CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

CTCN Technical Assistance
Response Plan

Country:	Thailand
Request Identification Number:	20150000085

Title:	Strengthening Bangkok's Early Warning System to respond to climate induced flooding

Summary of the CTCN Technical Assistance

Bangkok will flood more often, on a larger scale, and affect millions more people, if current climate change trends continue. The report *Climate Risks and Adaptation in Asian Coastal Megacities* examines the impact of climate change on Bangkok. The report concludes that Bangkok need to take **targeted, city-specific and innovative** approaches to meet these challenges. Bangkok is the capital city and center of national and regional economic growth contributing substantially to the GDP of Thailand. While commendable measures to counteract flooding have already been taken, much more needs to be done, the report argues. Given the damage costs associated with climate change, the report also recommends that governments of coastal megacities undertake proactive measures to address climate risks as an integral part of urban planning. This includes **developing strategic urban adaptation frameworks** for managing climate risks, **strengthening institutional capacity for adaptation and implementing measures** such as land use planning and zoning and **warning systems** to help reduce urban vulnerability. The proposed CTCN TA includes a technology transfer, demonstration and training program to help with early warning of flood. This will benefit the life, reduce traffic disturbances and decrease the people's risks for being exposed to contaminated floodwater (sewage and rain). More specifically, the result of the technical assistance will be an urban flood early warning system, applied for a limited, but representative catchment within the Bangkok Metro area. The system integrates the existing data monitoring network with data integration, modelling and web components provided as part of the technical assistance. The result is an automated, operational system providing information on flood risk zones (extent and duration) by means of web/mobile platforms. Further, the technical assistance will bring additional skills and competences to the staff of BMA and it will outline possible ways to expand the system to a city-wide warning system as well as share and disseminate the findings to other relevant cities and organizations in the region.

1. Overview of the CTCN technical assistance

1.1 Technology aspects

Currently the Bangkok Metropolitan Administration (BMA) has a working monitoring and data collections system, providing real time data for rainfall and water levels at critical points. The city also operates a citywide rainfall radar network, which may be included in the early warning system. Moreover, BMA has developed dynamic rainfall runoff hydraulic models for most of the city. For one sub catchment – the Sukhumvit – a 2D flood model was established in the past, and this model will be one of the components in the warning system. The technical assistance includes several components required to prepare, configure, adopt and deploy the early warning system:

- Review, update and fine tuning of the existing hydraulic 2D flood model to meet the required simulation speed
- Implementation and configuration of data validation routines to secure only validated data are applied for forecasts
- Linking the real time data and the 2D flood model and configure an execution environment to allow for short term forecasts
- Configure and deploy a web based information system (web and mobile) for presentation of early warning forecasts

The technical assistance may also identify if and how the existing weather radar system may provide additional useful information to BMA and the city. The more long-term perspectives includes better management of floods in the city. The increased knowledge capacity combined with the tools delivered as part of the technical assistance will enable BMA to apply more advanced methods and tools in future planning and management.

1.2 Objectives (outcomes)

Through CTCN technical assistance, the major outcomes to be delivered within the duration of the technical assistance are designed to enhance the capacity of BMA to address a number of flood-related issues, particularly creating and early flood warning system for the Sukhumvit district within the metropole. These short-term objectives are as follows:

a) To document and map the current monitoring network, sensors and data collection system. A thorough understanding of the data reliability, accuracy and availability is essential for designing a robust warning and forecast system. The review will also assist BMA in defining and setting priorities for the coming upgrades of the system, outside the scope of this technical assistance
b) All relevant data for the early warning system will be gathered in a time-series database. This database shall be designed particularly to allow for fast processing and enable multiple processes access
c) Evaluate the quality, configuration and flexibility of the weather radar system, particularly if the radar short-term forecasts are applicable to the early warning system
d) The existing 2D flood model of the Sukhumvit area needs to be updated and reconfigured to suit the purpose of running in real-time. The model is implemented using a regular grid resolution. By porting the model to a so-called flexible mesh, a much shorter computation time can be achieved without loss of accuracy
e) The early warning system requires installation of dedicated hardware and software. A suitable server equipped with basic software and databases form the platform for the data and process flow.
f) The deliverables include dedicated high-speed simulation software (Flexible mesh engine), a data integration and management system and a web-configuration tool. Configuration and deployment of the dedicated software is a key part of the technical assistance
g) Knowledge sharing and training of BMA staff as an integrated part of the technical assistance. The participating staff will get additional skills and motivation and participation will enable the staff to further disseminate competences within the organisation
h) Workshop open for attendance from other Thai cities and agencies. The technical assistance outcome will be shared with other interested parties at the end of the technical assistance

1.3 Results (outputs expected from CTCN assistance)

i. With the completed early warning system, BMA have an operational information environment to help manage the consequences of flood and ease the daily life for the inhabitants during floods.
ii. The enhanced competences and skills of the BMA staff enable them to make more comprehensive use of the updated hydraulic flood model. With the option of making further and more detailed analysis, the planning and operation of the drainage of the city will be more cost effective.
iii. The system and the competences achieved by BMA may inspire other cities in Thailand or in the region to implement similar approached, possibly with support from BMA.

1.4 Expected use of outputs

The technical assistance will develop accumulated knowledge and experience within BMA and the other Thai stakeholder. These experiences and the lessons learned can be communicated to a wider group of relevant audience through a series of presentations, papers and other forms of dissemination. They may reach out to both local, national (Thai), regional (SEA) and global levels. BMA may also use the implemented system and the acquired skills to establish a **Learning Centre for Flood Warning**.

BMA remains the sole owner to all the data from the existing system as well as model results. Use of these data is restricted outside the technical assistance and requires approval from BMA. CTCN and the contractor have the right to publish the results, lessons learned and other publications and activity reports of this technical assistance.

2. Description of the Assistance

2.1 Activities

The activities have been grouped into four groups. The first groups focuses on the Technology, both the existing as well as the proposed additions. The second group includes hydraulic model enhancements, a key to achieve the required speed and accuracy. The third addresses the Knowledge and training activities followed by the fourth where possible future directions and finances are examined.

Activity 1 – Inception workshop

As a very first activity, key stakeholders are gathered to be aligned regarding scope, deliverables, time-plan, expectations and individual contributions. Risks and risk management is included in the agenda of the workshop. This workshop will create a joint ownership and ease the collaboration throughout the TA. The workshop will be a 2-day event, and depending on actual interest and input, the participants will attend the full two-days or only relevant parts.

Deliverables	Delivery, weeks after start
Report on stakeholders feedback	2

Activity 2 – Technology

Activity 2.1 Mapping and understanding of the existing BMA data management system

BMA operates and maintain a number of data collection systems. The systems collect monitored data from different types of sensors installed at relevant and strategic locations in the city and the drainage networks. Sensors include rain gauges, water level meters, pump monitors and newly installed rainfall radars. The data collection system – also called SCADA – brings all data to the operational unit, where data are processed, evaluated, and used for decision management. This base of information forms the backbone for the early warning system. Hence, it is important to establish a uniform documentation of the data, their availability, reliability and quality to decide how the individual

parameters can be included in the warning system. This data analysis and review is primarily carried out as inspection at BMA's premises. The data are fed into the forecast model, and poor data will consequently create poor forecasts. This activity will have special focus on the radar data source, including the expected quality of the short term forecast functionality – an inherent feature of the radars that are unexplored in Bangkok.

Deliverables	Delivery, weeks after start
Report on Documentation of existing system	12

Activity 2.2 Review, update and model enhancements
BMA have an existing model of the pilot area in Sukhumvit – a key business district in Bangkok. The model has been developed for analysis of flood risks and includes all major drainage components, including the so-called klongs (open canals), gates, pumps and major lined pipes. The model describes overland flow as well as subsurface flows and is linked with GIS for visualization of flood maps. GIS information in terms of land-use and property value have been included to asses flood risks (combination of flood depth, duration and costs of flooding). A busting city changes constantly – and models describing the city needs to be updated to continue to provide a proper representation of the systems. Hence, the activity will identify major physical structural changes in the drainage system as well as the surface (streets, houses and other terrain adjustments) – and update the model data consequently. The data identification will be a combination of site inspection and review of BMA data repository. Models have many uses and depending on the use case, different requirements are of priority. For flood analysis, high resolution of the terrain and drainage network are important, whereas the computational time is of lesser importance. Very detailed 2D simulations of larger areas run slower than real-time and is thus not suitable for operational use, like forecasts. By reducing the accuracy, the computations are faster – but on expense of the details. There is a delicate balance between speed and accuracy – and the activity will address and identify a proper balance to at the same time have fast simulations without losing the accuracy. Newly developed modelling techniques (like flexible mesh) and software tailored to use the power of multi-kernel PCs for parallel processing makes it possible to achieve both speed and accuracy, and the Sukhumvit model will be tuned to fit to this software.

Deliverables	Delivery, weeks after start
Updated model including report on performance documentation	24

Activity 2.3 Design, configuration and deployment of data and business process system
The documentation and analysis results from Activity 1.1 provide the input for this activity. This activity is mainly a back-office activity. This is the Back-End data integration activity and the core of the technology work package. Selected results from the SCADA system will be transferred to a core database, where data are validated and subsequently used for the model forecast predictions. It is also this component that controls the simulation engine and feeds it with updated boundary conditions in terms of rainfall data, water levels and operational conditions for pumps and gates. The predicted simulation results are stored in the same structure and the database supply the web engine with all information to be published. Significant and substantial BMA involvement is a key for this activity.

Deliverables	Delivery, weeks after start
Core data management system including system documentation	32

Activity 2.4 Design, configuration and deployment of web-based early warning system
During normal operation, there is very little interaction between the operators and the system. The system is configured to work automatically when there is a risk for flood. All information from the system is broadcast to the operators though the web interface. The information includes identification of areas exposed to high flood risks, and the system will provide details on extent and duration. This information may subsequently be used by the operators to redirect or divert traffic from high-risk areas as well as issue general flood risk alarms to the civil population. The final design and layout of the web pages will be decided between BMA and the contractor. The data flow and the suggested flexibility is illustrated in the figure 1.

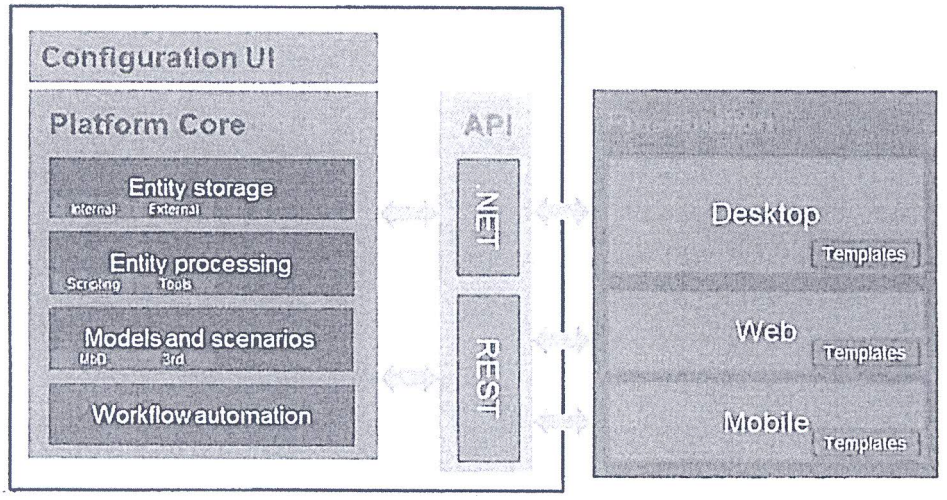

Figure 1 – System overview, showing the interaction between the back-end and front end's (Presentation). The web presentation is based on REST API, allowing for both normal and mobile web access

An example of the web layout is illustrated in Figure 2.

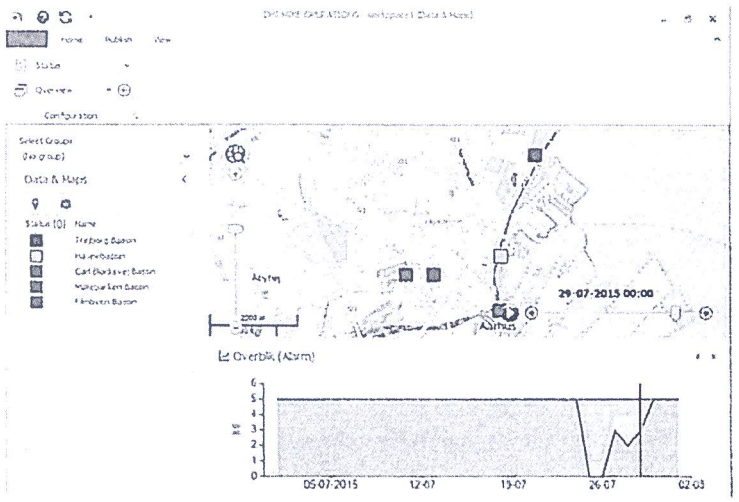

Figure 2 – example of web based info system combining measured data and model based forecasts, showing (in red) where the is a risk for overload of a pumping station.

Deliverables	Delivery, months after start
Web system providing direct access to measurements and model data	44
M&E short summary about lessons learned in activity 2 (section 3.4)	45

Activity 3 – Capacity Building – On-the-job- and a more structured training course

Activity 3.1 On-the-job training

Under supervision of the dedicated international experts and under a detailed work plan, the actively participating BMA staff will receive on-the-job training. Their tasks will be directly related to the development of the model, the configuration of the core data management system and configuration and deployment of the web based reporting system. Through active participation, the BMA staff will achieve a thorough understanding of the system and its configuration. The purpose of the activity is, along with a continued work on the technical assistance jointly with the contractor experts, that BMA can take over the forecasting system after the technical assistance completion and maintain it in operational conditions without need to external consulting services. This activity will extend over the duration of the project.

Deliverables	Delivery, weeks after start
On-the-job training – competences achieved. Small report on topics and areas covered.	34

Activity 3.2 Training course on Urban Flood Modelling

A dedicated, special focused training course on urban flood modelling. Within BMA, there is very limited knowledge and experience with 2D flood modelling. It is essential for the long-term sustainability of the technical assistance as well as a general upgrade of the skill base that relevant BMA officers are offered a one-week training course with hands-on exercises, based on the BMA data. It is suggested to invite up to six BMA staff to participate in the course. A higher number of attendees will requires additional tutors and increase the costs accordingly. Having completed the course, the attendees will have a good basic understanding of the value of models, the limitations and the data needed. Participants completing the course will receive a course certificate.

Deliverables	Delivery, weeks after start
Advanced Urban Flood modelling course including course notes	20
M&E short summary about lessons learned in activity 3 (cf section 3.4)	35

Activity 4 – Dissemination and sharing - workshop

Drawing from the experiences arising from this technical assistance as well as the assumed previous experience from the appointed contractor, the technical assistance will prepare and deliver a workshop to take place in Bangkok. The workshop will be organized in an appropriate and suitable venue, with a projected duration of 3-4 hours. Representatives of relevant local, regional and national authorities (up to a maximum of 20) will be invited to follow the presentations and participate in the discussions addressing issues of urban flooding risks in general, climate change, emergency planning and early flood warning. The workshop will also discuss how to replicate the technical assistance results over a wider area. As part of the workshop the participants will received a technical assistance brief including presentations and discussions of the workshop topics.

Activity 4 – Deliverables

Deliverables	Delivery, weeks after start

Report from Dissemination workshop	50
M&E short summary about lessons learned in activity 4 (cf section 3.4)	52

Activity 5 – Future directions, develop financing options

This technical assistance is designed as a first step in developing the expertise and information required to create a city-wide early flood warning system that can provide a decision-support system to allow operators to better understand the impacts of flood interventions and to adopt more sustainable measures. Therefore, in order to maximise the potential of this demonstration implementation, longer-term funding is required to extend beyond the pilot-project area.

Using national experts, likely to be in the order of three-five people, at least two half-day meetings will be held. Firstly, identify likely future funding streams and secondly, with the results of the CTCN-funded technical assistance to date, to support in identifying relevant proposals for further extension and/or expansion of the current technical assistance to the previously-identified funding bodies. There may be advantage in identifying the funding sources at an early stage and keeping them updated as to the progress of this technical assistance through invitations to some of the workshops and/or dedicated meetings.

Activity 5 – Deliverables

Deliverables	**Delivery, weeks after start**
Report from Meetings and recommendations for additional funding	50
M&E short summary about lessons learned in activity 5 (cf section 3.4)	52

2.2 Synergies and Baseline Setting

Bangkok has been exposed to flood for centuries. There is inherent focus on the flood challenges, and BMA is no exception. As drainage service provider of the city, BMA invest continuously in flood protection measures. The city has a reasonable working telemetry network providing data from water level meters and rain gauges, and most recently invested in rainfall radar system. BMA have also used hydraulic models to help understanding the drainage patterns. The academic world have engaged with Bangkok in a number of relevant research projects, and today there are valuable knowledge in some of the universities and institutes. The basic understanding, knowledge and tools are available, what is lacking is an integration activity like the proposed technical assistance, bringing monitoring and modelling together and combining it with efficient information management.

2.3 Timeline

Activity	Month (assuming technical assistance start 1. June 2016)											
Month #	1	2	3	4	5	6	7	8	9	10	11	12
Month calendar	06/16	07/16	08/16	09/16	10/16	11/16	12/16	01/17	02/17	03/17	04/17	05/17
1 Inception Workshop												
2 Technology												
2.1 Documentation of existing system												
2.2 Updated model												
2.3 Core data management system												
2.4 Web System												
2.5 M&E short report												
3 Capacity Building												
3.1 On-the-job training												
3.2 Advanced training course												
3.3 M&E short report												
4 Dissemination												
4.1 Dissemination workshop												
4.2 M&E Short report												
5 Future												
5.1 Meeting and recommendations												
5.2 M&E short report												
M&E teleconference with country and international partners												

2.4 Expertise required

The required expertise is summarised below. It is envisaged that special qualified experts may cover more than one position. In addition, in addition to the resources listed in the table, it is essential that an experiences Project Manager (PM) be assigned to the technical assistance to secure fulfilment of the scope, including risk management, communication with NDE and CTCN and the stakeholders. The PM position is added to the table. Activity 1 will be conducted by the Project Director and Project Manager appointed by the Contractor. The table includes indicative number of man-days.

Activity 1 – Inception workshop	
Expert 1	Project director and project manager, 5 man/days
Materials	Workshop material, lunch, meeting room rentals,
Others	Travels, accommodation and DSA
Activity 2 - Technology	
Expert 1	IT and Data Integration, 25 man/days
Expert 2	Radar data expert, 5 man/days
Expert 3	Hydraulic and hydrology expert including 2D flood model competences, 25 man/days
Expert 4	Data analysts and web expert, 40 man/days
Local staff BMA	IT- , hydraulic model- and data-analyst experts, 130 man/days
Materials	Suitable server, OS, Antivirus, remote control, , SQL data base, High speed simulation engine, web configuration tool, Integration software
Others	Travels, accommodation and DSA
Activity 3 – Capacity building	
For the on-the-job-training	Active engagement from the Experts staff listed in Activity 1, no additional costs in terms of extra, or separate man/days
Expert 5	Training course tutor, 15 man/days
Local staff BMA	150 man/days
Materials	Course material,
Activity 4 - Dissemination	
Expert 6	Project manager and participation from one or more of the expert 1-5, 15 man/days
Materials	Workshop material, lunch, meeting room rentals,
Activity 5 - Future	
Expert 7	Planning, Financing options, 5 man/days
Activity Project Management	
Expert 8	Project management, communication, technical insights, 20 man/days

2.5 Main partners

Stakeholder	Role to support the implementation of the CTCN assistance
Bangkok Metropolitan Administration - BMA	Main counterpart and primary beneficiary
Thai Meteorological Department - MET	Local weather knowledge, Climate knowledge
Hydro and Agro Informatics Institute, Ministry of Science and Technology - HAII	Data provider, measurements and forecasts from Chao Praya river
Royal Irrigation Department - RID	Data provider, measurements and forecast data

2.6 Indicative budget

Activities	Cost (USD) per activity	Estimated personnel days input from BMA
Activity 1	10.000	15
Activity 2	186.000	130
Activity 3	20.000	150
Activity 4	21.000	20
Activity 5	12.000	5
Two Audits	2.000	0
Grand Total	250.000	335

Note to Budget Estimate: the Personnel costs includes International and Domestic Experts lumped into one figure. BMA input is included as a separate column, unit is days.

2.7 Gender considerations

There is no particular attention to gender aspects in the technical assistance. The overall purpose – to reduce inconvenience and damage due to urban flood will have a positive impact on the city dwellers. As the relative share of low-income people is high, the technical assistance will benefit this group of people.

2.8 Risk identification and risk mitigation

Risk	Consequence	Probability	Mitigation measure
Difficulties in access to information about SCADA etcetera	Reduce accuracy of warning results	20-30%	Through liaison with BMA management, strengthen value
IT infrastructure stability	Intermittent service	10-20%	Focus on robustness in design of data flow

Drainage data for model update is unavailable	Reduced accuracy	10-20%	Use alternative sources, including site visits (added cost)
Staff replacement	System less sustainable	10-30%	Focus on value and learning
Cost overruns	Incomplete system	5-15%	Tight project management and early action

3. Long-term impacts of the assistance

3.1 Expected climate change-related benefits

	CTCN climate technology impact	Anticipated contribution from CTCN assistance
1	Climate technologies adapted to national context are identified and prioritized to enable their deployment and/or transfer in the requesting countries	The early warning system is implemented to support the specific characteristics of Bangkok, and the local staff is trained to operate and maintain the system
2	New national Technology Needs Assessment (TNA) and Technology Action Plan (TAP) as a result of the response	A TNA/TAP update can be initiated as a result of the technical assistance results
3	Progress made against mitigation objectives (i.e. energy and carbon intensity reduction) as a result of the response	NA
4	Progress made against adaptation or resilience objectives (e.g. climate vulnerability index improvement) as a result of the response	The technical assistance focus is reduction of losses from urban floods
5	New mitigation or adaptation technology projects/initiatives implemented as a result of the response	Based on the pilot implementation, additional similar initiatives may be recommended
6	New or strengthened policies/ laws developed, approved and enacted as a result of the response	The result may generate updated recommendations from the flood control authorities
7	New policies/laws where climate change was mainstreamed as a result of the response	Local bye-laws and regulations can be designed to adopt specific measures that accommodate the impacts of climate change, i.e. flood adaptation and flood response
8	Country integrating climate change mitigation and/or adaptation issues into its planning and policies as a result of the response	It is anticipated that at the city-level the government will adopt the findings from this work to better manage flood response and planning authorities will use the results to

		better adapt to future flood risks
9	New or strengthened Public-Private Partnerships (PPP) created directly as a result of the response	There is likely to be an enhanced partnership between the technology recipient (public) and the technology provider (private). Further development of the technology will likely strengthen this partnership
10	New or strengthened twinning arrangement created as a result of the response	The response is looking to develop partnerships as a South-South Cooperation within the Asia-Pacific and South Asia
11	Capacities to access and attract public and private finance increase to enable financing of technology deployment	Activity 4 specifically looks to identify future funding partners to enhance the technology and to broaden its use to other locations.
12	Post-response intervention funding attributable to the response.	NA
13	Framework and analysis of local production developed to enable deployment of national production of climate technologies	The technology transfer can allow the development of an urban flooding Centre of Excellence to disseminate the methods and techniques on to a national and international scale. A potential close cooperation partner could be HAII

3.2 Co-benefits

The aim of the technical assistance is to provide relevant tools and expertise to support operators to reduce the negative consequences of floods in Bangkok. As part of this, the technical assistance also aims to enhance the technical capacity of BMA in order to better support sustainable operation of the drainage of the city. In doing so, the technical assistance also aims to contribute to the long-term viability and sustainability of the affected urban areas. In economic terms, flood alleviation will allow a more resilient economy to develop without the risks associated with flood damage. In social terms, as the threat of flood damages are reduced, it will also produce scope for greater economic development and also produce stronger social cohesion as communities remain *in situ* rather than undergo rehousing or suffer from further flood damage. Additionally the technical assistance addresses some of the UN Sustainable Development Goals as outlined below.

	Sustainable Development Goal	**Contribution from CTCN assistance**
1	End poverty in all its forms everywhere	Reduction in loss of property and possessions through flooding
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	Through the protection of urban arable land from flooding
3	Ensure healthy lives and promote well-being for all at all ages	Reduce occurrence of flood-related disease outbreaks
4	Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	NA
5	Achieve gender equality and empower all	NA

	women and girls	
6	Ensure availability and sustainable management of water and sanitation for all	Better management of water resources
7	Ensure access to affordable, reliable, sustainable, and modern energy for all	NA
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Capacity building creates more water professionals and CIT experts
9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Contributes to government "flood operation and management" activities in future developments. Reduction in flood damage will enhance resilience of infrastructure
10	Reduce inequality within and among countries	Alleviation of flood damage will be of greater benefit to the poor.
11	Make cities and human settlements inclusive, safe, resilient and sustainable	Better flood protection will produce safer, more resilient and sustainable cities
12	Ensure sustainable consumption and production patterns	NA
13	Take urgent action to combat climate change and its impacts	Early warning for flood protection is needed to ensure correct adaptation and mitigation measures are taken
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	By reducing the risk of mixing sewage and storm water, the waste load on the receiving waters is reduced
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Use of ecosystem-based technologies and restoration of terrestrial/coastal ecosystems to increase resilience of city and communities
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	The technical assistance benefits both the more wealthy as well as the low-income groups of people
17	Strengthen the means of implementation and revitalize the global partnership for sustainable development	Contributes to the strengthening of synergies in building resilience to flooding in the region

3.3. Post-assistance plans and actions

If utilised correctly, further results from the model can be used to inform relevant policy makers and planners to build resilience into their strategies well into the future. However, this requires long-term support for the modelling process, in terms of data collection and management, maintaining hardware and software capabilities and maintaining the expertise needed to successfully continue with this endeavour.

With appropriate governmental support, this could be achieved by the inception of some form of agency or institution tasked with the continuation of this technical assistance. On the national level, this task could be a responsibility of HAII. This agency would act as a focal point or knowledge base for all requirements related to urban hydrodynamic flood modelling, flood alleviation and early warning.

Once the capacity building is suitably mature, the flexibility of the system should allow the process to be adapted to other cities, either on the national scale, or at the international scale where a number of cities are undergoing similar problems, e.g. Ho Chi Minh City, Mumbai and Guangzhou.

3.4 Monitoring and Reporting of technical assistance results and impacts

Technical assistance meetings will be conducted, as minimum on a monthly basis. Preferably as physical meetings with a standard agenda. The PM will minute all meetings. The NDE will be invited to attend the monthly technical assistance meeting. Progress reporting will be carried out on a quarterly basis through a brief, written report submitted to the NDE and CTCN.

Expected activities and milestones under this assistance are explicitly described in sections 1.3, 2.1, 3 and the performance indicators table below (see also log frame in annex). Activities progress and deliverables will be monitored closely by the Lead Implementer of this Response Plan with the collaboration of the NDE in Thailand, the request proponent (BMA) and CTCN. The Lead Implementer is responsible for verifying project progress against timeline, associated milestones, and communicates these results to the NDE and CTCN. At the end of each activity, the Lead Implementer will provide a short summary of lessons learned of the activity reflecting on the progress, successes and challenges encountered during the activity. Every month a teleconference with country and international partners is held to communicate the state of advancement of the project, challenges, possible needs for adjustments etc. The Lead Implementer is responsible for planning these. All suggested changes to the activities, processes and/or approaches as outlined in current response plan must be accepted by the CTCN and NDE before they can be applied.

Performance indicators of CTCN Assistance				
Response output *(linking to sec 1.2)*	**How output will be used to ensure creation of result**	**Expected result**	**Expected outcome of result** *(linking to sec 1.1)*	**Anticipated impact that outcome will produce** *(linking to section 3)*
Map of existing conditions	Review of existing system in close dialog with BMA	Overview map of current operating systems established	Increased understanding of the existing systems	Future operations of the drainage system more effective
Time series data base available	Thorough analysis of current systems	Data base with link to BMA system installed and populated with updated real time data	Efficient data repository available	Future operations of the drainage system more effective
Rainfall radar review	Inspection of system, review of documentation and possibly communication with supplier	Clarification if radar forecast can be included in the overall system forecast	Decision if system will include radar forecasts. If not an alternative method, like a general rainfall forecast model will be applied	
2D flood model updated	Review of existing model and changes implemented reflecting the changes in the city	Updated hydraulic model, applicable for additional detailed analyses	Improved analyses tool for BMA	Improved planning and design of the drainage systems
Hardware and software installed	Acquisitions of needed equipment from competitive supplier	Necessary hard- and software in operation	Early warning system can be established	Better information of flood risks provided to the citizen in Bangkok
Model ported to fast computing	Testing a range of improvement actions and implementation	Fast 2D hydraulic model for real-time simulation is available	Efficient and yet accurate forecast system in operation	
Knowledge sharing, training	Identify relevant staff and make a plan listen topics to be covered	Training course and on-the-job training completed	Enhanced skills and competences within the BMA staff	Better planning and operation of the drainage system and higher staff satisfaction
Workshop	Plan content, identify and invite relevant participants	Workshop conducted	Knowledge and experiences from the technical assistance	Knowledge available outside BMA will improve value of

			shared at local, regional and possibly international level	similar systems

4. Signatures

Signatures of the requesting country

NDE National Science Technology and Innovation Policy Office, Thailand
Name: Surachai Sathithunarat
Title: Director of Energy and Environment Dept
Date: 29 Apr. 2016
Signature:

Request Proponent Bangkok Metropolitan Administration
Name: Mr. Sompong Veangkaew
Title: Director General, Department of Drainage and Sewerage
Date:
Signature:

Signatures of the CTCN

CTCN Director

Name: Jukka Uosukainen
Title: Director
Date: 25/04/2016
Signature:

Climate Technology Manager

Name: JADWIGA ENSLER
Title: CLIMATE TECHNOLOGY MANAGER
Date: 25/04/2016
Signature:

Annex 1: Response Logframe

Activity *(link to sec 2)*	Description of sub-activities conducted by the CTCN	Output/ Deliverable *(link to sec 1.3)*	Expected Outcome *(link to sec 3)*	Main national partners involved	Objectively Verifiable Indicator *(see Annex 2 for guidance*	Means of Verification (data source, method of collection, responsibility and periodicity)
Activity 2: Technology	*Activity 2.1 Documentation of existing system* *Activity 2.2 Updated Model* *Activity 2.3 Core data management system* *Activity 2.4 Web system*	Existing system documented Current model is updated Core data system is established Web system is available	Integration is possible Model can be included Data flow from sensor to model Results visible on web	BMA, HAII, MET, RID	Early warning system is available and can be demonstrated	System is documented, timely delivery M&E report for activity 1 reflecting progress of model implementation
Activity 3: Capacity building	*Activity 3.1 On-the-job training* *Activity 3.2 Advanced modelling course*	Involved staff have increased their skills Course participants acquired modelling competences	Staff capable of maintaining and running system Course participants capable of building new flood models	BMA, HAII	Early warning system can be maintained by BMA staff No. of staff trained	System is in operation, staff know all relevant details, timely delivery List of staff trained
Activity 4: Dissemination	*Dissemination workshop*	Relevant stakeholders in the region (utilities, agencies, water institutions, met offices) are aware of the project, the outcome and lessons learned	The result from the Technical Assistance may inspire other organisations to use same approach and benefit from the experiences from Bangkok	BMA, HAII, MET, RID	No. of workshop participants	List of workshop participants Summary report of Workshop

Activity 5: Future direction	*Recommendations*	Mapping and listing of possible financial resources to advance the pilot implementation to a city wide system	Easy accessible information for funding options available for BMA	BMA, HAII	BMA have an additional instrument for long term planning of the improvement of the drainage system for Bangkok No. of possible financial resources identified	Report on possible resources for continuation of the project are identified and reported List of potential financial resources

Annex 2: Indicative list of performance indicators

Overall Activity	Specific Activity	Indicator
Capacity Building	▪ development and delivery of workshops ▪ development and delivery of trainings (e.g. webinars, e-learning, ad-hoc) ▪ development and delivery of toolkits	Number of participants trained or training days received; Post training evaluation and feedback (and minutes); CTCN Knowledge Management System (KMS) users; Webinar content/minutes/feedback; e-learning content/feedback
Advisory	▪ development of needs assessment/ studies/ reports/ etc. ▪ establishment/development of recommendations	Diversity of sources used; Response Implementer efforts days; Recommendations; Scope of dissemination; Level of detail used; Feedback; Uptake of recommendations
Policy development	▪ development of strategy ▪ drafting of implementation plan ▪ formulation inputs to policy/ law	Strategy available and adapted to local context and national priorities; Number of interview/events conducted to developed the strategy/ plan; Strategy/Plan dissemination; Number of technologies recommended in the strategy/plan; Scope of changes recommended by the strategy/plan.
Project implementation	Mitigation ▪ Energy supply ▪ Energy use ▪ Industry ▪ Transport ▪ Agriculture ▪ Waste management ▪ Forestry Adaptation ▪ Water ▪ Infrastructure, transport and urban design ▪ Early warning and environmental assessment ▪ Coastal zones ▪ Agriculture and forestry	Outputs available and adapted to local context and national priorities; Level of private sector participation; Planning/Outputs distributed to decision makers with feedbacks; Integration of outputs/outcomes into planning of host country; implementation of outputs/outcomes by host country or other multi/bi-lateral organization; Level of cooperation between Response Implementer, NDE and Response Proponent(s).

Overall Activity	Specific Activity	Indicator
	▪ Human health ▪ Marine and fisheries	
Development of a new partnership or strengthening of an existing one	▪ Development/ Establishment of basis for Twinning ▪ Development/ Establishment of basis for PPP ▪ Development/ Establishment of basis for knowledge partnership	