are as follows:

- Knowledge of flood regime of the pilot river catchment, including climate change impact,
- Identification of existing structures (culverts, bridges) with insufficient hydraulic performance,
- Flood hazard maps,
- Transferred technology of flood modelling and mapping software tools,
- Trained NMHS of NEA professional staff.

Post-assistance plan consists of actions that should further replicate this project outcomes in other river basins in Georgia and also in the Caucasus region overall. These follow-up actions include:

- The outcomes of the CTCN assistance, as an important step to contribute to the implementation of flood management measures and to increasing the ownership of the transferred methodologies in Georgia,
- The outcomes with knowledge and methodologies to be transferred into the similar river basins and relevant institutions with competencies in flood management in Georgia,
- The overall results, which will be a base for the development of the projects in the field of flood management and hazard management in Georgia in the future,
- Communication and project results discussions between local, regional and nationwide levels will significantly contribute to collaboration and implementation of the flood adaptation and mitigation measures.

Outputs of the project will contribute to flood mitigation and adaptation in Georgia. Knowledge of flood regime in the pilot catchment will enable to asses adequately flood hazard. Produced flood hazard maps of the pilot river catchment in Tbilisi will be deployed to inform land development planning processes in areas of risk. The proposed flood mitigation and adaptation measures will in the future enable to reduce flood damages and consequences. Identification of structures with insufficient hydraulic capacity, often one of crucial flood problems, and proposed adequate dimensions of these structures, will help to reduce flood damages and to serve as an example for improved practice in design and construction. Applied

methodology, transferred technology in form of technical and scientific software tools combined with training of NEA (request proponent) professional staff, will in the future enable replication of the used approach, methodology and technology in number of flood mitigation and adaptation projects in other river catchments in Tbilisi and across Georgia. NEA is national agency with nation-wide operation activity and it´s trained professional staff will be in position to replicate the technology to other river basins.

4 SCOPE AND ACTIVITIES OF THE PROPOSED CONTRACTED SERVICES

To get a better understanding of the objectives of the request for technical assistance, it is recommended that the Contractor refer to the complete Response Plan and the original request submitted by Georgia.

There are 4 main Activities, as detailed below. Aim of the first activity is to create an inventory of available data and selection of suitable methodology and technology for use in next activities. The second activity focuses on modelling of flood scenarios including influence of climate change. The third activity will propose suitable measures for flood mitigation and adaptation in the pilot catchment. The fourth activity consists of technology transfer, training, dissemination and propagation of results.

Activity 1 – Initial analyses and support

In initial phase of the project implementation, contact and base for cooperation between implementing organization, proponent and NDE in Georgia, will be set up. Kick-off meeting will be organized. After detailed inventory of available data and field inspection of the pilot river catchment, suitable flood modeling methodology and needed technology will be defined and described in detail. Needed data will be collected. NEA professional staff will be actively involved in this activity. Outcomes of this activity will be used by other activities, but beside that, they can be partly replicated to other river basins, because the needed data structure and data availability for other river basins in Georgia can be similar, as well as choice of suitable modeling technology.

Activity 1.1 – Data acquisition

Aim of this sub-activity will be field inspection of the pilot catchment and previous flood sites, definition of needed data, inventory and specification of data available, which will be necessary to acquire for the preparation of flood modelling and mapping. During the field inspection, also ecological status of the pilot river basin will be assessed to cover the requirements of the EU Water Framework Directive (WFD) and the EU Flood Directive. Such assessment is needed to avoid interferences in next activities as flood prevention measures. The missing data within this sub-activity will be acquired from available sources. The collected data (digitized, calculated, surveyed) will be stored by NEA and made available to the executing organization for all project implementation activities. No data collection infrastructure, instruments and devices will be installed in the framework of project implementation.

Activity 1.2 – Selection of suitable methodology and technology

Based on gained information about available data and information from site visits of pilot catchment, a suitable methodology and technology for flood modelling and mapping will be selected and described. Technology selection (i.e. modeling software tools) will reflect technical needs of the flooding problem in the pilot catchment, as well as a need for compatibility with specific software tools already in use at NEA.

The contracting company, executing this technical assistance, will need to identify the scientific and engineering software tools for flood modelling and mapping to be used, according to the following specifications (they can be used as a basis and revised, as needed):

1. Software for rainfall-runoff hydrological modelling with following features
    - Lumped hydrological modelling
    - Distributed hydrological modelling
    - Climate change scenario management
    - Possible integration with 1D river channel flow

2. Software for 1D hydrodynamic modelling with following features
    - Fully dynamic solution of the complete St. Venant equations for open channel flow
    - Automatic adaptation to subcritical and supercritical flow
    - Modelling of hydraulic structures and bridges
    - Flood mapping feature
    - Possible dynamic coupling with 2D overland flow model
    - Possible integration with rainfall-runoff model
    - GIS import/ export

3. Software for 2D hydrodynamic modelling with following features
    - Fully dynamic unsteady flow analysis
    - Flexible unstructured computational mesh
    - Flooding and drying feature
    - Modelling of hydraulic structures and bridges
    - Infiltration modelling feature
    - Rainfall on 2D model feature
    - Parallel computing for faster simulations
    - Flood mapping feature
    - Possible dynamic coupling with 1D channel flow model
    - GIS import/ export

The software selected will be suitable for use on standard PC or laptop computer with Windows operational system. No specific brand, name and version of the software is required and this needs to be

proposed by the assistance implementer. The tools will then be procured directly by UNIDO, to be put at the disposal of the implementing organization and the country.

Activity 1 – Deliverables

Deliverables
Kick-off meeting (minutes from the meeting)
Detailed work plan timeline including specific timeline, indicators and targets
Report on data acquisition
Description of suitable methodology and technology for flood modeling and mapping

Activity 2 – Modelling of flooding scenarios

Objective of this activity is to gain information and knowledge about flood characteristics of the pilot Dukniskhevi River catchment. Flood discharges, water levels and flooding extent for both present and future conditions will be determined, accounting for climate change effects. Hydraulic performance of existing structures, such as bridges, culverts, tunnels, will be evaluated. Active involvement of NEA professional staff in this activity will be limited and it is expected to be carried out by the executing organization. However, all the created and used numerical model set ups will be used in Activity 4 (training) together with NEA staff and all the models will remain in possession of NEA, after the project.

Activity 2.1 – Hydrological rainfall-runoff modelling

Flood water discharges in pilot catchment will be determined through this sub-activity. Hydrological rainfall-runoff model simulations will be used to calculate the river flow discharges for locations of interest along the Dukniskhevi River (present state). Flood discharges with 3 probabilities (or return periods), high, medium and small, will be defined.

Activity 2.2 – Climate change scenarios

Impact of climate change on hydrological regime of the pilot river catchment will be studied. Climate change scenarios will be defined and used for recalculation of flood discharges in the pilot Dukniskhevi River catchment (future flood flows accounting for climate change). Time horizon for projection of hydrological regime to future will be decided during project implementation.

Activity 2.3 – Hydrodynamic modelling

Hydrodynamic model of urban area of the pilot Dukniskhevi River catchment will be set up. Flood water levels for 3 different probabilities will be simulated using hydrodynamic modelling. Flood flows

determined in Activities 2. 1 (present state) and 2.2 (accounting for climate change) will be used by hydrodynamic model as boundary conditions. Hydraulic performance of existing structures, such as bridges, culverts, tunnels, will be evaluated to understand the potential impacts of flooding.

Activity 2 – Deliverables

Deliverables
Report on hydrological modelling
Report on climatic scenarios
Report on hydraulic modelling

Activity 3 – Adaptation measures

During this activity flood adaptation and mitigation measures will be suggested. Flood hazard maps will be created based on flood water levels modeled in Activity 2.3. Extent of flooding for present state scenario and for future scenario (accounting for climate change) will be determined. Flood prone zones and vulnerable objects will be identified. Suitable flood mitigation and adaptation measures will be proposed.

Activity 3.1 – Mapping of flood hazard

Mapping of flood hazard will be based on results of hydrodynamic simulations of flood water levels modeled in Activity 2.3. Extent of flooding and water depth for present state scenario and for future scenario (accounting for climate change) will be determined. Flood prone zones and vulnerable objects will be identified. Flood hazard maps of present state scenario will be created for 3 different probabilities (high, medium, low). The 3 different specific probabilities or corresponding return periods will be chosen during the project implementation. Flood extent and water depth for future scenario (accounting for climate change) will be determined for 1 chosen probability of occurrence (1 return period).

Activity 3.2 – Proposal of flood mitigation and adaptation measures

Based on knowledge about flooding extent and flood prone zones, various flood mitigation and adaptation measures will be considered, studied and proposed. A list of possible measures will be assessed and briefly evaluated. After evaluation, most promising measures will be described in more detail. The proposed measures will in the future, after more detailed evaluation and design, enable the country to reduce flood damages and consequences. NEA professional staff will be actively involved in this activity. Outcomes of this activity can be partly replicated to other similar river basins in Tbilisi and Georgia.

Activity 3 – Deliverables

Deliverables
Report on flood mapping
Flood hazard maps
Report on adaptation and flood mitigation measures

Activity 4 – Technology and knowledge transfer

Aim of this activity will be transfer of technology, tools, knowledge and skills defined and used in the project Activities 1, 2 and 3, as well as propagation and dissemination of project results. Technical and scientific software tools, used for modeling and mapping of flooding scenarios, will be delivered to NEA. The cost of software licenses will be covered by project budget and the licenses will be transferred after the project in possession of NEA. Set of technical trainings for 3 to 5 NEA specialists will be organized. Project activities, results, outcomes and lessons-learned will be disseminated in form of leaflets (1000 pcs.) and presentations during evaluation and dissemination workshop. Final report of the project will be created and compiled from outcomes of all project activities. Results of this activity (the delivered specialized software and learned skills) can be used by NEA in other similar river basins in Tbilisi and Georgia.

Activity 4.1 – Specialized software delivery

Specialized scientific and engineering software tools which will be defined in Activity 1.2 and used for flood modeling and mapping, will be delivered to National Environmental Agency. Planned is delivery of specialized software for following purpose: rainfall-runoff modeling including climate change impacts (1 installation), hydrodynamic 1D and 2D modelling (1 installation).

Activity 4.2 – Training

Set of technical trainings for NEA specialists will be organized, both theoretical and on-the-job. The aim of these trainings is to ensure proper usage of the delivered software tools. The trainings will address all relevant technologies and methodologies used in the project, namely hydrological rainfall-runoff modeling including climate change impacts, hydrodynamic 1D and 2D modelling, flood mapping techniques. Together 4 blocks of trainings with duration 3 days each will be organized. 3 to 5 participants from NEA will be trained during each of the trainings.

Activity 4.3 – Dissemination and propagation of results

Propagation leaflets (1000 pcs.) informing about the project implementation, used technology and results will be prepared, printed and distributed. Evaluation and dissemination workshop will be held with relevant stakeholders and organizations in Georgia (identified and contacted in cooperation with NEA and NDE) with the aim of creating awareness and knowledge of the technology transfer. Results of the technical analyses and modelling works will be presented. The workshop will include maximum of 25 participants for duration of half day. Audience for the dissemination workshop will be professional institutions (water management, hydro-meteorology, crisis management), municipality, media. Final report of the project will summarize implementation and results of all the project activities.

Activity 4 – Deliverables

Deliverables
Protocol about delivered software tools
Technical training material and presentations
Summary report and list of participants from trainings
Summary report of evaluation and dissemination seminar
Technical assistance closure report (see template in annex 1)[1]

The project will use the results and outputs from the previous projects in the Caucasus region and in Georgia as follows:

- EuropeAid Project „Programme for the Prevention, Preparedness and Response to man-made and natural disasters in the ENPI East Region (PPRD-East)", 2010 -2014.
- CENN, Strengthening local capacity and developing structured dialogue and partnerships for mitigating natural disasters and reducing poverty in Georgia;
- CENN, Institutional building for natural disaster risk reduction (DRR) in Georgia;
- NATO, 2008. Project SfP 977991 “South Caucasus River Monitoring”. Progress Report, Tbilisi;
- Tacis Project „Joint River Management Programme - Kura Basin“. Final Report, 2004;

[1] When closing the assistance and drafting the closure report, please make sure with the CTCN Secretariat you have the most up-to-date version of the CTCN closure report template

- UNDP/GEF "Reducing Transboundary Degradation in Kura-Aras Basin". Main Deposits, Useful Storage and Current Condition of Groundwater in the Republic of Armenia. Report, Yerevan, 2006;
- USAID South Caucasus Water Programme, Strengthen the Capacity of National Water Resources Management Agencies. Deliverables Report, 2006;
- USAID South Caucasus Water Programme, Strategic Water Monitoring Plan for Transboundary Rivers. Review Report, 2007;
- Adaptation Fund supported Project "Developing Climate Resilient Flood and Flash Flood Management Practices to Protect Vulnerable Communities of Georgia". The focus of the project was on the promotion of the most appropriate mix of structural and non-structural flood management measures. As one of the solutions was developed river basin livelihoods, the use of agroforestry etc. 2013;
- Slovakaid project „Support of the implementation process of the EU Directive on assessment of the flood risks into the legislation in Georgia", 2014.

Furthermore, it will be necessary to coordinate the activities of the project with projects that are planned to be carried out in the near future (UNDP/GEF, USAID, EU, etc.) to use the synergy effects. This will be achieved in cooperation with NEA and NDE, mostly in the frame of Activities 1 and 4.

The activities, progress and outcomes will be closely monitored by the National Designated Entity (NDE) of the CTCN in the country, and the requesting agency.

5 GENERAL TIME SCHEDULE

The activities under this contract should be completed within a period of twelve (12) months from the date of signature of the Contract.

6 PERSONNEL IN THE FIELD (PROFESSIONAL EXPERIENCE AND QUALIFICATIONS)

The Contractor is expected to provide the services of a team that should ideally comprise the following competencies:

- *Proven experience on climate change adaptation, especially on flood mitigation measures, knowledge of flood forecasting and warning systems*
- Proven experience and in depth expertise *in hydrological rainfall-runoff modeling and hydrodynamic modeling with experience in various data sources and formats*
- Proven experience and in depth expertise *in flood mapping and GIS*
- Proven experience in conducting data inventory and acquisition, analysis and processes, and for conducting surveys

- Proven experience in conducting training for staff in this field of work, and in conducting stakeholders consultations
- Proven experience in project coordination and facilitation, preferably in Georgia
- The staff assigned must have previous experience providing technical assistance to governments of developed and/or developing countries exceeding 8 years, preferably in Georgia
- Capacity to works closely with the national counterparts
- Very good conceptual, analytical and writing skills
- Very good networking and facilitation skills

The CVs of the respective experts assigned to this project by the Contractor must be provided.

7 LANGUAGE REQUIREMENTS

The working language for the purposes of this project is English, thus an excellent command of English is required of the proposed personnel. The command of Georgian language would be a strong asset. The final deliverables must be submitted in English, and possibly translated in to Georgian, depending on the requirements of national counterparts and potential donors/investors.

All delivered documents must be of such a quality, so that no further editing shall be required.

8 DELIVERABLES AND SCHEDULE

The table below details the indicative schedule for this assistance. This schedule can be revised in the contractors' proposal.

Deliverables	**Delivery date**
Activity 1	
Kick-off meeting (minutes from the meeting)	*Week 5*
Report on data acquisition	*Week 16*
Description of suitable methodology and technology for flood modeling and mapping	*Week 16*
Activity 2	
Report on hydrological modelling	*Week 30*
Report on climatic scenarios	*Week 30*
Report on hydraulic modelling	*Week 39*
Activity 3	

Report on flood mapping	*Week 43*
Flood hazard maps	*Week 43*
Report on adaptation and flood mitigation measures	*Week 48*
Activity 4	
Protocol about delivered software tools	*Week 48*
Technical training material and presentations	*Week 52*
Summary report and list of participants from trainings	*Week 52*
Summary report of evaluation and dissemination seminar	*Week 52*
Final report of the project	*Week 52*