Technical Assistance Response Plan – Terms of Reference

Country	**Malawi**
Request ID#	**2022000048**
Title	Using simple mobile technologies to scale up digital collection & processing of climate observations for adaptation actions in Malawi
NDE	**National Commission for Science and Technology** Private Bag B 303, Lilongwe 3, Malawi www.ncst.mw Contact: Mr. Lyson Kampira Chief Research Services Officer +265 1 771 550, +265 999 916 036 lkampira@ncst.mw, lkampira@yahoo.com
Proponent	**Malawi University for Science and Technology (MUST)** Centre for Climate Change and Disaster Risk Management (CCC DRM) P.O. Box 5196, Limbe, Malawi www.must.ac.mw/the-center-for-climate-change-and-disaster-risk-management-research/ Contact: Dr. Vincent Msadala +265 882 750 550, vmsadala@must.ac.mw
Other counterparties	**Ministry of Finance** Mr. Peter K. Simbani Director, Debt & Aid Management Division P.O. Box 30049 Lilongwe 3 Malawi Tel: +265 1 789 355 / +265 888 339 860 Fax: +265 1 789 173 Email: pksimbane@finance.org.mw, secpsdad@finance.gov.mw **Government of Malawi** **Department of Climate Change & Meteorological Services** Mme. Lucy Mtilatila, Director, lmtilatila@gmail.com **Department of Water Resources** Dr Modesta Kanjaye, Director, modesta.banda@gmail.com

Summary of the CTCN technical assistance

This Technical Assistance will complement the Department of Climate Change and Meteorological Services (DCCMS) and Department of Water Resources (DWR) by allowing DCCMS and DWR to extensively test and investigate the use of mobile phone technologies as a solution to comprehensively collect and digitize water, weather and climate observations and apply that data as basis for decision making in dealing with climate change and variability.

A first prefeasibility analysis will be done on the possibility to use simple mobile phones to conduct comprehensive and systematic collection of data for application in impact modelling and developing climate futures for purposes of adaptation and disaster risk management in Malawi. The system will probably include a cloud database that will collect and treat the data received by SMS from simple mobile phones. Once verified, this information will be sent to DCCMS and DWR directly and/or via an online Data Center (database management system). This additional observation data can from there be used to analyse and compare with historical data, daily observation from sensors and satellites and corresponding daily time series of climate projections to derive general and specific data resources for regional impact and adaptation models for Malawi.

The proposed technology is expected to provide techniques to adapt to climate change and provide

practical knowledge and skills to undertake effective data digitization and analysis for impact modelling and adaptation.

Once the prefeasibility finalized and should the technology seem to be implementable in the context of Malawi, the architecture of the system will be designed, defined, shared with the main stakeholders in the country and endorsed before being tested at a scale that demonstrates and validates the technical application potential of the observation data collected.

Additionally, a financial model will be elaborated to ensure the financial viability of the technology in the short, medium and long term in the context of Malawi.

Finally, future users and administrators will be trained to the new technology with "learn by doing" workshops to ensure the technology can be efficiently used once the TA is over.

Agreement:

(If possible, please use electronic signatures in Microsoft Word file format)

National Designated Entity to the UNFCCC Technology Mechanism
Name: Lyson Kampira
Title: NDE Malawi
Date: 04 April 2023
Signature:

Proponent (signature of the Proponent is optional)
Name: Vincent Msadala
Title: Head of Climate Sciences Dept - MUST
Date: 4 April 2023
Signature:

Proponent (signature of the Proponent is optional)
Name:
Title:
Date:
Signature:

Proponent (signature of the Proponent is optional)
Name:
Title:
Date:
Signature:

UNFCCC Climate Technology Centre and Network (CTCN)

Name: Rose Mwebaza
Title: CTCN Director
Date: 22.03.2023
Signature:

Technical Assistance Response Plan – Terms of Reference

1. Background and context

The impacts of climate variability and change fiercely come to light in low-income countries. To adapt, comprehensive analysis of daily observed records, forecasts of climate futures and impact modelling are crucial. But to deliver such climate information, National Hydro-Meteorological Services (NHMS) must collect, process, and integrate weather and water measurements from in-situ, automated and satellite observations.

In Malawi, climate change is worsening the combination of more extreme and frequent floods, with consecutive droughts. Concurrently, the timing of rainy seasons is shifting (Future Climate for Africa brief, 2017). Mean annual temperatures increased by 0.9°C 1960-2006 (McSweeney C. et al., 2013) and floods of recent years have been more severe than previous recorded. On average, floods and droughts cost 1.7% of GDP/yr. Comprehensive analysis of Cyclone Ana in January 2022 concludes that "greenhouse gas and aerosol emissions are in part responsible for the observed increases" (Otto E.L.F. et al., 2022).

Malawians' livelihood and safety are at risk with a changing climate. More than 80% depend on rainfed agriculture for livelihood and food, many live in flood-prone areas, and there are few alternative incomes or options for social mobility. The human costs of extreme events are large. Cyclone Ana of 2022, for example, caused 49 deaths and over 190,000 IDPs, as well as extensive damages to schools, hospitals, bridges, and roads, including disrupted power and water services.
Adaptation through improved climate information services and warnings is critical. But in Africa, only 26% of surface network stations met minimum requirement in 2019 (WMO GCOS 2021). With little change in the preceding nine years, the WMO argues "that recent efforts to improve these statistics have had little impact" (Ibid.). Research on Cyclone Ana found that "observations of rainfall in the region are sparse and contain many instances of missing data, a quantitative assessment of trends is therefore fraught with uncertainties" (Otto E.L.F. et al., 2022).

Malawi's Department for Climate Change and Meteorological Services (DCCMS) and Department for Water Resources (DWR) are looking for technical solutions to reactivate & expand many of its 700+ rainfall, and weather and water resources monitoring stations (surface and groundwater, including land-water processes such as sedimentation). The department argues that it is "one of the challenges the department is encountering in assessing, forecasting weather and developing climate futures for adaptation purposes" (DCCMS, 2020).

Building adaptation to climate risks in Malawi depends on strengthening DCCMS with the capacity to use new additional technologies – thereby elevating its role in society with greater capacities to provide climate information services. This can be supported by providing technical assistance with training and with testing and rolling out the use of improved low-tech mobile and cloud technologies for comprehensive collections of daily observed records for application in impact modelling and adaptation.

In the past decade, several international donors have funded the procurement of weather and hydrological observation solutions (e.g., the World Bank's Shire River Basin Management Project 2012-2019, the UNDP GEF Strengthening Climate Information & Early Warning Systems Project, 2013-2016, and the UNDP GCF Scaling Up the Use of Modernized Climate Services and Early Warning Systems Project, 2017-present.

As a result, approximately 80 physical automated equipment have been installed across Malawi in priority areas. This equipment sends data online using GSM or stores them in local data loggers. The stations rely on solar panels for power and operation and maintenance (O&M) for long-term operations.

The upfront investment cost for automated surface observation equipment is high, yet budgets for reoccurring O&M is insufficient. The cost for one hydrological station from SEBA Hydrometrie was, for example, $23,000 in 2018. And the recently completed Community Based Flood & Early Warning System activity for Malawi entailed installation of monitoring sensors at 21 locations. The in-situ data is combined with downscaled forecasts to provide alerts, yet the low-tech sensors face disruptions

(http://malawi.cbfews.com/). The investment cost was $600,000 (UNDP).

Unfortunately, the investment and installation of several automated stations and sensors are not backed with well-funded maintenance and capacity building and engagement of local staff. As a result, automated equipment often stops functioning due to vandalism, technological breakdown, and the financial constraints of low O&M budgets.

2. Problem statement

The DCCMS and DWR face specific technology barriers* which hinders the national efforts above and which the technology concept focusses on:

1. Inability to assess, select, develop & adapt appropriate new / improved technologies
2. Insufficient human and institutional capabilities
3. Lack of confidence in unproven technologies

These barriers are interconnected. The lack of institutional capabilities reinforces other barriers such as confidence in unproven technologies – which new innovations are by their nature.

Institutions such as DCCMS and DWR also face overall constraints of limited reoccurring budgets from central government to effectively sustain O&M of monitoring systems and to retain adequate staffing in the long-term. If financial and human resources are allocated for project implementation, they are unlikely allocated for projects that appear risky, have small budgets and uncertain outcomes.

Targeted support is therefore needed if NHMSs, such as DCCMS and DWR, is to be able to act as an “early adopter” of new or improved technologies.

There are additional barriers in the larger context of DCCMS and DWR that need to be acknowledged and which the technical concept addresses indirectly. Namely barriers among NHMS, international donors and market actors:

- Lack of understanding of the role of developed and developing countries and international institutions in the failures and successes of past technology cooperation
- Risk aversion & business practices that favour large projects in financial institutions (incl. MDBs)

The technology concept will complement the DCCMS and DWR, and donor efforts listed above, by allowing DCCMS and DWR to extensively test and investigate the use of mobile phone technologies as a solution to comprehensively collect and digitize weather and climate observations (Barrier #1).

MUST’s Center for Climate Change and Disaster Risk Management (CCC DRM) will provide capacity to DCCMS and DWR on the use of mobile phones to conduct comprehensive and systematic collection of data for application in impact modelling and developing climate futures for purposes of adaptation and disaster risk management. Training will be provided on new and improved mobile aggregator and software services and cloud technologies while DCCMS and DWR will integrate the readily available digitized data into its climate database management systems.

The databases and software will be used to analyse the historical data, proposed comprehensive daily observations and corresponding daily time series of climate projections to derive general and specific regional impact and adaptation models for Malawi.

The proposed technology will help to provide techniques to adapt to climate change and provide practical knowledge and skills to undertake effective data digitization and analysis for impact modelling and adaptation

3. Logical Framework for the CTCN Technical Assistance:

(Guidance: Please note that multiple activities lead to one Output, and multiple Outputs lead to one Outcome. There can be several Outputs, but only one Outcome description capturing the CTCN technical assistance. Deliverables are the products or services to be delivered to the NDE/Proponent/CTCN based on the Activities and the Outputs.)

***Objective**:* The objective of the technology concept is to strengthen DCCMS and DWR's capacity and confidence in using simple mobile technologies and integrating these and the related data not only in core forecasting and warning functions but also in impact modelling and adaptation by synergistically relating the data to critical time series of climate projections.

Outcome:
The technology concept will complement the Department of Climate Change and Meteorological Services, the Department of Water Resource and prior donor efforts, by allowing DCCMS and DWR to extensively test and investigate the use of mobile phone technologies as a solution to comprehensively and sustainably collect and digitize water, weather and climate observations.

MUST's Center for Climate Change and Disaster Risk Management (CCC DRM) will provide capacity to DCCMS and DWR on the use of mobile phones to conduct comprehensive and systematic collection of data for application in impact modelling and developing climate futures for purposes of adaptation and disaster risk management. The implementer will provide training on new and improved software and cloud technologies while DCCMS and DWR will integrate the readily available digitized data into its water and climate database management systems.

The databases and software will be used to analyse historical data, proposed comprehensive daily observations and corresponding daily time series of climate projections to derive general and specific regional impact and adaptation models for Malawi.

The proposed technology will help to provide pathways to adapt to climate change and provide practical knowledge and skills to undertake effective data digitization and analysis for impact modelling and adaptation.

Activities and outputs	Months														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Component 1: Development of detailed Work Plan, Monitoring & Evaluation Plan, and communication documents															
Activity 1: *All implementers must undertake the following activities at the beginning and at the end of the CTCN technical assistance.* i) A detailed work plan of all activities, deliveries, outputs, deadlines and responsible persons/organisations and detailed budget to implement the Response Plan. The detailed work plan and budget must be based directly on this Response Plan. ii) Based on the work plan, a monitoring and evaluation plan with specific, measurable, achievable,															

relevant, and time-bound indicators used to monitor and evaluate the timeliness and appropriateness of the implementation. The monitoring and evaluation plan should apply selected indicators from the Closure and Data Collection report template and enable the lead implementer to complete the CTCN Closure and Data collection report at the end of the assignment (please refer to item iv below and section 14 in the Response Plan); iii) A two-page CTCN Impact Description formulated in the beginning of the technical assistance and update/revised once the technical assistance is fully delivered (a template will be provided); iv) A Closure and Data Collection report completed at the end of the technical assistance (a template will be provided).															
Deliverable 1: i) Detailed work plan ii) Monitoring and evaluation plan iii) CTCN Impact Description iv) Closure and Data Collection report	X X X														X
Component 2: Creation of a steering committee, mapping of stakeholders and inception meeting															
Activity 2.1 Kick off call Immediately after the signature of the contract between the United Nations and the CTCN partner selected for the implementation of the project, a virtual meeting will be organized in the presence of the CTCN, and the consulting team so that everyone can introduce themselves. A reminder of the activities to be carried out, the expected results, an updated work schedule will be shared with NDE, and if necessary, a list of documents that may be necessary for the implementation of the mission may be requested from the NDE. This meeting will also be an opportunity to clarify any doubts that the beneficiaries or the CTCN partner may have. The agenda of this meeting could be as follows: i) Presentation of the consulting team and project stakeholders ii) Presentation of the role and function of the CTCN and the NDE. iii) Exchange of reference documents and data sources (national strategy, study, regulations, laws, strategies on climate services/ hydro-meteorological services in Malawi etc., as well as provision of historical observation data and time series) iv) Description of the methodology that will be applied for the prefeasibility study. v) Presentation of the work plan, the activities that will be carried out in this TA, the expected results. vi) Identification of the Stakeholders. vii) Possible questions.															

Activity 2.2: Creation of a steering committee and Mapping of stakeholders The activity will create a steering committee to drive the implementation of the TA and map relevant stakeholders among governmental institutions at the national and sub-national levels. These stakeholders will include at least the NDA, the NDE, the project proponent, the relevant ministries, and possible representative of the private sector specialized on climate and meteorological solutions in Malawi. A key part of the stakeholder mapping will be on the water and climate Gauge Readers and Observers, and beneficiary groupings. From these stakeholders, a restrictive working group (up to 8 people) will be created. The working group shall maintain a gender balance and an adequate representation of vulnerable groups. It will provide a technical overview and high-level guidance at every stage of the technical assistance. For this purpose, the members of the working group should have the capacity to take key decisions with regards to the selection of the appropriate technology, and formulation of policy and legislature that will support its use.															
Activity 2.3: Conduct an inception meeting An inception meeting with the stakeholder working group will be organized to present the team of experts, the goals, milestones, anticipated deliverables, and the responsibility and role of the stakeholder working group. It is expected that this meeting will be held in-person in Malawi, in presence of at least one international expert. The inception meeting should also be an opportunity for the implementer to list and further access any existing relevant documents and data sources including but not limited to laws, regulations, draft of standard operating protocols, ongoing initiatives, programs approved or under evaluation that could support the definition of a policy framework to set up a compliance standards and certification for climate technology or be relevant to achieve any other activities defined in this Response Plan. Taking advantage of their presence in the country, the international expert will plan bilateral meetings with the main stakeholders to gather as much relevant information as possible as well as clearly understand the expectations of the country.															
Deliverable 2:																

2.1 Minutes of the kick-off and inception meeting with list of participants disaggregated by gender, material used during the meeting.															
2.2a) Steering committee 2.2 b) Stakeholder mapping report containing a complete stakeholder list as well as a description of the stakeholder working group (including name, position, institution, gender, and role of each member).	X X														
2.3 a) Inception meeting report with materials, list of participants disaggregated by gender, photos, material used during the meeting. 2.3b) list of bibliographical documents to be shared with the implementer of the institution and person in charge. 2.3c) Planning of bilateral meetings to be held by the international expert while s/he is in the country.		X X X													
Component 3 – Diagnosis and prefeasibility of using simple mobile technologies as a solution to comprehensively collect and digitize weather and climate observations for application in impact modelling and developing climate futures for purposes of adaptation and disaster risk management. The impacts of climate variability and change fiercely come to light in low-income countries. To adapt, comprehensive analysis of daily observed records, forecasts of climate futures and impact modelling are crucial. But to deliver such climate information, National Hydro-Meteorological Services (NHMS) must collect, process, and integrate weather and water measurements from in-situ, automated and satellite observations. But in Africa, only 26% of surface network stations met minimum requirement in 2019 (WMO GCOS 2021). With little change in the preceding nine years, the WMO argues “that recent efforts to improve these statistics have had little impact” (Ibid.). Research on Cyclone Ana found that “observations of rainfall in the region are sparse and contain many instances of missing data, a quantitative assessment of trends is therefore fraught with uncertainties” (Otto E.L.F. et al., 2022). Malawi’s Department for Climate Change and Meteorological Services (DCCMS) and Department for Water Resources (DWR) are looking for technical solutions to reactivate & expand many of its 700+ rainfall and weather stations. The department argues that it is “one of the challenges the department is encountering in assessing, forecasting weather and developing climate futures for adaptation purposes” (DCCMS, 2020). As a result, approximately 80 physical automated equipment have been installed across Malawi in priority areas. This equipment sends data online using GSM or stores them in local data loggers. The stations rely on solar panels for power and operation and maintenance														

(O&M) for long-term operations. Also, the recently completed Community Based Flood & Early Warning System activity for Malawi entailed installation of monitoring sensors at 21 locations. The in-situ data is combined with downscaled forecasts to provide alerts, yet the low-tech sensors face disruptions (http://malawi.cbfews.com/).															
Activity 3.1: Diagnosis of the current systems and equipment available in Malawi to gather climate data The diagnosis will identify the current climatologic information systems and equipment in place to monitor weather and flooding, define their status (operational on hold, obsolete, or other) and localize their placement on a map. It will be particularly important to understand the characteristics of the equipment, information systems, data management systems/software and forecasting/hydrological modelling tools used by DCCMS and DWR to collect, analyse and put to use hydroclimatic information. This part is relevant as the data collected through simple mobile phone will need to be transferred to these systems and applied in the forecasting/modelling tools, and thus it will be the responsibility of the implementer to make sure the format/type of data is compatible. In addition, a list of possible interventions or similar or complementary initiatives that have recently been implemented in the country or in the region will be established in order to identify obstacles or barriers, or on the contrary, good practices that could be replicated in Malawi.															
Activity 3.2 Assessment of needs and requirements of future users and administrators of the system A workshop will be held with representatives of DCCMS and DWR, technical experts in climatology, meteorology and hydrology, as well as end users and administrators to understand the needs and requirements of the system to be developed. This workshop will focus, inter alia, on the following aspects: - Functionalities of the system - Required data and processes for data gathering, treatment, and transformation - Definition of indicators (short-term (up to 3 days), medium-term (e.g. 10 days), seasonal timeframes, etc.) to operate national hydro-meteorological services effectively - Delivery of information (dashboard, downloadable daily summaries, web/mobile, etc.) and frequency															

- Target audience (DCCMS, DWR, communities, farmers, etc.)

The collected information will be captured in a report that summarizes the the needs and requirements for the system. This list of needs will serve as a reference for the design and development the architecture of the system.

Furthermore, a matrix will be developed comparing the information already collected, already available, along with the new data requested in order to cover DCCMS and DWR needs, the functionalities of the system in place, and the upgrade needed to be able to treat and transform the information as expected by DCCMS and DWR.

Activity 3.3: Evaluation of mobile phone technologies as a solution to collect and digitize weather and climate observations

The purpose of this activity will be to evaluate the use of simple mobile phones to be used to send manual observations of weather and climate using simple mobile aggregator services (such as Shared Shortcode SMS) to an online database. From this online database, the implementer will analyze all the systems and technological solutions that would enable the transfer of the data collected through SMS and integration into DCCMS and DWR' database. The objective of the technology concept would be to use the data outputs not only in core forecasting and warning functions but also in impact modelling and adaptation by synergistically relating the data to daily time series of climate projections. This will enable the development of climate futures for purposes of adaptation and disaster risk management.

Based on the needs assessment, this analysis will include the following aspects on the choice of technology options that should be described in details:

- **Data collection:**
  - Device (mobile phone) requirements
  - Type of data collectable and frequency
  - Data transmission mode and format (e.g. Shared Shortcode SMS)
  - Data encoding
  - Connection to online database
  - Geo-localization of the meteorological and hydrological stations from where the data is sent
- **Data processing and analysis**
  - Online database infrastructure (cloud-based, etc.)

- Operating system and programming environment used
- Methods of data processing, formatting, verification and calibration to match data management systems of DCCMS and DWR
- Anomaly detection and quality control through data analysis, filtering, classification and categorization

- **Data storage and visualization**
  - Accessibility of data (online Data Center and/or through API integration with the DCCMS and DWR data management systems (i.e., ClimSoft and HYDSTRA)) and further transmission (API to third parties, etc.)
  - Data delivery and visualization formats (dashboard, data download, etc.) independently and in DCCMS and DWR platforms, as well as frequency and target audience
  - Data characteristics: format/type, language
  - What will be the forecasting period that could be obtained based on the information received (short term forecast -3 days / medium term?)

The ultimate objective of the databases and software platforms will be to provide DCCMS and DWR with the capacity to analyze any historical data in combination with proposed comprehensive daily observations and corresponding daily time series of climate projections to derive general and specific regional impact and adaptation models for Malawi. The objective of this activity is to analyze is such goal is achievable, and what would be the technological options.

Several strategic questions will need to be answered:

- Should the data be shared with other stakeholders apart from DCCMS and DWR experts? How would this be ensured?
- How will the data be transformed into relevant information to DCCMS, DWR and other stakeholders if needed?
- Will the data be accessible online, on the phone, on computers, transmitted by radio, etc.?
- The tools necessary to consult the data (an internet subscription, a telephone, other)?
- How will technology ensure that information gets to remote rural areas? Is that something necessary?
- What are the delays and costs of transmitting information?

Another part of the report will describe the role of the administrator:

- Which national entity will be in charge of administering the information system?
- Who will be able to update the system (all users, only one administrator?)?

• How often will the system be updated? • What is the cost of maintaining the system per year? • What measures will be taken to ensure that the system is properly maintained? (Legal decree, annual budget allocated by whom? How much?) This list of questions only provides an example of the reflections that you be initiated by the implementer. The list is not exhaustive and should be adapted, revised, complemented to ensure that the technologies selected provide solutions to the needs and expectations defined in the previous activity. A report will be redacted to reflect this preliminary analysis, the suggested technological solutions that could be used to provide the expected service to DCCMS and DWR.														
Activity 3.4: Identify the barriers, the challenges, the opportunities and strength of the systems in place at DCCMS and DWR to implement such a technological system Following the previous activities of mapping existing systems, user needs and technology options, the implementer will map the requirements for the proposed systems towards the current DCCMS and DWR systems in place in terms of equipment and software. This exercise will also identify strengths, opportunities, barriers and challenges, as well as risks. The risks could include (but should not be limited to) technological risks (bad quality of the network for example), institutional risk (any laws, regulations that could complicate the implementation of the technology), economical risks (a financial mechanism will be designed as part of the TA to ensure the sustainability of the system), financial risks (cost of the technology , maintenance of the technology) as well as any other risks such as risks of political risks (between governmental agencies, right to access data, etc). Mitigation measures will be suggested when possible. For each of these risks, the implementer will define the level of risks, probability of occurrence, impact on a possible deployment. The document will also identify opportunities and strengths of the systems. As a results of the previous activities, the implementer should be able to define whether this technology concept could (or could not) be implemented in the context of Malawi.														
Activity 3.5: Design the architecture of the systems Based on the results of the previous activities, the implementer will design the architecture of the														

systems in terms of hardware setup (devices used), front-end (visualization in a dashboard, etc.) and back-end (data infrastructure and system connections between SMS, online platform, data centre or data management systems of DCCMS and DWR, as well as data analysis). The final result is a visual prototype. In addition, a user manual (technical and final user) will be developed for the system and its functionalities. A summary report matching the needs identified by the DCCMS and DWR (Activity3.2) and the proposed system functionalities and architecture will be developed. This detailed report will then be shared with the restricted working group at least one week before the next activity – the validation of the prototype technology.															
Activity 3.6: Organize an in-person meeting to validate the prototype technology A one-day workshop will be organized in Malawi with the stakeholder working group and the participation of at least one expert from the team of consultants. The objective of this workshop will be to introduce the functionalities of the system, the characteristics of the mobile phone system connected to DCCMS and DWR data management systems, the best configuration suggested for an efficient use of the system, and the possible technologies identified along with its estimated full cost (including installation, use and maintenance). It is considered that a full day will be requested for this workshop. In the morning, the results of activity 2 & 3 will be presented. In the afternoon, the stakeholder working group will analyze the design and architecture and discuss which technology (equipment) would fit better the county´s needs (in case more than one technology be shortlisted in activity 4). The workshops will also allow time for questions, comments, suggestions, questions, of the stakeholder working groups. At the end of the session, the stakeholder working group should have agreed on one specific technology (in case more than 1 technology was pre-selected during the activity 4).															
Deliverables 3:															
3.1a Diagnosis of the climatic, meteorologic and hydrological systems of information available in Malawi and the region 3.1b List of recommendations, barriers, opportunities of the existing equipment in view of the deployment of the technology to be tested 3.1c List of previous international or similar / complementary initiatives implemented in Malawi		X X X X													

3.1d IT characteristics of DCCMS and DWR´s data management systems		X													
3.2a Minute of the workshop with list of participants disaggregated by gender, agenda, material 3.2b A report that will summarizes the clear definition of the needs as defined by the client. This list of needs will serve as a reference and as Terms of References while defining the architecture of the system. 3.2c A matrix comparing the information already collected, already available, along with the new data requested in order to cover DCCMS and DWR needs, the functionalities of the system in place, and the upgrade needed to be able to treat and transform the information as expected by DCCMS and DWR			X X X												
3.3 Preliminary analysis of the use of simple mobile phones as a solution to comprehensively collect and digitize weather and climate observations				X											
3.4 Report on the possible challenges, barriers, risks, opportunities, and strengths defined by the level of risks, probability of occurrence, impact on a possible deployment of the solutions proposed in the previous report (3.3)				X											
3.5a Draft architecture of the systems as well as user manual. 3.5b Matrix explaining which needs (as defined in 3.2) could be reached and which ones won't be reachable.					X										
3.6 Minute of the one-day workshop with list of participants disaggregated by gender, agenda, material, photos					X										
Component 4- Piloting the use of mobile phone technologies as a solution to comprehensively collect and digitize weather and climate observations. Before jumping into the piloting of the technology, the sites where the project will be piloted should be selected based on a set of criteria that will be defined and discussed with the stakeholder working groups. Some of the criteria will be mandatory criteria such as: - The area benefit from an in-situ weather and water management equipment (one active or new weather or hydrological monitoring station of emerging importance) - The area should also have informants (Gauge Readers and Observers): experts that are qualified to transfer the relevant information by sms to the cloud. - Importance of data for critical and prioritized water, weather and climate change challenges facing Malawi. Such criteria should be defined as "selection criteria": - Vulnerability assessment of the site (a desk analysis of existing data will be done and if															

needed completed with satellites data, historical data). The most vulnerable sites to flood, drought and sedimentation changes will receive the higher score, while the less vulnerable will be ranked lower. - Demographics of the zone: High densified zone, as well as strategic zones for key national infrastructure and agriculture for food security will ranked the highest. - Quality of internet / mobile phone connection could also be a key factor - Existence of indigenous people could also be taken into account - Risk of vandalism of the material - Others to be defined between the implementer, the NDE and the project proponent. - Cost consideration of necessary on-site training of Gauge Readers and Observers in terms of travel distance, fuel, car rental and staffing. These criteria will be defined in a matrix and scored to prioritize the most critical locations in Malawi where the system should be tested. The 10 best locations will be identified.	
Activity 4.1 Select the best sites for the piloting Before jumping into the piloting of the technology, the sites where the project will be piloted should be selected based on a set of criteria that will be defined and discussed with the stakeholder working groups. Some of the criteria will be mandatory criteria such as: • The area benefit from an in-situ weather and water management equipment (one active weather and hydrological monitoring station) • The area should also have informants (Gauge Readers and Observers): experts that are qualified to transfer the relevant information by sms to the cloud. • Importance of data for critical and prioritized water, weather and climate change challenges facing Malawi. Such criteria should be defined as “selection criteria”: • Vulnerability assessment of the site (a desk analysis of existing data will be done and if needed completed with satellites data, historical data). The most vulnerable sites to flood, drought and sedimentation changes will receive the higher score, while the less vulnerable will be ranked lower. • Demographics of the zone: High densified zone, as well as strategic zones for key national infrastructure and agriculture for food security will ranked the highest. • Quality of internet / mobile phone connection could also be a key factor	

• Existence of indigenous people could also be considered • Risk of vandalism of the material • Others to be defined between the implementer, the NDE and the project proponent. • Cost consideration of necessary on-site training of Gauge Readers and Observers in terms of travel distance, fuel, car rental and staffing. These criteria will be defined in a matrix and scored to prioritize the most critical locations in Malawi where the system should be tested. The 10 best locations will be identified based on critical rivers across Malawi and will not be proportioned based on region.															
Activity 4.2: Organize a one-day workshop with the stakeholder working group to discuss the preliminary ranking of selected sites A one-day workshop will be organized in Malawi with the stakeholder working group to discuss and agree on the location where the technology and the system should be tested. The implementer will explain the methodology applied to rank the sites and present the preliminary list of selected sited. This list will be reviewed based on the Stakeholder´s working group and a final list of sites will be chosen.															
Activity 4.3 Plan the implementation of the pilot project The implementer will prepare a detailed implementation plan (workplan) for the deployment of the pilot. This report will provide in a clear, complete and precise manner all the specificities of the pilot implementation, included but not limited to the technical, human, financial requirements for the implementation of the pilot project in the selected area, as well as the role and responsibilities of each entity. This may include but will not be limited to: • Number of people required to deploy the technology • Time required to deploy and make the technology working properly • Composition elements of the technology (measurements, length, weight, material, connection etc., in particularly for monitoring of sedimentation). • Basic implementation guide. • Necessary equipment (including a maintenance guide) • Conditions of use • Logistics: work plan, time for the technology to be tested in Beta and in deployment ready condition, person in charge of deployment, etc.															

Activity 4.4 Organize an online meeting to discuss the logistics and implementation of the pilot Following the elaboration of the detailed implementation plan, the implementer will set up a virtual meeting with the stakeholder working group to present the detail of the deployment of the pilot, including the expected timeline and persons in charge of the different steps to be followed to ensure the success of the operation. The implementer will review the work plan based on the relevant comments received and will send back a final version of the implementation plan.	
Activity 4.5 Organize on-sites workshops with the representatives of the communes in which the pilot will be tested Once the pilots' areas will be selected, the implementer with the support of its local team of experts will ensure that each of the selected communes are adequately informed about the project, about the objective of the pilot, the reasons they have been selected, the final purpose, the advantages of piloting the technology in their communes, and their responsibility (avoid acts of vandalisms on equipment for example). These communications will be done in-person to make sure the project is approved and receives the support from the selected area. Should one of the areas be against the pilot, it will not be implemented. For this purpose, it is highly recommended to contact the Mayor of the commune, as well as the informants, and if relevant the representative of the district where the monitoring equipment is installed.	
Activity 4.6 Purchase / route / install the needed equipment to the selected areas The implementation plan will be deployed, and the needed equipment will be purchased, routed, installed to the pilot areas. Please note that the budget used for the purchase of equipment should not exceed 35,000 USD. The team leader as well as technical team of experts will be on site, in Malawi for this phase of deployment as is necessary, financially viable and elevates the quality of on-site training and deployment.	
Activity 4.7 Implement the small-scale project in the pilot area In presence of the team leader and technical team of experts, the simple mobile phones connection	

to the online Data Center and/or directly into the data management systems of DCCMS and DWR will be deployed and made operational. The implementer will solve any issues or problems that could make the technology difficult to use, or that could lower the efficiency of the technology. Once this test will be finalized, it is expected that the technology will work in an efficient manner, meaning that all functionalities will be activated and that the country will be able to start using the data received through sms as a reliable decision-making tool. The activity shall be evaluated at the 3-month mark to fully capture the technical and design viability of the solution and approach. Thereafter Gauge Readers and Observers shall continue data collection for another 3 months. The latter phase of data collection will enable evaluation of the application and scalability value, particularly to the important impact modelling and adaptation by synergistically relating the data to daily time series of climate projections modelling.														
Activity 4.8: Development of the digital system integrated with the DCMMS and DWR Data Management Systems In parallel to the deployment of the equipment needed to collect the data from the ground, the digital system prototype as defined under Activity 3.5 will be developed in terms of data infrastructure, back-end and front-end. This system prototype will receive and treat the information received from SMS, and the improve the DCCMS and DWR data management systems to receive, treat and transform this new data into weather and water forecasting and modelling with effective data visualizations and integrations.														
Activity 4.9: Demonstration Workshop (5h) of the prototype to the restricted working group A demonstration workshop of the prototype (equipment and system) will be held with the restricted working group. This will be a practical and interactive demonstration of the Data Center and potential upgrades to the DCCMS and DWR data management systems. It is important that the members of the restricted working group have time to test the system by themselves and time to ask any questions that could come to their mind. The budget for this workshop considers the rental of equipment (IT-equipment, internet connection) for one day and for a maximum of 8 people in order to facilitate a proper demonstration and testing of the system.														
Activity 4.10: Adjustments to the demonstration prototype and pilot demonstration														

The modified and adjusted demonstration systems based on the comments received during the previous workshop will become a pilot demonstration during which data will start to be received from SMS to the Data Center and to DCCMS and DWR data management systems through direct API integration (as possible and requested). During three (3) full months, the members of the restricted working group will be able to test the systems and to provide feedbacks. During this period, the implementer will be available and may be asked to organize online demonstrations to clarify recurring questions or help a user or an administrator. If bugs are identified, the implementer will fix them.														
Activity 4.11: Validation of the final prototype A meeting will be held with the members of the restricted working group to validate the modified system.														
Deliverables 4: 4.1) Preliminary assessment of the possible sites for the pilot						X								
4.2 a Minute of the one-day workshop with list of participants disaggregated by gender, agenda, material, photos 4.2 b Final selection of the sites where the technology should be deployed						X								
4.3 Detailed implementation plan (workplan) for the deployment of the pilot.						X								
4.4 a Minute of the meeting with list of participants disaggregated by gender, agenda, material 4.4b Final implementation plan for the deployment of the technology						X X								
4.5 a Minute of the local workshops with list of participants disaggregated by gender, agenda, material, photos 4.5 b Official endorsement of the communes for the deployment of the pilot. (letter, email, writing confirmation)							X X							
4.6 Report on the reception, installation of the equipment's on the ground with pictures, short explanations, name of personnel involved.							X							
4.7 Report demonstrating the start of the testing of the equipment technology on the ground with pictures, short explanations, name of personnel involved.							X							
4.8 Development and operationalization of the digital system							X							
4.9 Minute of the demonstration workshops with list of participants disaggregated by gender, agenda, material, photos							X							
4.10 – Report on updated equipment and digital system											x			
4.11 - Minute of the validation of the technology workshop with list of participants disaggregated by gender, agenda, material, photos											X			

Component 5- Designing a financial mechanism that would make this technology concept sustainable in the context of Malawi														
Activity 5.1: Cost analysis of the system During this activity, the implementer will provide an estimated annual budget for a 15 years period on the cost of maintaining the system operating, updated, functioning at full and best of its capacity and efficiency. This budget will include, but will not be limited to: • Cost of the equipment's (replacement of the equipment when needed) • Cost of the informants • Continuous training of the informants • Training of DCCMS and DWR • Cloud database (that received and treat the sms/mobile data and send it to DCCMS and DWR data management systems, i.e., API integration) • Maintenance and update of cloud-based data center and API integration into DCCMS and DWR data management systems. • Cost of integration and harmonization of other sources of observation data, particularly emerging earth observation data sources • Monitoring equipment • Cost of maintenance • Cost of installation • Cost of operation														
Activity 5.2 Define business model(s) that would ensure the system is financially sustainable The implementer will design at least one and up to 3 business models to ensure the system can be financially sustainable in the context of Malawi for at least the next 15 years.														
Activity 5.3: Business model presentation workshop During the validation workshop, the draft business models will be explained to the stakeholder working group, It is expected that the different scenario, functionalities, options, flexibility, price of the system, as well as the maintenance and technical service designed will be explained to stakeholder working group. The limits, bottlenecks, advantages of each financial models will be explained to the stakeholder														

working group and inputs will be received. The objective of this meeting will be to understand what business model seems to be the most relevant for the country, what changes should be considered, what functionalities, costs should be added / considered.														
Activity 5.4: Review of the business model based on the inputs from the workshop until reaching the final version endorsed by the stakeholder working group. Following the workshop, the most relevant business model will be adapted, modified, updated to consider all the relevant inputs received from the stakeholder working group. A revised version of the business model will be submitted to the stakeholder working group for review. Up to 3 rounds of comments could be requested under this activity until reaching the final version. This final version will be deeply explained to the Stakeholder working group during a meeting.														
Deliverable 5.1 Cost analysis of the system								X						
5.2 At least one and up to 3 business models to ensure the system can be financially sustainable in the context of Malawi for at least the next 15 years									X					
5.3 a Minute of the Business Model validation workshop, with list of participants disaggregated by gender, agenda, material, photos 5.3 b: From the 3 BM presented, one is selected by the restrictive working group									X X					
5.4 a Up to three rounds of review on the Business Models 5.4 b Final business model											X	X		
Component 6: Train future users, administrators and beneficiaries of the system														
Activity 6.1 Redact a detailed manual on the use and maintenance of the technology This manual should include all relevant and exhaustive information that the county needs for a correct and effective use and maintenance of the implemented system aiming at using simple mobile phone to as a solution to comprehensively collect and digitize weather and climate observations. The long-term sustainability of the system depends on the ability of future users and administrators to use and maintain efficiently and sustainably the technology. The manual should include but is not limited to: • clear indications on when, what and how maintenance should be made to the system: when material should be replaced, where should equipment be purchased, estimated price, estimated time for delivery, conditions of the guarantee for the equipment and its component,														

and every detail that will be needed by the country to make an efficient use of the technology. • How and how often should the equipment on the ground be replaced / maintained • Requirements related to the cloud database • Requirements related to the online Data Center and its integration with DCCMS and DWR data management systems and models as well as any other source of data from sensors and satellites. • This manual will also include a step-by-step description of the deployment of the technology • This manual will describe best practices and a clear list of practices to be avoided. • Other important aspects. This manual will be designed in English and could be translated, if required into up to 1 more local languages according to the instructions of the stakeholder working group and considering a possible scale-up of the project to other provinces of the country. This manual should be created in a digital manner (youtube video) as well as a word document printed and delivered to the users of the system. An electronic version of the manual in the different languages will be provided to the NDE and the NDA under the format of their choice (iCloud, WeTransfer, usb key, else).														
Activity 6.2 Organize a training for future users and administrators of the system as well as municipal and national officer This workshop will be organized over 3 days in order to encourage the participation of i) the technicians who will be in charge of the administration of the system, ii) the users of the system, iii) civil society: NGOs, private sector, other ministries not represented in the restricted working group and other relevant stakeholders, including iv) national and municipal relevant officers (including the ministry of agriculture, ministry of environment, of water use and protection, and others). • For system administrators, special attention should be paid to building the capacity of local technicians in programming and local data processing. Administrators should be trained in the applied programming language (syntax and semantics) and the architecture and management of the operating system, software configuration, and data processing. A manual describing all the steps will be drawn up to ensure a certain autonomy of the teams in transferring the knowledge.														

• For the users, the workshop should focus on the use of data as a tool for prioritized user-groups of climate services – e.g., water resources use for agricultural planning and management, hydropower and early warnings. During this workshop, it will be explained how the data provided are adapted to their needs, how to interpret these data, the speed of transmission, the frequency of data updates, and the equipment necessary for its operation. This will be explained in an introductory page of the information system. • For the civil society, the workshop will focus on the impact that this tool could have on key areas of adaptation, such as early warning systems if used correctly. Vulnerable populations (women and youth) will be encouraged to participate. • For national and municipal officers, the technical assistance will be briefly explained, and the pilot projects will be communicated. Systems functionalities will be explained to them, and the manual designed in activity 6.1 will be shared. The objective of this training is to create the capacity for these leaders to disseminate information about this new system.														
Deliverables															
6.1 Detailed manual in both digital version (YouTube video) and printed version (up to 3 translations in local language requested).												X			
6.2 a Minute of the capacity building workshop with the future users, with list of participants disaggregated by gender, agenda, material, photos 6.2 b Minute of the capacity building workshop with the future administrators, with list of participants disaggregated by gender, agenda, material, photos 6.2 c Minute of the capacity building workshop with the civil society, with list of participants disaggregated by gender, agenda, material, photos													X X X		
6.3 Minute of the capacity building workshop with the future users, with list of participants disaggregated by gender, agenda, material, photos													X		

Technical Assistance Response Plan – Terms of Reference

1. **Resources required and itemized budget: 200,000 USD maximum**

Activities and Outputs	**Input: Human Resources** *(Title, role, estimated number of days)*	**Input: Travel** *(Purpose, national vs. international, number of days)*	**Inputs: Meetings/events** *(Meeting title, number of participants, number of days)*	**Input: Equipment/Material** *(Item, purpose, buy/rent, quantity)*	**Estimated cost** *Please accumulate the costing at Activity and Output level and provide an estimated costing range for each activity and the total Response Plan*	
					Minimum	**Maximum**
Component 1: **Development of implementation planning and communication documents**						
Activity 1.1: Formulation of a) Detailed work plan, ii) Monitoring and evaluation plan, iii) CTCN Impact Description, iv) Closure and Data Collection report.	IE1: 5 days NE1: 5 days	/	/	/	$3 500,00	$3 850,00
Component 2 – Creation of a steering committee, mapping of stakeholders and inception meeting						
Activity 2.1: Creation of a steering committee and Mapping of stakeholders Activity 2.2: Conduct an inception	IE1: 5 days NE1: 5 days	/	/	/	$3 500,00	$3 850,00

meeting						
Component 3 – Diagnosis and prefeasibility of using simple mobile technologies as a solution to comprehensively collect and digitize weather and climate observations for application in impact modelling and developing climate futures for purposes of adaptation and disaster risk management.						
Activity 3.1: Diagnosis of the current systems and equipment available in Malawi to gather climate data	IE1:5 days IE2:2 days NE1:5 days NE2:2 days	/	/	/	$4 900,00	$5 390,00
Activity 3.2 Assessment of needs and requirements of future users and administrators of the system	IE1:3 days IE2: 3 days IE5:3 days NE1:2 days NE2:1 day NE3:1 day	International Travel - IE1 International DSA - IE1 Local Travel - NE1, NE2, NE3, 5 participants Local DSA - NE1, NE2, NE3, 5 participants	Meeting Room Workshop - Supply	/	$9 320,00	$10 252,00
Activity 3.3: Evaluation of mobile phone technologies as a solution to collect and digitize weather and climate observations	IE1:5 days IE2 : 2 days IE3: 1days IE4:1days IE5: 1days NE1: 5 days NE2:2 days	/	/	/	$6 400,00	$7 040,00
Activity 3.4:	IE1:2 days	/	/	/	$2 100,00	$2 310,00

Identify the barriers, the challenges, the opportunities and strength of the systems in place at DCCMS and DWR to implement such a technological system	IE2:1days NE1:2 days NE2:1 days					
Activity 3.5: Design the architecture of the systems	IE1: 3 days IE2:1 days IE3:1 days IE4:1 days IE5:10 days NE1:2 days NE2:2 days	/	/	/	$8 800,00	$9 680,00
Activity 3.6: Organize an in-person meeting to validate the prototype technology	IE1:3 days NE1:2 days NE2:1 days NE3:1 days	International Travel - IE1 International DSA - IE1 Local Travel - NE1, NE2, NE3, 5 participants Local DSA - NE1, NE2, NE3, 5 participants	Meeting Room Workshop - Supply	/	$6 320,00.	$6 952,00.
Component 4- Piloting the use of mobile phone technologies as a solution to comprehensively collect and digitize weather and climate						

observations.						
Activity 4.1 Select the best sites for the piloting	IE1:1day IE2:1day NE1:3 days NE2:3 days	/	/	/	$2 200,00	$2 420,00
Activity 4.2: Organize a one-day workshop with the stakeholder working group to discuss the preliminary ranking of selected sites.	IE1:3 days NE1:1day NE2:1day NE3:1day	International Travel - IE1 International DSA - IE1 Local Travel - NE1, NE2, NE3, 10 participants Local DSA - NE1, NE2, NE3, 10 Participants	Workshop - Meeting Room Workshop – Supply	/	$7 220,00	$7 942,00
Activity 4.3 Plan the implementation of the pilot project	IE1:5 days IE2:1day IE3:1 day IE4:1 day IE5:1 day NE1:1day NE2:1 day	/	/	/	$4 900,00	$5 390,00
Activity 4.4 Organize an online meeting to discuss the logistics and	IE1:1 day IE2:1 day NE1:1 day NE2:1 day	/	/	/	$1 400,00	$1 540,00

implementation of the pilot						
Activity 4.5 Organize on-sites workshops with the representatives of the communes in which the pilot will be tested	NE1:10 days NE2:10 days NE3:1 day	Local Travel - NE1, NE2, 2 participants Local DSA - NE1, NE2, 2 participants	/	/	$6 020,00	$6 622,00
Activity 4.6 Purchase / route / install the needed equipment to the selected areas	Equipment	/	/	/	$35 000,00	$35 000,00
Activity 4.7 Implement the small-scale	IE1:5 days IE2:5 days IE5:5 days	/	/	/	$7 500,00	$8 250,00

project in the pilot area						
Activity 4.8: Development of the digital system integrated with the DCMMS and DWR Data Management Systems	IE3: 13 days IE4: 15 days IE5:2 days	/	/	/	$15 000,00	$16 500,00
Activity 4.9: Demonstration Workshop (5h) of the prototype to the restricted working group.	IE1: 3 days NE1:1 day NE2:1 day NE3:1 day	International Travel - IE1 International DSA - IE1 Local Travel - NE1, NE2, NE3, 10 participants Local DSA - NE1, NE2, NE3, 10 Participants	/	/	$8 720,00	$9 592,00
Activity 4.10: Adjustments to the demonstration prototypes based on the comments received during the previous	IE1:1 days IE3:5 days IE4:5 days IE5:3 days NE1:1 day		/	/	$7 200,00	$7 920,00

workshop.						
Activity 4.11: Validation of the final prototype	IE1:3 days NE1:1day NE2:1day NE3:1day	International Travel - IE1 International DSA - IE1 Local Travel - NE1, NE2, NE3, 10 participants Local DSA - NE1, NE2, NE3, 10 Participants	Workshop - Meeting Room Workshop –Supply	/	$7 220,00	$7 942,00
Component 5- Designing a financial mechanism that would make this technology concept sustainable in the context of Malawi						
Activity 5.1: Cost analysis of the system	IE1 IE6 NE1	/	/	/	$3 200,00	$3 520,00
Activity 5.2 Define business model(s) that would ensure the system is financially sustainable	IE1 IE6 NE1	/	/	/	$3 200,00	$3 520,00
Activity 5.3: Business model presentation workshop	IE1 NE1 NE2	International Travel - IE1 International DSA - IE1	Workshop - Meeting Room Workshop – Supply	/	$6 220,00	$6 842,00

	NE3	Local Travel - NE1, NE2, NE3, 10 participants Local DSA - NE1, NE2, NE3, 10 participants				
Activity 5.4: Review of the business model based on the inputs from the workshop until reaching the final version endorsed by the stakeholder working group.	IE1 IE6 NE1	/	/	/	$1 700,00	$1 870,00
Component 6: Train future users, administrators and beneficiaries of the system						
Activity 6.1 Redact a detailed manual on the use and maintenance of the technology	IE1 IE2 IE3 IE4 IE5 NE1	/	/	/	$5 100,00	$5 610,00
Activity 6.2 Organize a training for future users and administrators of	IE1 NE1 NE2 NE3	International Travel - IE1 International DSA - IE1 Local Travel -	Workshop - Meeting Room Workshop - Supply	/	$21 560,00	$23 716,00

the system		NE1, NE2, NE3, 25 participants Local DSA - NE1, NE2, NE3, 25 participants				
Estimated range of costing for the entire Response Plan					$189 840,00	$205 324,00

2. Profile and experience of experts

Based on the required Human Resources identified in section 4 (Resources required and itemized budget) please provide a description of the required profile of all involved experts for the implementation of the CTCN Response Plan.

Experts required	Brief description of required profile
International experts	
International Expert 1: Team Leader and expert in Climatic Information Services (Hydro-Meteorology)	- A minimum of 12 years of relevant work experience in climate information services and water resources management - Demonstrated experience in developing countries is required, preferably including Malawi. - Excellent abilities to interact with local stakeholders, collect and evaluate data and transform the information into high quality documentation tangible to the target audience. - Experience in Project and financial management - Excellent written and communication skills in English
International Expert 2: Expert in hydrology, remote sensing and water management	- A minimum of 10 years relevant work experience in hydrology, flood modelling, remote sensing and water management. - At least 3 demonstrated experience in water management, water modelling, water forecasting in Africa. - Excellent abilities to interact with local stakeholders, collect and evaluate data and transform the information into high quality documentation tangible to the target audience, and ensure capacity building. - Knowledge in climate services is a plus - Excellent written and communication skills in English
International Expert 3: Data Scientist & Back-end Developer	- At least 5 years of experience in managing complex data projects responsible for creation, design, development of digital information and data management systems. - At least 5 years of experience in the back-end development and coding of database management and processing systems including building the technical functions for integrating data from SMS/mobile aggregator services and data from parallel API sources. - At least 5 years of experience attesting to this experience.
International Expert 4: Front-end developer	- At least 5 years of experience in the front-end development of database functions and processing, building on the back-end architecture. - At least 5 years of experience attesting to this experience
International Expert 5: UX/UI Designer	- At least 2 years of experience in the user experience and user interface design process where ultimate Data Center functions are designed against the user needs and pain points. - At least 2 years of experience attesting to this experience.
International Expert 6: Economist	- Master or above in economics, finance, management of companies, international economics, water economics, or affiliate - Minimum of 10 years' experience in designing financial analysis and business models. - At least 5 references in the economic analysis for climate services (e.g., NPV, RoI, Full Cost of Ownership of technologies etc.) - At least 3 experiences in developing business models for the developing countries - Previous experience in Africa or in southern Africa will be valued. - Fluency in English is mandatory.

National experts	
National Expert 1: Expert in water management, hydrology and meteorology/ climate information services (National Coordinator)	- A minimum of 10 years relevant work experience in water management in Africa, climate risk analysis, and in analyzing climatic, hydrological and meteorologist data, in creating climate forecast, climate modelling in Africa. - At least 5 demonstrated experience in in the collection of water data, hydrological monitoring, treatment of water data, and work on the ground in Africa - Knowledge in meteorological system is a plus - Excellent abilities to interact with local stakeholders, collect and evaluate data and transform the information into high quality documentation tangible to the target audience. - This expert is expected to be based in Malawi or to have the possibility to travel to Malawi frequently and for long period of time. - A strong knowledge of the country of Malawi is requested.
National Expert 2: Water and climate expert (Project Officer)	- A minimum of 2 years experience working on water, weather and climate related projects in Malawi. - BSc or MSc Training in water management, climatology, meteorology or similar.
National Expert 3: Expert in gender	- A minimum of 5 years relevant work experience in the field of gender equality and gender mainstreaming. - Formal training in gender analysis and gender planning and demonstrated expertise in mainstreaming gender in projects and programmes. - Excellent abilities to interact with local stakeholders, collect and evaluate data and transform the information into high quality documentation tangible to the target audience. - At least 5 previous work experience in Africa is required. - Excellent written and communication skills in English. - Presence in Malawi desired or great availability to travel frequently and for long periods of time.

3. Intended contribution to impact over time

Please provide a brief description of the intended contribution to impact over time of the outcome and outputs provided by this technical assistance on resilience to climate change and/or carbon abatement. To the extent possible, please quantify the intended impact contribution, for example by indicated estimated number of people potentially impacted over time, GDP contribution of the focus sector, carbon emissions by the focus sector, etc. This intended contribution to impact is what will happen if the objective (as articulated in section 3) is met. Please ensure relevant complementarity with text in sections 7 to 12. (Maximum 1250 characters including spaces).

This Technical Assistance will ensure progress is made towards adaptation and resilience to climate change because of the data collected and stored in data bases for the DCCMS and DWR to help the country plan and become more resilient to climate change impacts.

4. Relevance to NDCs and other national priorities

Please identify relevance and contribution from the technical assistance to the Nationally Intended Contributions (NDC) and other relevant national prioritized efforts (TNAs, TAPs, NAPs, NAMAs, etc.). (Maximum 2500 characters including spaces)

The technology concept aligns with, and directly contributes to several policies, objectives and activities of the Government of Malawi, including the strategic adaptation actions of Malawi's updated NDC (2021).
The proposed project concept is in line with the National Climate Change Management Policy (NCCMP) of 2016 under Outcome 4 that promotes 'research, technology development and transfer' in relation to 'strengthened and enhanced systematic observations.
The concept supports the following actions under the NDC's Objective: improve capacity for data and information management and sharing, and access to technology and financing for adaptation:

- Development & implementation of a research programme on climate change impacts and CCA actions (e.g., Activity D).
- Implementation of a capacity-building plan and integration of CCA into curricula (DCCMS) (e.g., Activity C).

The concept further supports one keystone adaptation strategy in The National Adaptation Plan (NAP, 2020). In the NAP, the concept will support the goal to "improve weather and climate forecasting and monitoring of climate (adequate database and easy access for all people)".
The Malawi Growth & Development Strategy III (2017) guides all investments. The concept will directly contribute to outcome improved weather and climate monitoring for early warning, preparedness, and timely response, in the Strategy's action to "promote effective and efficient generation, analysis and utilization of reliable, responsive, high quality, up to date and timely climate services", and "improving spatial weather and climate monitoring and prediction systems through automation". In the Strategy's objective for enhanced climate change research and technology development, the concept supports "promoting research, technology development and transfer in climate change and meteorology".
Finally, the concept overall supports Malawi's National Climate Change Investment Plan's objective generate climate change adaptation technologies suitable for Malawi.

5. Linkages to relevant parallel on-going activities:

Please identify relevant previous and ongoing public and private sector initiatives, projects, or programmes that the CTCN assistance will specifically build on and contribute to. To the extent possible, please add practical and operational details on the linkages between existing activities and the CTCN assistance. (Maximum 2500 characters including spaces)

In the past decade, several international donors have funded the procurement of weather and hydrological observation solutions (e.g., the World Bank's Shire River Basin Management Project 2012-2019, the UNDP GEF Strengthening Climate Information & Early Warning Systems Project, 2013-2016, and the UNDP GCF Scaling Up the Use of Modernized Climate Services and Early Warning Systems Project, 2017-present.

As a result, approximately 80 physical automated equipment have been installed across Malawi in priority areas. **This equipment sends data online using GSM or stores them in local data loggers. The stations rely on solar panels for power and operation and maintenance (O&M) for long-term operations.**

The upfront investment cost for automated surface observation equipment is high, yet budgets for reoccurring O&M is insufficient. The cost for one hydrological station from SEBA Hydrometrie was, for example, $23,000 in 2018. **And the recently completed Community Based Flood & Early Warning System activity for Malawi entailed installation of monitoring sensors at 21 locations.** The in-situ data is combined with downscaled forecasts to provide alerts, yet the low-tech sensors face disruptions (http://malawi.cbfews.com/). The investment cost was $600,000 (UNDP).

Unfortunately, the investment and installation of several automated stations and sensors are not backed with well-funded maintenance and capacity building and engagement of local staff. As a result, automated equipment often stops functioning due to vandalism, technological breakdown, and the financial constraints of low O&M budgets.

6. Anticipated follow up activities after this technical assistance is completed:

Please describe the expected future use of the outputs and deliveries produced by this technical assistance, after the CTCN implementation is completed, towards contributing to the anticipated impacts over time articulated in section 6. For example, what organizations or stakeholders will use the outputs of the technical assistance after it is completed, for what purpose, at what scale and scope the outputs and deliveries will be applied, when and what will be the next steps undertaken, etc. (maximum 2500 characters including spaces)

Following this TA, and if the technology piloting has been a success, the project could apply to the Component 3 of the AFCIA programme that is the preparation of a Concept Note and a Full Proposal for up to 5 million USD.

7. Gender and co-benefits:

Imbedded in design of the activities:	Capacity building at DCCMS and DWR, and the training and engagement of, Observers and Gauge Readers will be performed in a manner that ensure the inclusion of female staff and Observers and Gauge Readers. Observers are enlisted by the DCCMS and Gauge Readers by DWR. As part of training for testing, the station ID, climate variable format and timing, phone number, name, gender, livelihoods, and age is registered with their consent. Observers and Gauge Readers are integral to the solution, and allows evaluation of engagement per gender, age and location. From engagement, training and to completion, we will actively engage female Observers and Gauge Readers, and demonstrate the value both genders bring to the solution. In exploring the format and design of improved climate information services, such as warnings, the recipient will need to be considered, including female beneficiaries alongside male, and how they can access mass-communication and warnings (e.g., mobile ownership is higher for men than

	women in Malawi). The development of specific adaptation models for the key relevant sectors will emphasize on the integration of climate change into planning, development, coordination and monitoring in a gender sensitive manner.
Gender and co-benefits intended as result of the activities:	*Please describe all gender aspects, women's equality and other co-benefits expected as a result of the CTCN technical assistance.*

8. Main in-country stakeholders in implementation of the technical assistance activities:

Using the table below, please list and describe the role of in-country stakeholders, participants and beneficiaries who will be involved in or directly consulted during implementation of the assistance.

In country stakeholder	Role in implementation of the technical assistance
National Designated Entity National Commission for Science and Technology Private Bag B 303, Lilongwe 3, Malawi www.ncst.mw Contact: Mr. Lyson Kampira Chief Research Services Officer +265 1 771 550, +265 999 916 036 lkampira@ncst.mw, lkampira@yahoo.com	Strategic guidance to ensure alignment with Malawi's plans for adaptation and NDC Activities and leveraging its results for greater uptake.
Designated Authority Ministry of Finance P.O. Box 30049, Lilongwe 3, Malawi Contact: Mr. Peter K. Simbani Director, Debt & Aid Management Division +265 1 789 355, +265 888 339 860 pksimbane@finance.org.mw, secpsdad@finance.gov.mw	Strategic advice on leveraging results of technology concept in the planning and mobilization of long-term financing for the sector.
Project Proponent Malawi University for Science and Technology (MUST) Centre for Climate Change and Disaster Risk Management (CCC DRM) P.O. Box 5196, Limbe, Malawi www.must.ac.mw/the-center-for-climate-change-and-disaster-risk-management-research/ Contact: Dr. Vincent Msadala +265 882 750 550, vmsadala@must.ac.mw	Role: Project management, research and community outreach The center performs research, technology and innovation in climate and earth sciences. The Center will also manage activities related to capacity building and scientific analysis for enhanced use and integration in impact modelling, forecasting, climate adaptation and warnings.
Ministry of Forestry and Natural Resources Department of Climate Change & Meteorological Services P.O. Box 1808, Blantyre, Malawi wwww.metmalawi.gov.mw Contact: Mr. Charles Vanya, Mr. Amos Mtonya +265 1 822 014 charlesvanya@gmail.com, amosmtonya@gmail.com	The DCCMS will participate in training and testing to validate and integrate technical concept in forecasting, adaptation, impact modelling and warning services.
Ministry of Water and Sanitation Department of Water Resources	The DWR will participate in training and testing to validate and integrate technical concept in

Private Bag 350, Lilongwe 3, Malawi Contact: Chikondi Mbemba +265 999 232 708 chikondimbemba@gmail.com	hydrological and flood forecasting, adaptation, impact modelling and warning services.
National Hydro-Meteorological Services (NHMS)	Must collect, process, and integrate weather and water measurements from in-situ, automated and satellite observations.
Observers	Data collection using simple mobile technologies
Department of water resources	Participate in the consultation process
Civil Society	Provide comments on the project

9. SDG Contributions:

*Instructions: Please complete the grey section below for **a maximum of three SDGs** that will be advanced through this TA. A complete list of SDGs and their targets is available here: https://sustainabledevelopment.un.org/partnership/register/.*

Goal	Sustainable Development Goal	Direct contribution from CTCN TA (1 sentence for top 1-3 SDGs)
1	End poverty in all its forms everywhere	
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	Yes, The TA will have a secondary benefit in promoting sustainable agriculture resulting from the impact modelling that will result from collecting the necessary weather data and disseminating to the people of Malawi including farmers.
3	Ensure healthy lives and promote well-being for all at all ages	
4	Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	
5	Achieve gender equality and empower all women and girls	
6	Ensure availability and sustainable management of water and sanitation for all	Yes- From the acquired data, flood management can be achieved as a secondary benefit arising from a more resilient and data driven Department of Climate Change and Meteorological Services that can then advise first responders before and during flooding seasons
7	Ensure access to affordable, reliable, sustainable, and modern energy for all (consider adding targets for 7)	Solar pumping systems are also related to RE as they work with solar energy.
	7.1 - By 2030, ensure universal access to affordable, reliable, and modern energy services	
	7.2 - By 2030, increase substantially the share of renewable energy in the global energy mix	
	7.3 - By 2030, double the global rate of improvement in energy efficiency	
	7.a - By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy	

	efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	
	7.b - By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support	
8	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all	
9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	
10	Reduce inequality within and among countries	
11	Make cities and human settlements inclusive, safe, resilient, and sustainable	
12	Ensure sustainable consumption and production patterns	
13	Take urgent action to combat climate change and its impacts	The use of simple mobile technologies to scale up digital collection & processing of climate observations for adaptation actions in Malawi is a direct response to combat the impacts of climate change by adapting accordingly.
	13.1 - Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	
	13.2 - Integrate climate change measures into national policies, strategies, and planning	
	13.3 - Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	
	13.a - Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible	
	13.b - Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth, and local and marginalized communities	
14	Conserve and sustainably use the oceans, seas, and marine resources for sustainable development	
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	
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	
17	Strengthen the means of implementation and revitalize the global partnership for sustainable development	

10. Classification of technical assistance:

Please indicate primary type of technical assistance. Optional: If desired, indicate secondary type of technical assistance.

Please tick off the relevant boxes below	*Primary*	*Secondary*
☐ 1. Decision-making tools and/or information provision	X	☐
☐ 2. Sectoral roadmaps and strategies	☐	☐
☐ 3. Recommendations for law, policy, and regulations	☐	☐
☐ 4. Financing facilitation	☐	☐
☐ 5. Private sector engagement and market creation	☐	☐
☐ 6. Research and development of technologies	☐	☐
☐ 7. Feasibility of technology options	X	☐
☐ 8. Piloting and deployment of technologies in local conditions	X	☐
☐ 9. Technology identification and prioritization	X	☐

Please note that all CTCN technical assistance contributes to strengthening the capacity of in country actors.

11. Monitoring and Evaluation process

Upon contracting of the implementing partners to implement this Response Plan, the lead implementer will produce a monitoring and evaluation plan for the technical assistance. The monitoring and evaluation plan must include specific, measurable, achievable, relevant, and time-bound indicators that will be used to monitor and evaluate the timeliness and appropriateness of the implementation. The CTCN Technology Manager responsible for the technical assistance will monitor the timeliness and appropriateness of the Response Plan implementation. Upon completion of all activities and outputs, evaluation forms will be completed by the (i) NDE about overall satisfaction level with the technical assistance service provided; (ii) the Lead Implementer about the knowledge and learning gained through delivery of technical assistance; and (iii) the CTCN Director about timeliness and appropriateness of the delivery of the activities and outputs.

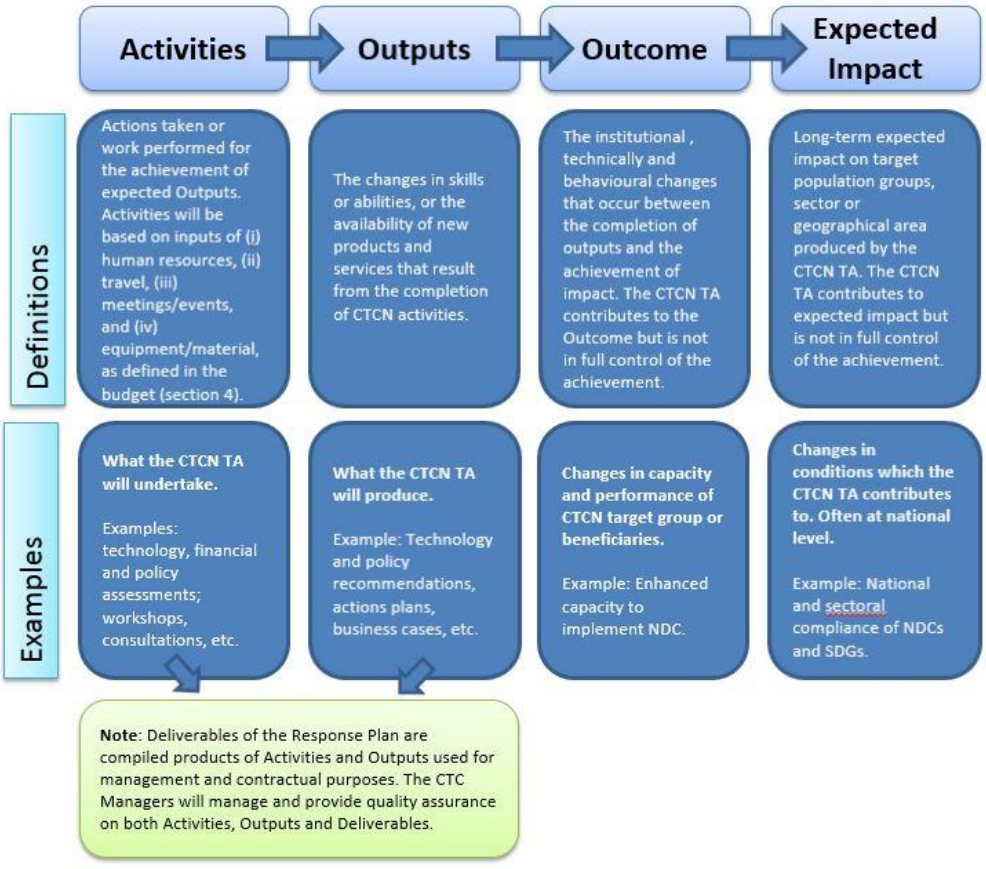
Annex 1: Guidance note for designing a Response Plan (to be deleted when submitting the Response Plan)

1. Objective of the Response Plan

The Response Plan is developed by CTCN specialists in response to a country request for technical assistance. It constitutes the Terms of Reference of the CTCN technical assistance that will be provided to the country, and it provides the formulation of and subsequent basis for the monitoring and evaluation of the Response Plan implementation, as well as its expected outcomes and anticipated impacts.

2. Results chain and Logical Framework Approach to be defined in the CTCN Response Plan

The result chain is the causal sequence that stipulates the necessary flow of actions and processes to achieve desired objectives and results – beginning with inputs, moving through activities and outputs, and culminating in individual outcomes. The outcome will contribute to the desired impact in the society. The Logical Framework Approach is an analytical process used to support objectives-oriented project planning and management. It provides a set of pre-defined concepts which are used as part of an iterative process to aid structured and systematic analysis and management of the CTCN technical assistance.



3. Role of the Response Planning Design Team

The Response Planning Design Team is selected by the Climate Technology Centre (CTC). The composition of the team depends on each request but may include the National Designated Entity

(NDE), the request Proponent, Climate Technology Manager of the CTCN, experts from the CTCN Consortium, UNIDO and UNEP experts from regional offices and other experts as needed.

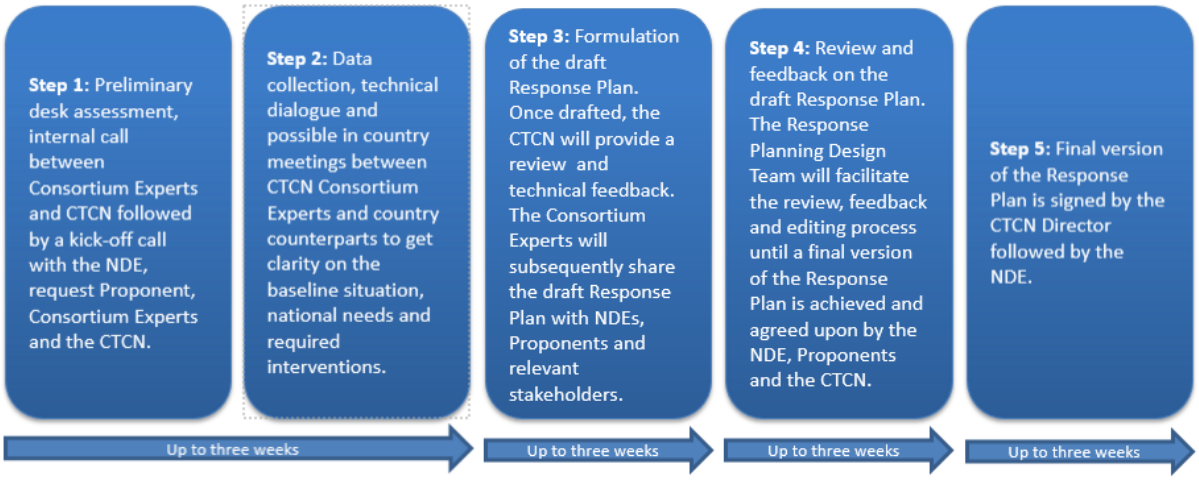
The role of CTCN Consortium experts is to lead the design of the Response Plan. The NDE will provide overall guidance on national context and priorities whereas the request Proponent will provide more detailed information on the sector, barriers and requested assistance. The Climate Technology Manager of the CTCN will provide quality assurance of timeliness and appropriateness of the Response Plan.

The Response Planning Design Team will draft all sections of the Response Plan template building on the information contained in the CTCN Request, based on expertise on the given topic and potentially further data collection, as required. This will be done by the CTCN Consortium Experts in consultation with the NDE, request Proponent and relevant stakeholders. The Response Plan must be agreed to and approved by the NDE and the CTCN Director. This Response Plan will serve as the basis to identify, select, and engage an expert institution from the Climate Technology Network or Consortium to lead the implementation of the CTCN Response Plan in the requesting country.

To the extent possible, staff from UNEP and UNIDO Regional, Sub-Regional and/or National Offices should be involved in all stages of formulation of the Response Plan to maximize synergies and avoid overlap with ongoing initiatives, as well as ensure relevance to regional and national context.

4. Process for designing the Response Plan

The Response Planning process should be completed over a period of up to 60 working days (12 weeks). Indicative steps and related timelines are laid out below:



5. Design Considerations

To maximize the impact of the technical assistance provided by the CTCN and provide an effective M&E process, the Response Plan should integrate as much as possible the considerations below:

Climate Technology focus: The Response Plan should have a clear focus on climate technologies, and identify activities that enable the identification, development, deployment, or diffusion of one or several specific technologies (including equipment, techniques, knowledge, and skills).

Barrier removal / Problem solving: The activities should contribute to address the specific problem statement identified in the Request. The barriers identified should be those hampering the identification, development, deployment, or diffusion of one or several climate technologies or climate actions. Therefore, it may be necessary to limit the CTCN Response Plan to a set of activities for technical assistance commonly agreed with the NDE (and Proponent when needed) compared to the original request submitted. The CTCN will liaise with NDEs and Proponent in case the scope of the technical assistance deviates from the original request.

Use of the CTCN assistance by stakeholders: The Response Plan should identify clearly how the products of the CTCN assistance will be used in the short term once support is delivered, by who and when, to ensure it will lead to specific impacts in the country. The activities should engage the stakeholders that will use the concrete results of the assistance to deploy the technologies, including from the private sector, the public sector, research institutions, etc.

Within the scope of CTCN resources: The cost of the technical assistance provided by the CTCN cannot exceed USD 250,000 per Response Plan. Therefore, it may be necessary to prioritize activities and limit the CTCN Response Plan to a set of priority activities commonly agreed with the Proponent and the NDE to remain under this value. Under section 4 of the Response Plan template, an indicative activity-based budget should be presented. The proposed budget is indicative and should present an estimated costing range per activity, output as well as a total costing range for the delivery of the Response Plan. Once the Response Plan is finalised and published for tendering, interested parties will provide competitive offer against the indicative budget.

CTCN activities and outputs should be linkable to monitoring and evaluation indicators: All proposed activities and outputs must be linkable to monitoring and evaluation indicators that are specific, measurable, achievable, relevant, and time bound. The monitoring and evaluation process and corresponding indicators will be developed by the Lead Implementer as part of the work plan and will allow the CTCN technology Manager to monitor the timeliness and appropriateness of the implementation.

Synergies with existing efforts: The Response Plan should focus on activities that are not already being fully supported or that are in the process of being fully supported by another national, regional, or international organization. Synergies and complementarity also require that the CTCN assistance is not duplicating past activities. It is possible in the Response Plan to indicate co-financing from the government, the Proponent, or another stakeholder, that will maximize the effectiveness of the CTCN assistance.

Gender mainstreaming: The CTCN mission is to build or strengthen developing countries' capacities to identify technology needs, to facilitate the preparation and implementation of technology projects and strategies considering gender considerations. The Response Plan must therefore describe how gender considerations will be included and monitored within the proposed activities, and any gender co-benefits that will be gained because of implementing the CTCN technical assistance.