20th November 2024

# GBON National Contribution Plan of Cambodia

Systematic Observations Financing Facility

Weather and climate data for resilience

# GBON National Contribution Plan

## Cambodia

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|---|---|
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# Module 1. National Target toward GBON Compliance

Table 1. GBON National Contribution Target

**Table 1 – GBON National Contribution Target**

| Type of station | WMO GBON Global Gap Analysis, June 2023 | | | | GBON National Contribution Target | |
|---|---|---|---|---|---|---|
| | Target | Reporting | Gap | | To improve | New |
| | | | To improve | New | | |
| | [# of stations] | | | | [# of stations] | |
| **Surface** | 5 | 9 | 0 | 0 | 5 | 0 |
| **Upper-air** | 1 | 0 | 0 | 1 | 0 | 1 |
| **Marine** | *when applicable | | | | | |

**Figure 1 - Proposed GBON surface stations in red showing 200km diameter circles**

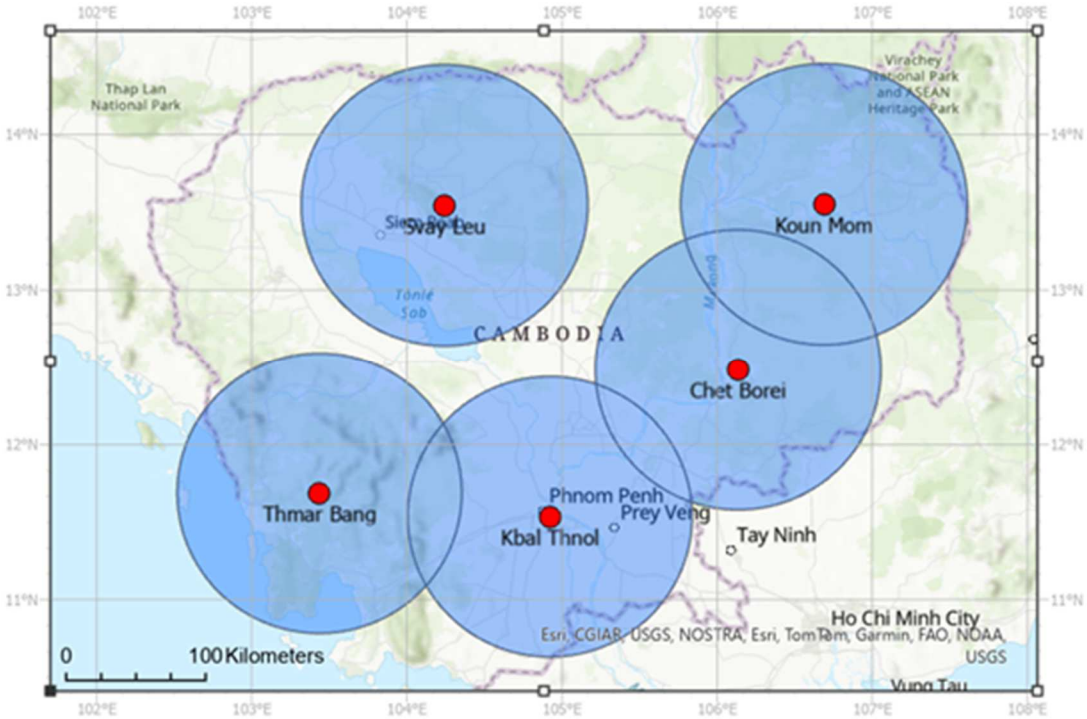


**Figure 2 - Proposed GBON upper air station in red showing 500km diameter circle**

# Module 2. GBON Business Model and Institutional Development

## 2.1. Assessment of national governmental and private organizations of relevance for the operation and maintenance of GBON

The Cambodia Department of Meteorology is part of the Ministry of Water Resources and Meteorology (MOWRAM) and works with a wide range of national governmental agencies, providing services and sharing data across a variety of different application areas. The primary national stakeholders who make direct use of data shared by the Department of Meteorology are summarised below:

- Ministry of Environment (MoE), Climate Change Department (CCD): Climate observation data including temperature and rainfall for climate related research and planning.
- Ministry of Health (MoH), Department of Preventive Medicine: Daily rainfall and temperature data / 3-day, monthly and seasonal forecast rainfall and temperature / location specific flood and drought forecasts.
- Cambodia National Mekong Committee (CNMC): Temperature and rainfall data in the Mekong River basin
- Department of Water Resources Management and Conservation (DWRMC): Monthly and annual precipitation averages / monthly temperature mean, min and max

**Recommendation 2(1)**: To support the success of the SOFF initiative in Cambodia, we recommend a stakeholder engagement event to highlight the benefits that SOFF will bring and the opportunities for other government agencies.

**Recommendation 2(2)**: In addition, we recommend routine meetings, frequency to be agreed at the stakeholder event, with Ministry officials to update on progress and provide advocacy for DoM.

However, it should be noted that there are organisations within Cambodia that collect weather data – especially rainfall data – and do not share this data with DoM on an operational basis. There are no commercial private sector partners outside of equipment suppliers currently involved in the operation or maintenance of national observing networks.

In addition, the following departments and agencies make use of forecasts, products and services which are derived from or supported by meteorological observations in Cambodia:

- Farmer Water Users Community (FWUC): Flood and drought warnings and advisories
- National Committee for Disaster Management (NCDM) and provincial CDM: Location-specific weekly forecasts / natural disaster warnings / monthly and seasonal forecasts (rainfall, temperature, flood and drought warning)
- Ministry of Agriculture, Forestry and Fisheries (MAFF): Daily, 3-day, weekly and 10-day forecasts / monthly forecasts to inform pests, insects and disease / seasonal forecasts (rainfall, rainfall timing and distribution, temperature, soil moisture / humidity, wind speed, drought warning)
- Department of Irrigated Agriculture (DIA): Monthly and seasonal forecasts in Mekong basin and tributaries / Flood and drought warnings and advisories.
- Ministry of Energy and Mines (MEM): Extreme weather forecasts (heatwave, thunderstorm, lightning, heavy rainfall, strong winds)

Manual meteorological observations are taken in each of the 24 provinces of Cambodia. There are 2 observers at each of the sites who are employed under MOWRAM through Provincial Departments of Water Resources and Meteorology (PDWRAM). These observers are responsible for manual observations and basic maintenance of AWS instruments on site, including at proposed GBON sites.

**Recommendation 2(3)**: We recommended that the legal arrangements for this resource are reviewed, updated and made suitable as part of the investment phase to ensure formal and ongoing provision for these staff and recognition of their responsibilities (including their international responsibilities) with respect to meteorological observations.

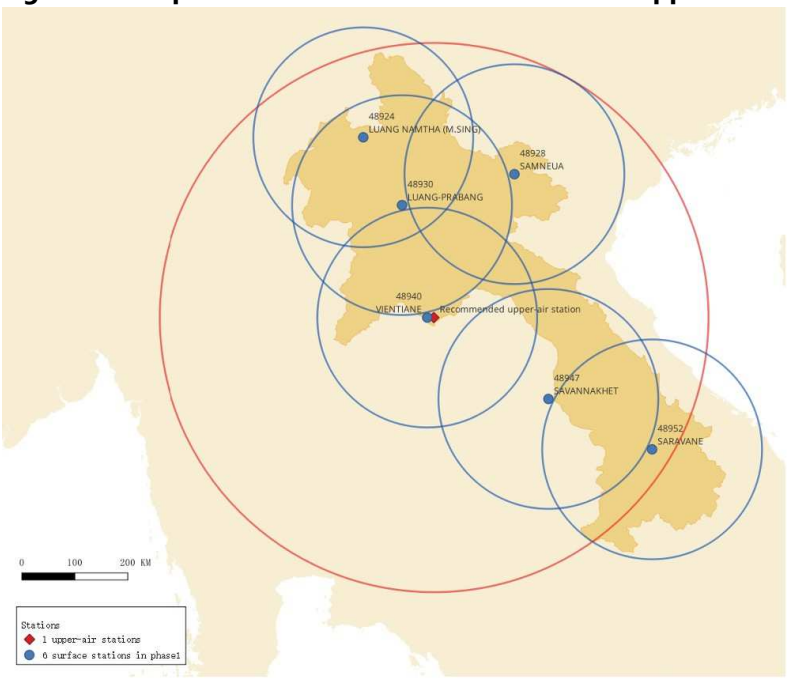
## 2.2. Assessment of potential GBON sub-regional collaboration

The Association of South East Asian Nations Specialised Meteorological Center (ASMC) is a regional collaboration programme among the NMHSs of Association of South-East Asian Nations (ASEAN) member states (including Cambodia, Laos Thailand and Vietnam). The ASMC is responsible for monitoring and assessing land and forest fires, providing early warning on transboundary smoke haze as well as conducting seasonal and climate predictions for the ASEAN region.

There is very limited data sharing between the Department of Meteorology (DoM) and the Hydromet services of Thailand, Laos and Vietnam. The Mekong River Commission (MRC) and its member countries (Cambodia, Lao PDR, Thailand and Vietnam) have agreement to collect and share data for monitoring and forecasting purposes. Hydromet data are collected by NHMSs and relevant agencies in each member country. Data is shared with MRC through their National Mekong Committees. Near real-time hydromet data is monitored along the Mekong mainstream and its key tributaries. The near real-time hydromet data is used for flood and drought monitoring and forecasting.

The neighbouring country of Laos is also a SOFF beneficiary country and extensive consultation has been undertaken between the Peer Advisors (Geosphere Austria) and Implementing Entity (World Bank) to identify opportunities for regional collaboration. There are a range of ongoing initiatives in the region, in particular under CREWS and EW4All and these initiatives have been evaluated in order to avoid overlap between the projects. Surface Land & Upper Air GBON stations across the two countries that are recommended to be funded by SOFF have been reviewed to ensure that most efficient station spacing can reasonably be achieved across national boundaries (see Figure 3). There are also opportunities to potentially collaborate with Laos on training, in particular for WIS2.0 implementation, as well as activities such as procurement and calibration. A regional stakeholder workshop is planned in the investment phase. The proposed regional training activities are indicated below and outlined in the Investment Phase Funding Request.

**Figure 3 - Proposed SOFF GBON Surface Land and Upper Air station in Laos (Geosphere Austria)**




**Recommendation 2(4):** Where feasible, we recommend regional training and procurement with neighbouring countries and regional projects for the installation, operation, maintenance and calibration of the GBON network.

**Recommendation 2(5):** We recommend the recruitment of a project manager to take responsibility for project management, financial planning, regional coordination and communication & advocacy with the owning ministry. There is an opportunity to share this project manager resource with CREWS and any other relevant project.

Training and support for the implementation of WIS2.0 has the potential to benefit other countries in the region. It also makes sense to explore economies of scale with WIS2.0 capability as this is a common functionality required by all SOFF countries. This could be achieved on a regional or global basis. A WIS2Box training event has been undertaken at JMA in Nov 2023 coordinated by WMO. It is recommended that DoM continue to engage and collaborate with regional Hydromet services and that the benefits of the development of Climate Database Management Systems (CDMS) software and implementation of WIS2.0 are realised as widely as possible. The Region II Regional Instrument Centres at Tsukuba, Japan, and Beiijng, China may provide an opportunity to potentially collaborate further on the calibration of instruments. The Chinese Meteorological Agency (CMA) is a co-peer advisor for Lao and a regional approach for instrument calibration is being considered, pending the outcome of the readiness phase for Lao.

**Recommendation 2(6):** We recommend Cambodia DoM collaborate with regional nations on a WIS2.0 implementation and requires dialogue and agreements with other projects and regional partners.

## 2.3. Assessment of a business model to operate and maintain the network

The MOWRAM five-year strategic plan has a budget for implementation of USD 2.79 billion, of which 2.19 billion or 78.5% is allocated to the management and development of water resources including

the repair, maintenance and expansion of irrigation and drainage systems, reservoirs, ponds and canals. The budget reserved for capacity enhancements in administration and human resources through training and workshops is USD 56 million, representing 2% of the total budget. Similarly, only 0.6% or USD 15.7 million is provided for the installation and / or rehabilitation of hydro-meteorological equipment. The national government is only able to provide an estimated 15% or USD 429.52 million of the total budget for implementation of the strategic plan. International development partners provide about 80% or USD 2.24 billion while the remaining 4% or USD 125.5 million is yet to be funded.

The budget allocation for the Department of Meteorology (DoM) is dependent on the funds available at the national government level. In 2022, DoM received USD 450,000 as budget allocation (this does not include staff salaries, which are paid centrally). Of this budget, USD 170,000 (37.7%) was used to pay Meteo-France International for the maintenance of the radar and Synergie forecasting system. A further USD 100,000 (22.2%) was used for the maintenance of the AWS network and USD 50,000 (11.1%) for the maintenance of manual observation stations. The remainder of the budget allocation for 2022 was used for general maintenance and office expenses e.g. car maintenance, repair of air conditioning and stationery.

DoM do not sell any meteorological data or services and do not, therefore, have any further source of funds DoM highlights the relevance of grant projects from donors and implementing partners in providing equipment and capacity enhancement support. However, grant funding varies significantly year-on-year and in many cases donors and implementing partners have their own work programmes or promote their own equipment and technology, which may be incompatible with existing systems and/or require further capacity building among staff.

The current observations network is fully funded by the government. These funds provide a minimum level of support to DoM for this activity, which puts the network at risk. It is recommended that the SOFF Investment Phase commissions the development of new Strategic and Operational plans, to enable DoM to strengthen their engagement with government, highlight the importance of the network to Cambodia, and provide a more sustainable, publicly owned observation network, including the GBON stations. The recent studies conducted on DoM under the CREWS project, by RIMES and RMSI respectively, should provide a significant contribution to this corporate capacity development.

Owing to the lack of private sector capacity in Cambodia, it is recommended that a fully public business model is continued to operate and maintain the GBON network. The sustainability model for the GBON stations will be through SOFF funding for ongoing maintenance with DoM providing in-kind human resource for maintenance activities, monitoring and data sharing. In the investment phase a series of activities are proposed to ensure the success and sustainability of this model including development of a workforce plan for the DOM. Legal arrangements with MOWRAM are reviewed and updated to ensure formal support and ongoing provision for observing staff and recognition of their responsibilities, DoM Strategic and Operational plan is revised and brought up to date, Socio-economic benefit analysis of DOM for now and the potential, highlighting the cost benefit of forecast-based anticipatory action (geared towards advocacy messaging within Government of Cambodia). These will feed into the further development of DOM business model linked to the GBON Network sustainability plan to support the modernized infrastructure.

The following support through SOFF, with indicative costs to be finalized in the investment phase funding request, is required to reach GBON compliance in Cambodia:

- GBON observation station implementation: Upgrade physical infrastructure and communications equipment for five proposed surface GBON stations plus calibration and spare equipment for repairs and resilience. Physical infrastructure including buildings, power supply, hydrogen generation for one proposed Upper Air GBON station, plus consumables.
- IT infrastructure: Review all available solutions for upgrading and replacing the ICT meteorological data collection and management systems, and support the design and specification of a replacement system.
- Human capacity/Other: Establish all necessary functions to run the GBON in Cambodia, including NMHS institutional capacity and human capacity.

## 2.4. Assessment of existing national strategies and projects related to observing networks

The Asian Development Bank (ADB) - The ADB's Irrigated Agriculture Improvement Project (Dec 2019 - Jun 2025) includes design and development of the National Water Resources Data Management Center (NWRDMC) and Water Resources Information System (WRIS), which integrates all water resources data including, but not limited to i) hydro-meteorological information, ii) land use, crop distribution and soil maps as well as maps of irrigated/non-irrigated areas, iii) topography and river basin boundaries, iv) population distribution map, v) map and information on water infrastructures such as pumping stations, reservoirs, and vi) secondary data and products from modelling.

Dan Church Aid (DCA) - DCA installed one AWS in Cambodia and introduced the Khmer Smart Farming app in 2019, providing advisories on the weather as well as on farming techniques. It would be useful to integrate DoM forecasts in the app.

Korean Meteorological Administration (KMA) - KMA recently concluded a project (2020-2023) focused on enhancing DoM's observation network, forecasting and early warning system through the installation of automatic weather stations (AWS), provision of ICT related equipment, and technical capacity building. The agency also supported DoM through its project "Support of the GEOKOMPSAT-2A Receiving and Analysis System in Cambodia" (2020-2023), which aimed to enhance satellite data reception, operation, analysis and use through installation of a satellite receiver, provision and installation of related equipment, and technical capacity building of DoM staff.

RIMES - RIMES provides technical training on numerical weather prediction and statistical seasonal forecasting for DoM staff, and hydrological forecasting for DHRW staff. RIMES provides DoM access to the forecast customization (FoCus) tool and Data Exchange (DataEx) Platform. It also continues to coordinate with DoM on the SESAME decision support system for the development and dissemination of agromet advisories for selected crops in pilot locations of the country.

The World Bank - The SeA DRM Project II aims to improve disaster and climate resilience of flood damaged roads in target areas, improve the capacity of the government to prepare for and respond to emergencies, and provide immediate and effective response in case of a crisis or emergency. This requires effective coordination with DoM and DHRW, which are the technical agencies responsible for providing hazard forecasts, warnings, and advisories. CREWS involves technical capacity building, (ICT) equipment support, etc. for DoM and DHRW.

United Nations Development Programme (UNDP) - UNDP is currently implementing the project, "Enhancing Integrated Water Management and Climate Resilience in Vulnerable Urban Areas of the Mekong River Basin" (Sep 2021 - Sep 2025), which aims to address the need for risk data to inform

integrated water resources management. UNDP works with MOWRAM to establish climate risk and water resource management baselines, climate and disaster risk assessment. In addition, the project aims to enhance communication with Lao PDR on climate risks and in linking (transboundary) early warning systems in both countries.

UNDP are developing a proposal to support Cambodia with GCF funding. The proposal covers a range of activities and support to MOWRAM, including observation infrastructure and operations & maintenance outputs for DoM. It is recognised that close coordination with UNDP is vital for both projects.

World Meteorological Organization (WMO) and its Regional Specialized Meteorological Centres (RSMC) including Regional Climate Centers (RCC) - WMO programmes and projects in Cambodia include i) DE-RISK Southeast Asia (Apr 2018 - Dec 2023), ii) CREWS Cambodia and Lao PDR (Jul 2021 - Jul 2025), iii) Southeast Asia Flash Flood Guidance System, and iv) Severe Weather Forecasting Programme. DoM receives regionally focused high-resolution data and NWP products from the Regional Center of Tokyo, and from the RCC in Beijing through the Regional Telecommunication Hub (RTH) in Bangkok. The programmes and projects generally include technical capacity building for staff of DoM and DHRW. CREWS, in particular, also includes (ICT) equipment support. The RCC of Tokyo provides useful resources such as the iTacs, monthly and seasonal outlooks, El Nino monitoring, ClimatView and TCC News. DoM forecasters generally refer to products from Tokyo rather than those from Beijing. Forecasters also use the meteorological charts from Thai Met Department (TMD)

This identifies the complex landscape of project activity from the recent past or ongoing.

**Recommendation 2(7):** We recommend an event at project initiation with all development partners relevant to SOFF to raise awareness of SOFF Cambodia's plans and to ensure coordination, cooperation, and collaboration.

The DoM have an existing Strategic Plan and Action Plan, however, these were published in 2014, are now out of date and in need of redevelopment. Throughout the investment and compliance phases, consideration should be given with this strategy refresh to, for example, the rationalization of existing networks / technologies (including the potential to share data from additional stations in Cambodia) and to ensure that future investment will be sustainable and complementary with existing and planned initiatives. This will interact strongly with the proposition to introduce the role of a network manager (see recommendation 4(2)). Revision of the Strategic and Action Plans will enable DoM management to refocus on priority activities, including the consistent and sustainable development of the observations network.

**Recommendation 2(8)**: We recommend a new Strategic and Operational Plan is commissioned at an early stage of the Investment Phase.

## 2.5. Review of the national legislation of relevance for GBON

MOWRAM was created based on Proclamation NS/RKM/0699108, dated 23 June 1999. Its duties and responsibilities include the following:

- Establish political and strategic position with respect to water resources availability for local development, and its sustainability at national and international scale;

- Carry out scientific research on the potential of underground and surface water resources;

- Set directions and roadmap in the short-, medium- and long-term with respect to water consumption to fulfil the needs for the country's development;

- Control and monitor water consumption to mitigate risks;

- Prepare and draft laws and regulations linked to the use and control of water

- Gather documents and technical data/research about climate and hydrology, as well as water use;

- Provide technical advice to, and raise the awareness of, the industry, NGOs, communities and populations about the development and use of water resources;

- Communicate and promote innovative techniques on water treatment and use;

- Collaborate and participate in the management of the Mekong Basin in the management of water resources, as well as in meteorology.

The relevance of hydro-meteorological early warning is also highlighted in many other national policies and plans including, but not limited to, the following:

- Law on Disaster Management, NS/RKM/0715/007 (2015)

- National Disaster Risk Reduction Framework 2019-2030

- National Action Plan for DRR (NAP-DRR) 2019-2023 and its preceding iterations - NAP-DRR 2014-2018 and SNAP DRR 2008-2013

- Cambodia Climate Change Strategic Plan 2014-2023

- Climate Change Action Plan for Water Resources and Meteorology 2014-2018, and Climate Change Action Plan for Disaster Management Sector 2014-2018

- National Strategic Development Plan (NSDP) 2019-2023, and its preceding iteration - NSDP 2014-2018

It is recognized that the legislation and policy relating to meteorological services in Cambodia needs review and revision, to ensure that DoM can provide the essential services to the public in a sustainable manner as climate and other environmental-related risks increase. This should also enshrine the mandate for free and unrestricted sharing of data and warnings both amongst organisations within Cambodia and internationally where this is not currently formally recognised.

The legislative framework for government procurement is set out in the Law on Public Procurement 2012. Public Procurement is applicable to all government ministries, national bodies, public enterprises, administrative institutions and sub-national administrations and is subject to audit by the Ministry of Economy and Finance. With respect to exemption of import duties and taxes, the Law on Customs 2007 refers. The Implementing Entity has significant experience of procuring and installing hardware in Cambodia under previous projects and it is anticipated that similar processes and procedures will be used in the SOFF investment phase to mitigate any potential impact of procurement, import and customs law.

As part of the stakeholder engagement with government ministries, and in recognition of the similar activities undertaken in support of the meteorological services provided to the aviation sector in Cambodia, we recognize the complementarity of the activities of the DoM and the provider of aviation meteorological services, and that there may be a case for consideration of greater collaboration, or even a merger, of these two organisations. This would provide a more capable and sustainable meteorological infrastructure and organisation for Cambodia.

**Recommendation 2(9)**: We recommend that the specific legislation of relevance to meteorological services in Cambodia are reviewed and revised, that there is advocacy for reform, and that there is consideration of enhanced collaboration with the aviation meteorological service provider.

**Recommendation 2(10)**: In coordination with other projects, such as CREWS and EW4All, we recommend that an advocacy communications strategy is developed and presented to the government.

# Module 3. GBON Infrastructure Development

## 3.1. Design the surface and upper-air observing network and observational practices

*Surface Observations*

The Cambodia Department of Meteorology currently operates an extensive network of surface observations, comprising 85 automatic weather stations (AWS) and 25 manual stations. Of the 85 AWS, 39 are reported as being in good condition, 40 have reduced functionality due to issues with individual sensors, modem, or data loggers and 6 are currently non-functional. The AWS network is comprised of stations from 3 manufacturers SUTRON (35), ADCON (24) and WEATHEX (26). The SUTRON and ADCON stations measure wind speed and direction, temperature, humidity, rainfall, pressure, evaporation, soil temperature, soil moisture and global radiation while the 26 WEATHEX stations do not measure evaporation, soil temperature and moisture and global radiation parameters.

The 25 manual surface observation stations are located in each of Cambodia's 24 provinces as well as in Phnom Penh. 17 of the 25 stations are co-located with AWS. All 25 stations collect rainfall and temperature data and the station in Phnom Penh also collects wind speed and direction and humidity data. Local staff take daily readings between 8 and 9 am and relay this data to the Department of Meteorology Climate Office.

There are currently no upper air observations in Cambodia and 1 new upper air observing site will be established as part of the SOFF project.

Table 2 below sets out the existing surface observation network in Cambodia

**Table 2 – Surface Observation sites in Cambodia**

| Station name | GBON variable measured | | | Reporting cycle | | | | GBON Compliance (Y/N) |
|---|---|---|---|---|---|---|---|---|
| | SLP | T | H | W | P | SD | | |
| Koursrov | Y | Y | Y | Y | Y | N | >24 | N |
| Kbal Thnol | Y | Y | Y | Y | Y | N | >24 | N |
| Chantrea | Y | Y | Y | Y | Y | N | >24 | N |
| Romeas Haek | Y | Y | Y | Y | Y | N | >24 | N |
| Svayteab | Y | Y | Y | Y | Y | N | >24 | N |
| Mesang | Y | Y | Y | Y | Y | N | >24 | N |
| Preyveng | Y | Y | Y | Y | Y | N | >24 | N |
| Sithor kandal | Y | Y | Y | Y | Y | N | >24 | N |
| Kranglev | Y | Y | Y | Y | Y | N | >24 | N |
| Kompong Chhnang | Y | Y | Y | Y | Y | N | >24 | N |
| Steung trang | Y | Y | Y | Y | Y | N | >24 | N |
| Prey chhor | Y | Y | Y | Y | Y | N | >24 | N |
| Cheng prey | Y | Y | Y | Y | Y | N | >24 | N |
| Krouch Chhmar | Y | Y | Y | Y | Y | N | >24 | N |
| Dombae | Y | Y | Y | Y | Y | N | >24 | N |
| Pogna kraek | Y | Y | Y | Y | Y | N | >24 | N |
| Memot | Y | Y | Y | Y | Y | N | >24 | N |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Kong chey | Y | Y | Y | Y | Y | N | >24 | N |
| Tbongkhmom | Y | Y | Y | Y | Y | N | >24 | N |
| Snuol | Y | Y | Y | Y | Y | N | >24 | N |
| Kratie | Y | Y | Y | Y | Y | N | >24 | N |
| Chet Borei | Y | Y | Y | Y | Y | N | >24 | N |
| Siem Bouk | Y | Y | Y | Y | Y | N | >24 | N |
| Talaboriwat | Y | Y | Y | Y | Y | N | >24 | N |
| Koun Mom | Y | Y | Y | Y | Y | N | >24 | N |
| Bar Kaev | Y | Y | Y | Y | Y | N | >24 | N |
| Banlong | Y | Y | Y | Y | Y | N | >24 | N |
| Lumphat | Y | Y | Y | Y | Y | N | >24 | N |
| Koh Nheaek | Y | Y | Y | Y | Y | N | >24 | N |
| Pechreada | Y | Y | Y | Y | Y | N | >24 | N |
| Ou Reang | Y | Y | Y | Y | Y | N | >24 | N |
| Senmonorom | Y | Y | Y | Y | Y | N | >24 | N |
| Kaev Seima | Y | Y | Y | Y | Y | N | >24 | N |
| Chi Kraeng | Y | Y | Y | Y | Y | N | >24 | N |
| Varin | Y | Y | Y | Y | Y | N | >24 | N |
| Banteaysrey | Y | Y | Y | Y | Y | N | >24 | N |
| Svay Leu | Y | Y | Y | Y | Y | N | >24 | N |
| Koh Tom | Y | Y | Y | Y | Y | N | >24 | N |
| Sa Ang | Y | Y | Y | Y | Y | N | >24 | N |
| 7 Makara Dam | Y | Y | Y | Y | Y | N | >24 | N |
| Vihear Loung | Y | Y | Y | Y | Y | N | >24 | N |
| Phnom Srouch | Y | Y | Y | Y | Y | N | >24 | N |
| Tasal Dam | Y | Y | Y | Y | Y | N | >24 | N |
| Chbamorn | Y | Y | Y | Y | Y | N | >24 | N |
| Boset | Y | Y | Y | Y | Y | N | >24 | N |
| Oral | Y | Y | Y | Y | Y | N | >24 | N |
| Thpong | Y | Y | Y | Y | Y | N | >24 | N |
| Bait District | Y | Y | Y | Y | Y | N | >24 | N |
| Sam Roung District | Y | Y | Y | Y | Y | N | >24 | N |
| Borey Cholsar | Y | Y | Y | Y | Y | N | >24 | N |
| Kirivong | Y | Y | Y | Y | Y | N | >24 | N |
| Donkeo | Y | Y | Y | Y | Y | N | >24 | N |
| Tram Kok | Y | Y | Y | Y | Y | N | >24 | N |
| Chum Kiri | Y | Y | Y | Y | Y | N | >24 | N |
| Kompot | Y | Y | Y | Y | Y | N | >24 | N |
| Angkor Chey(Tani) | Y | Y | Y | Y | Y | N | >24 | N |
| Dong Tung District | Y | Y | Y | Y | Y | N | >24 | N |
| Krong Kep | Y | Y | Y | Y | Y | N | >24 | N |
| Chamksan | Y | Y | Y | Y | Y | N | >24 | N |
| Kompongpronak | Y | Y | Y | Y | Y | N | >24 | N |
| Chey Sen | Y | Y | Y | Y | Y | N | >24 | N |
| Chory Thmor | Y | Y | Y | Y | Y | N | >24 | N |
| Kompong seila | Y | Y | Y | Y | Y | N | >24 | N |
| Preah Sihanouk | Y | Y | Y | Y | Y | N | >24 | N |
| Sre Ambel | Y | Y | Y | Y | Y | N | >24 | N |
| Thmar Bang | Y | Y | Y | Y | Y | N | >24 | N |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Botum Sakor | Y | Y | Y | Y | Y | N | >24 | N |
| Koh Kong | Y | Y | Y | Y | Y | N | >24 | N |
| Kirisakor | Y | Y | Y | Y | Y | N | >24 | N |
| Kohkong | Y | Y | Y | Y | Y | N | >24 | N |
| Porsat | Y | Y | Y | Y | Y | N | >24 | N |
| Mongreusey | Y | Y | Y | Y | Y | N | >24 | N |
| Battambong | Y | Y | Y | Y | Y | N | >24 | N |
| Ratanakmondol | Y | Y | Y | Y | Y | N | >24 | N |
| Phnompreuk | Y | Y | Y | Y | Y | N | >24 | N |
| Pailin | Y | Y | Y | Y | Y | N | >24 | N |
| Sireysophorn | Y | Y | Y | Y | Y | N | >24 | N |
| Ochrev | Y | Y | Y | Y | Y | N | >24 | N |
| Banteay Ampil | Y | Y | Y | Y | Y | N | >24 | N |
| Samrong | Y | Y | Y | Y | Y | N | >24 | N |
| Stungstong | Y | Y | Y | Y | Y | N | >24 | N |
| Sandan | Y | Y | Y | Y | Y | N | >24 | N |
| Brasatsambo | Y | Y | Y | Y | Y | N | >24 | N |
| Stungsen | Y | Y | Y | Y | Y | N | >24 | N |
| Santuk | Y | Y | Y | Y | Y | N | >24 | N |

In addition, a network of automatic rain gauges is operated across the country, as part of the Mekong Integrated Water Resource Management (MIWRM) project supported by World Bank. These stations only include automatic rain gauges and do not measure other relevant meteorological parameters for GBON.

**Table 3 - Automatic rain gauge sites MIWRM**

| No. | Station Name | Basin | River / Catchment | Province | Village / town | X-coord | Y-coord |
|---|---|---|---|---|---|---|---|
| 1 | Chang Hab (Kbal Damrey) | 4P | Prek Krieng | Kratie | Chang Hab | 628018 | 1418370 |
| 2 | Chimeat | 3S | Sre Pok | Mondul Kiri | Peam Chimeat | 735174 | 1471897 |
| 3 | Koh Nhek | 3S | Sre Pok | Mondul Kiri | Maem Oun | 721704 | 1447645 |
| 4 | Bousra | 3S | Sre Pok | Mondul Kiri | Bousra | 763957 | 1386330 |
| 5 | Dak Dam | 3S | Sre Pok | Mondul Kiri | Pu Chhorb | 750860 | 1374197 |
| 6 | Oyadav | 3S | Sesan | Ratanak Kiri | Plong | 753744 | 1512548 |
| 7 | Koun Mom | 3S | Sre Pok | Ratanak Kiri | Phumi Pi | 691661 | 1501836 |
| 8 | Siem Pang | 3s | Sekong | Stung Treng | Siem Pang | 648253 | 1560200 |
| 9 | Khe Nang | 3S | Prek Smang | Stung Treng | O Chay | 660818 | 1564901 |
| 10 | Somroung/Samroang | 3S | Sekong | Stung Treng | Somroung | 628586 | 1547437 |
| 11 | Phluk | 3S | Sesan | Stung Treng | Phluk | 624873 | 1499280 |

**Recommendation 3(1)**: As stated in the GBON National Gap Analysis, we recommend that Cambodia's Department of Meteorology improve five existing surface observation sites to GBON standards. The locations of the 5 stations are shown in Figure  and details of the site locations are shown in Table 4. The selected sites are existing observation stations, which are sited in secure, accessible locations away from obstructions in accordance with WMO No.8, Vol 1. In addition, each location has local staff regularly on site who can perform basic maintenance and provide additional security to the site. This recommendation is subject to revision, based on coordination with other projects and partners.

**Figure 4 - Proposed GBON surface stations in red showing 200km diameter circles**

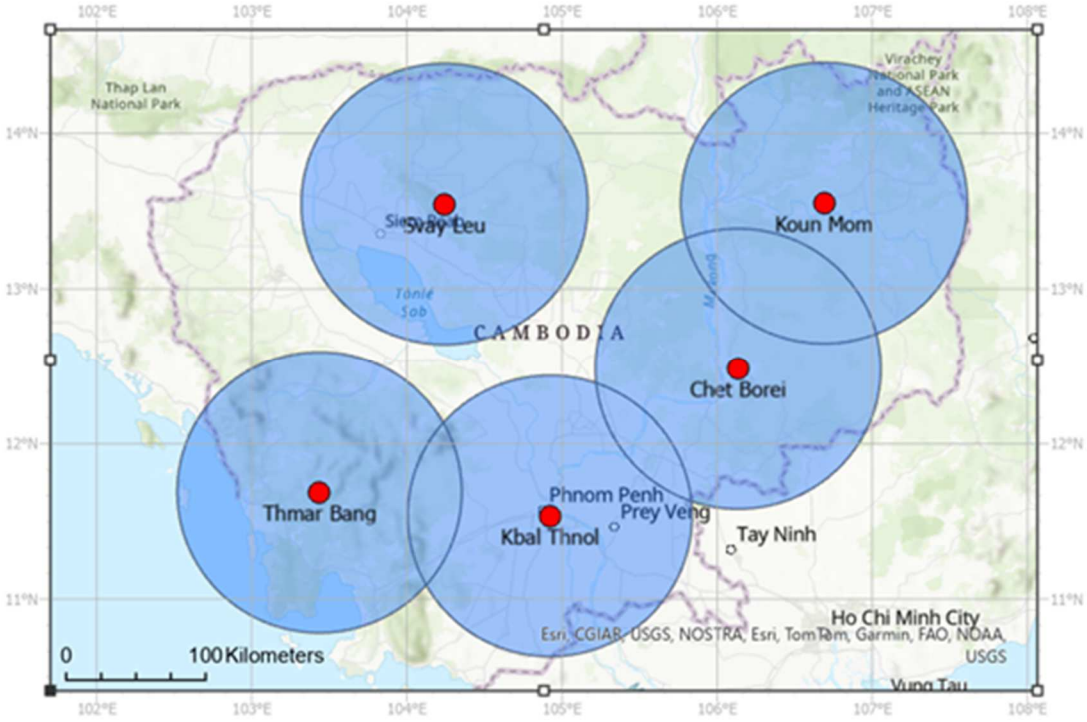



**Table 4 - Details of GBON surface observation site locations**

| Station name | Station type (S/UA) | Lat | Lon | GBON variable measured | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | SLP | T | H | W | P | SD |
| Svay Leu (Siem Reap) | S | 13.5396 | 104.2477 | Y | Y | Y | Y | Y | N (N/A) |
| Kbal Thnol at (Phnom Penh) | S | 11.5299 | 104.9271 | Y | Y | Y | Y | Y | N (N/A) |
| Chet Borei (Kratie) | S | 12.4782 | 106.1400 | Y | Y | Y | Y | Y | N (N/A) |
| Koun Mom (Ratanakiri) | S | 13.5462 | 106.6941 | Y | Y | Y | Y | Y | N (N/A) |
| Thmar Bang (Kohkong) | S | 11.6824 | 103.4414 | Y | Y | Y | Y | Y | N (N/A) |

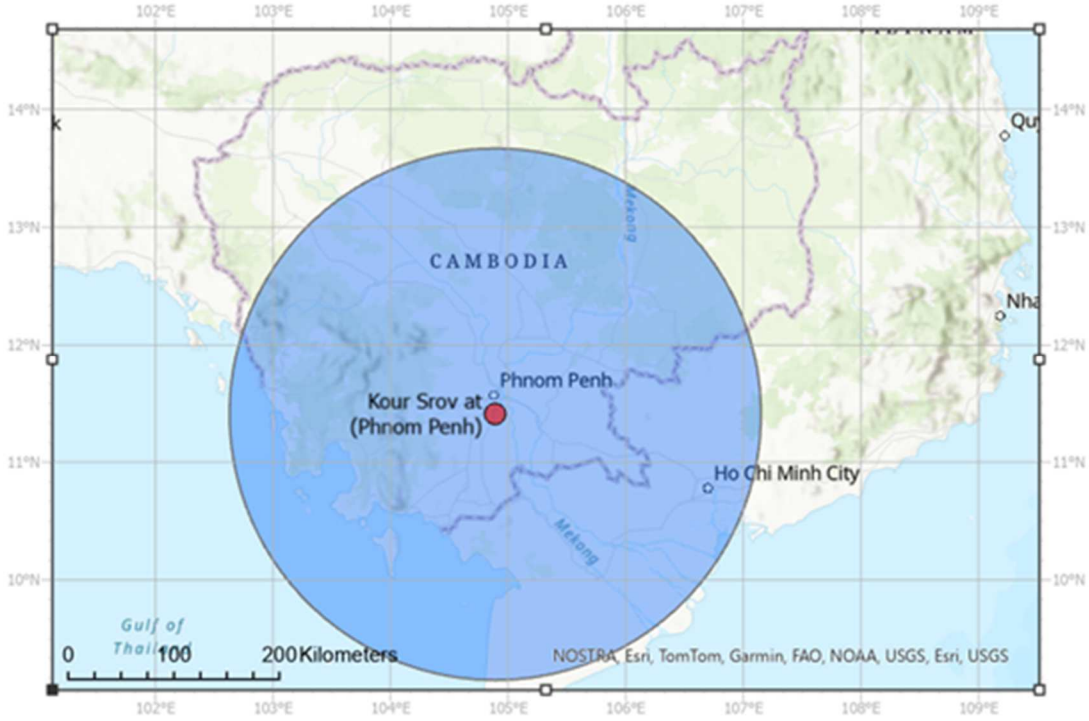
*Upper air observations*

There are currently no upper air observations in Cambodia. As indicated in the National Gap Analysis 1 upper air station will be commissioned in Cambodia in order to contribute to GBON. The location of the proposed upper air station was identified by DoM and the peer advisor as a feasible existing observation site on government owned land. The site has existing access to reliable power and communications as well as ample physical space for the installation of an upper air station. The compound area is surrounded by walls on all sides and entrance is via a secure gate. The existing site includes DoM observers who work permanently on site and, with the appropriate training as outlined in section 4.2, will be able to operate twice daily launches from the site.

**Recommendation 3 (2):** We recommend that this site receives the installation of upper air capability and is designated as the GBON upper air site for Cambodia.

The location and details of the proposed upper air station are shown in Figure 5 below.

**Figure 5 - Proposed GBON upper air station in red showing 500km diameter circle**




With reference to Figure 6 below, it can be seen that a GBON-compliant upper air station is currently operated near to Ho Chi Minh City to the south east of Phnom Penh, with the distance between the existing Tan Son Hoa site in Vietnam and the proposed Kour Srov site in Cambodia then being less than the standard 500km GBON station separation distance. It is acknowledged that the proposed station would ideally benefit from a more centralised location within Cambodia, more evenly spaced between the Tan Son Hoa station in Vietnam and the Bangna Agromet site near Bangkok to the northwest in Thailand (noting that this latter station is not currently compliant). However, the Kour Srov site was chosen for key pragmatic and logistical reasons where it was not considered feasible to sustainably develop a new site in a more remote area with less developed infrastructure, further from the maintenance capabilities of DoM headquarters technical staff. The Kour Srov location would extend a radiosonde presence directly into the Cambodian national territory and, in practice, the wind regime across the seasonal southwest and northwest monsoons means that sonde releases should independently add significant value in resolving complex modelling challenges around the

seasonal movement of the Monsoon. This will have practical implications for the accuracy of flood or tropical cyclone warnings around the main population centres while also enabling better forecasts of the arrival of much-needed rains for agriculture.

**Figure 6 – Regional Upper Air station design with existing WDQMS compliant (green), existing non-compliant (amber) and proposed (blue) SOFF stations.**

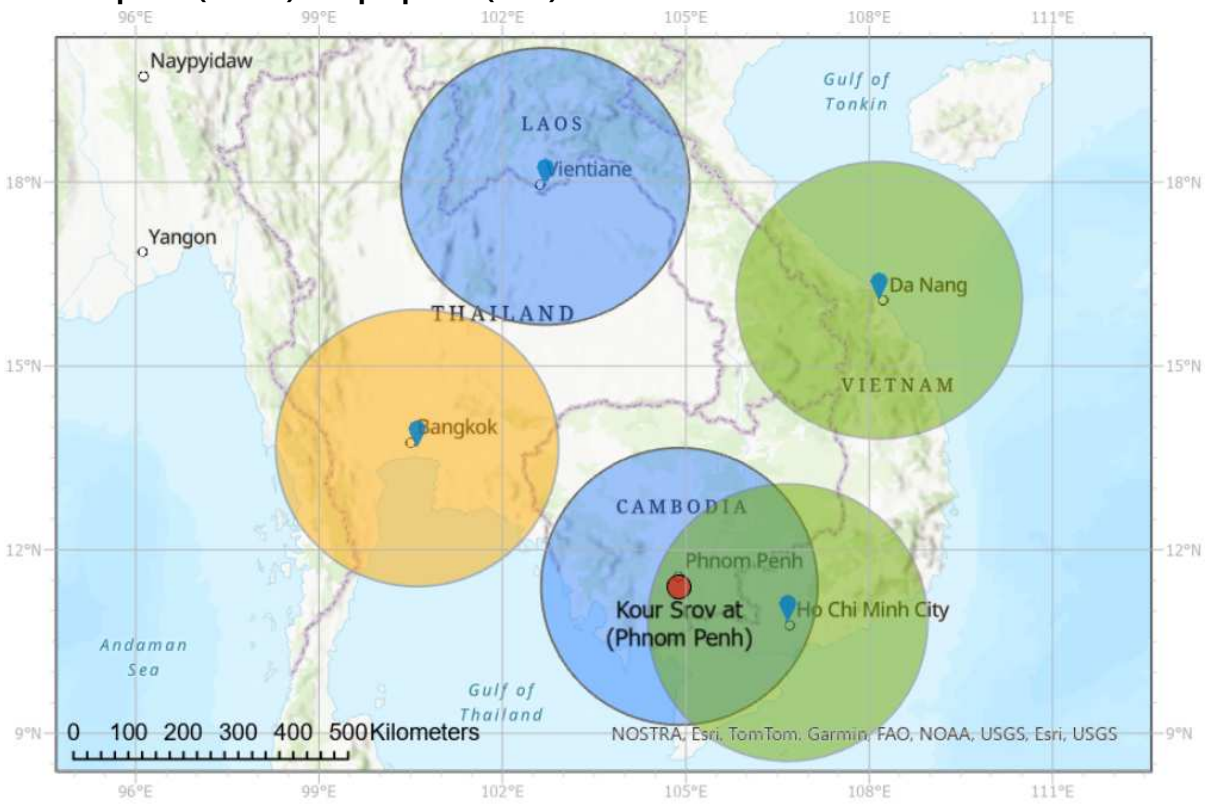


**Table 5 - Details of GBON upper air observation location**

| Station name | Station type (S/UA) | Lat | Lon |
|---|---|---|---|
| Kour Srov at (Phnom Penh) | UA | 11.4091 | 104.8963 |

*Investments and activities needed for the installation of new stations and the improvement of existing stations / list of observation instruments and systems per site*

*Surface observations*

We recommend 3(1) the improvement of the five existing stations in Cambodia, to enable the collection and international sharing of high-quality data for GBON, include the procurement and installation of replacement instruments at each site. These will replace instruments which have been deployed for some time and have lacked maintenance and calibration during that period. The installation process will be managed by the DoM Network Manager (this is a proposed new role, see section 4 below for details) and undertaken by DoM technicians with support and advice from the instrument manufacturer and the peer advisor, wherever necessary. Existing infrastructure, for examples fences and enclosures and wind sensors platforms, can be utilized alongside the upgraded equipment to be procured through SOFF where appropriate. This will require thorough investigation and review of the infrastructure in place for signs of wear and deterioration ahead of the installation of new equipment, and replacements should be procured and installed, if necessary.

**Recommendation 3(3):** In addition, we recommend a full store of spares should be procured and maintained at DoM HQ or at an appropriate regional centre. The technical specification for the procurement process is set out in section 3.1f.

*Upper air observations*

The commissioning of the upper air station will require investment and activities to procure and install all necessary infrastructure for manual radiosonde launches from the site, including:

- Physical infrastructure and building including any necessary groundworks
- Hydrogen generation and storage equipment and water purification
- Ground station IT hardware for data collection storage and transfer
- Consumable parts (balloons, sondes, strings etc.)

The procurement process for all upper air and surface equipment shall follow guidance set out in TT-GBON 6.1 *GBON Tender specifications for AWS* and TT-GBON 6.2 *Requirement document to be used as input to tender specifications for radiosonde-related procurements*. These guidance documents set out the technical specification and tender requirements for radiosonde related equipment and must be used as the basis for procurement and tender documents for the upper air station in Cambodia.

**Recommendation 3 (4):** We recommend training on the safe operation and basic maintenance of the hydrogen generation and storage equipment will be provided by the instrument manufacturer to the DoM staff on site. **Recommendation 3 (5):** In addition, we recommend the development of robust standard operating procedures for the operation of the upper air station is recommended as an activity in the investment phase – see **recommendation 2(2)**. This documentation will be complemented by the development of operational plans for the maintenance and calibration of the observation network more broadly as well as incorporating these elements into the update of the DoM strategic plan.

## *Observational practices defined per network / preliminary maintenance plan for existing and improved / new stations including calibration practices*

DoM currently undertakes scheduled preventative maintenance at all observation sites in their network, carrying out site inspections, instruments checks and routine maintenance on the observation equipment. The preventative maintenance includes checking the condition of anemometers and thermometer shelters for signs of physical deterioration, corrosion and dirt as well as ensuring that electrical systems are working correctly. The surroundings of the site are also assessed and any changes which may affect exposure recorded. This preventative maintenance is carried out largely by local staff at observations sites across the country. It is recommended (part of recommendation 3 (5)) that a full maintenance and calibration schedule is developed during the investment phase to ensure the reliability and quality of observations – see **recommendation 2(8)**.

As set out in WMO-No. 8 Vol V, an optimum frequency of site inspection visits cannot be generally specified. It is recommended that in addition to ongoing basic maintenance by staff on site at the observation locations, the maintenance schedule ensures that each site is visited at least 3 times per year by DoM technical staff i.e. more often than the suggested frequency of six months for AWS sites. Continuous remote monitoring of the function and performance of the sites is included in the recommendations in ANNEX A3.2/3.3 and the maintenance schedule should be reviewed annually to ensure that it is consistent with the provision of continuous, high-quality data.

**Outline Maintenance Plan for GBON Surface Stations**

In line with international best practice, a four stage maintenance process is proposed for the GBON surface stations. The maintenance plan comprises the following elements:

1. Remote monitoring

Remote monitoring will be conducted by the DoM technical team. They will check the availability of data via the proprietary software provided with the AWS and also the WIS2BOX. Monthly statistical analysis will identify trends in the data over time that could indicate calibration drift, or complete sensor failure. The technical team will maintain a backlog of potential faults which should be updated once potential faults have been investigated and resolved. In this way any systematic faults can be identified and addressed.

2. Routine site inspection and Maintenance

The technical team will be responsible for conducting routine inspection and maintenance of GBON sites, as well as fault resolution site visits. It is expected that each site should be routinely visited at

least once every 6-months as a minimum with budget to accommodate travel and subsistence accounted for in the investment phase funding request. Provision must be made either within local staffing or via MoU or contractual SLA with MOWRAM to ensure sites are kept in good order, with fences maintained and vegetation controlled. The team will also conduct calibration checks during each visit and carry spares so that sensors and other hardware (e.g. solar panels, batteries and loggers) can be exchanged if they are found to be out of tolerance. Sensors should also be rotated during these visits and sent back to the DoM main office for more thorough calibration/investigation where necessary. A central maintenance log will be updated and any changes to metadata recorded as part of each visit.

3. Fault resolution

If a potential fault at a station has been identified, the technical team will undertake a fault resolution visit. These visits will take priority over routine maintenance visits in order to maintain GBON compliance on data availability. It is expected that most faults will be resolved by the team swapping out a component at a site with a spare. It is expected that during a fault resolution visit, the regional team will also conduct routine site inspection and maintenance of the site (in line with point 2 above).

4. Calibration and supplier support

It is expected that some instruments will need to be either directly replaced or calibrated through an ongoing relationship with the AWS supplier. Historically, DoM and other met services in the region have struggled to calibrate instruments due to high costs of transportation and have thus tended simply to replace instruments when past reasonable use. The implementing entity should work with other SOFF funding recipients in the region (In particular Laos) to understand the best approach to calibration testing against known standards, eg via a central specialist authority such as the RIC. An ongoing service agreement with the instrument supplier would enable an alternative mechanism for ongoing calibration support. It would also provide 3rd line support to DoM staff in maintaining the network and in dealing with more complex issues. It would be expected that this agreement would provide training throughout the SOFF investment and compliance phases, so that the DoM technical staff continually increase their capacity and skill. Each instrument should be supplied with a paper and electronic (pdf) calibration certificate that at least specifies:

• Manufacturer
• Model
• Instrument type/Principle of Operation
• Serial number
• Hardware/Software version [if applicable]
• Calibration Date
• Validity period of calibration/Recommended next date of calibration
• Calibration range
• Traceability of calibration (including applicable standard)
• Calibration method
• Calibration factor and uncertainty
• Name and signature of calibration technician that performed the calibration. [**]”

**Outline maintenance plan for Upper-Air station**

The DoM technical team will be required to routinely operate the upper air station and undertake routine inspection and maintenance of the system. SOPs will be established with the operators to routinely cross check the ground system against the AWS measurements at that location and ensure minimum height requirements are met. It is recommended that a service agreement is established with the radiosonde supplier as part of the procurement, this will provide third line support in the event of ground system failure; the technical team should undertake training from the provider to undertake routine maintenance and safety checks of the station.**Recommendation 3 (6):** We recommend that calibration of sensing equipment is carried out at regular intervals through the manufacturer's regional centre or at an accredited calibration facility – see preface and **recommendation 2(8).** The period of validity of the calibration will be determined by the sensor type ranging from one year for relative humidity sensors to up to 8 years for platinum resistance thermometer. The DoM Network Manager (**recommendation 4(2)**) will take responsibility for calibration of instruments. This will include a full calibration regime and provision of calibration services to be produced in consultation with the instrument provider as part of the procurement process and in accordance with the requirements set out in WMO tender specification for AWS:

*Technical specifications for new instruments and observing systems*

The specifications for upgraded and replacement instruments at the two GBON surface observations sites are recommended to align with TT-GBON approved material | World Meteorological Organization (wmo.int) for each observation instrument and observing system. The recommended instruments meet or exceed these specifications in all cases and should alternative instruments or systems be identified as part of the procurement process, these must meet the specifications referred to above.

## 3.2. Design of the ICT infrastructure and services / 3.3 Design the Data Management System

The IT infrastructure of DoM has improved significantly during the past decade, and more so during the last 5 years due to support they received from donors and implementing partners. DoM operates a dedicated system to maintain their AWS network. However, as AWSs have been commissioned through three different funding sources and the network is comprised of different instrument manufacturers, there are in practice three independent data ingestion and storage systems for each AWS network and the receipt and storage of manual observations, summarized in Table 6. AWS connections should be used to send data direct to WIS2.0, or, to a centrally hosted CDMS at DoM which will the forward to WIS2.0. A full review of available solutions has been proposed for the investment phase, at which point alignment with regional proposals for the GBON network will be incorporated. Further, DoM do not currently have a comprehensive database for data management, storage and transmission. As such, a complete implementation of a comprehensive data management system is required as an activity in the investment phase.

**Table 6 - DoM IT hardware**

| System | Server | Remarks |
|---|---|---|
| **DOM** | | |
| AWS – SUTRON | • 16GB RAM, GPU 3.0 GHz | • Workstation/server used to store AWS data |
| AWS – ADCON | • Dell Power Edge R330 server (Intel Xeon®E3-1220 V6 @ 3.00GHz, 16GB RAM, 2 x 400GB SSD SAS, Windows Server 2012 R2) | • Server used to store AWS data |
| AWS – WEATHEX | • Dell EMC Power Edge 740 (Intel® Xeon® Gold 5218 2.3G, 128GB RAM, 2 x 960GB SSD SAS, 4 x 1.9TB SSD SAS, CentOS) | • 2 servers each (one operational, 1 back-up) for data collection, storage (10 TB capacity) and access to the data via IP address |
| Manual stations | • Workstation and external drive | • Data in excel file is stored in the workstation and external drive |

The data management system should use open protocols and open-source technologies to ensure that the system can be operated sustainably. In consultation with DoM, Climsoft was identified as a potential solution and the ongoing development of OpenCDMS, which is expected to become available in 2025, should also be considered. OpenCDMS will include real-time data processing and sharing in BUFR format via WIS2.0, a requirement for contributing to GBON.

**Recommendation 3 (7):** We recommend that a thorough review of the available software solutions be undertaken in the investment phase in consultation with IT staff at DoM and including third-party contractors to support the design and implementation of the system.

The data management system must provide relevant APIs for data ingestion, and support at least MSQT and SFTP protocols for data transfer. Additionally, a quality control module which supports real-time quality control, as well as allowing manual quality control, must be included as an independent part of the system. The system must be capable of serving as real-time and long-term data storage. The system must be capable of storing all relevant metadata relating to stations, networks and observations and should be capable of updating the WMO/OSCAR system as well as data storage and access, data delivery, descriptive metadata management (where network changes should be recorded) and real-time monitoring of data, processing and service.

A significant improvement to IT infrastructure is required at DoM to fully realise the benefit of the implementation of GBON stations supported through SOFF, including provision of updated proprietary software, related data ingestion and storage servers/hardware and ability to interact with/share data internationally via WIS 2.0. Transition from local hard drive to cloud storage is recommended where affordable and achievable, but recurring costs associated with cloud storage mean that local server-based storage for data backups is probably the more sustainable and resilient option in this instance.

The preferred mechanism for sharing GBON observation data from automated instruments available to WIS 2.0 would be via direct feed from site via MQTT to the WIS2BOX. As such, the following design is recommended for replacement of the current Surface station ICT infrastructure (including CDMS and visualization tools via WIS2BOX).

**Figure 7 GBON Surface network proposed ICT infrastructure design**

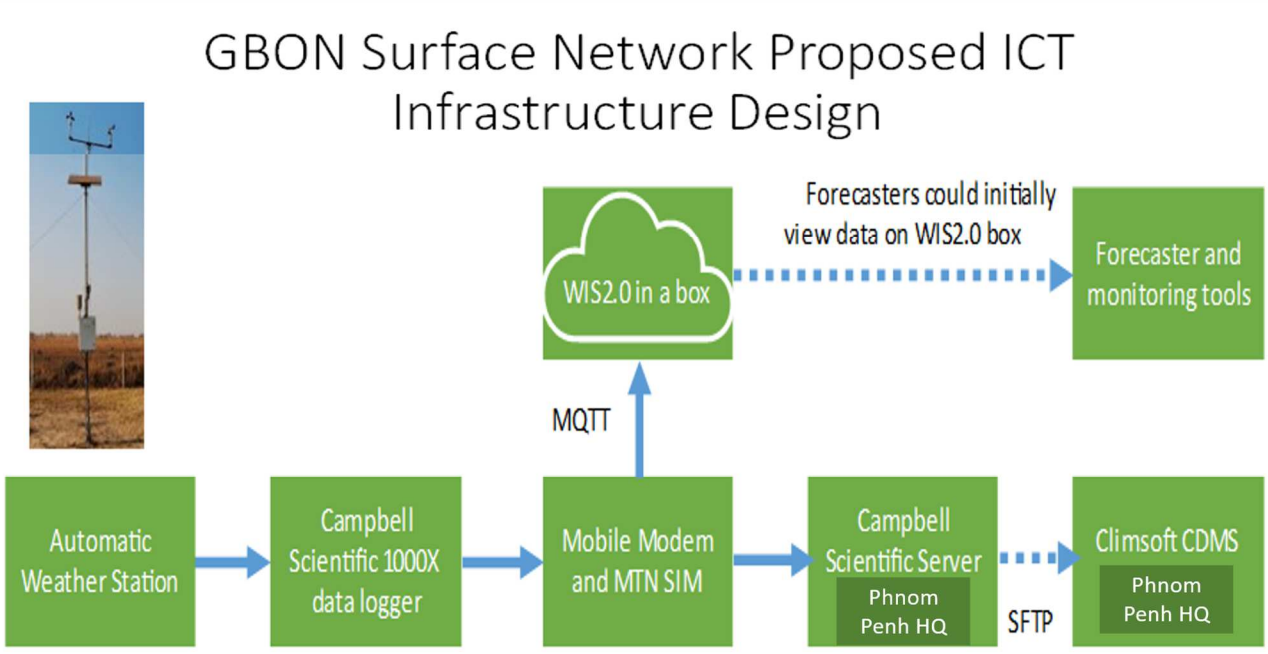
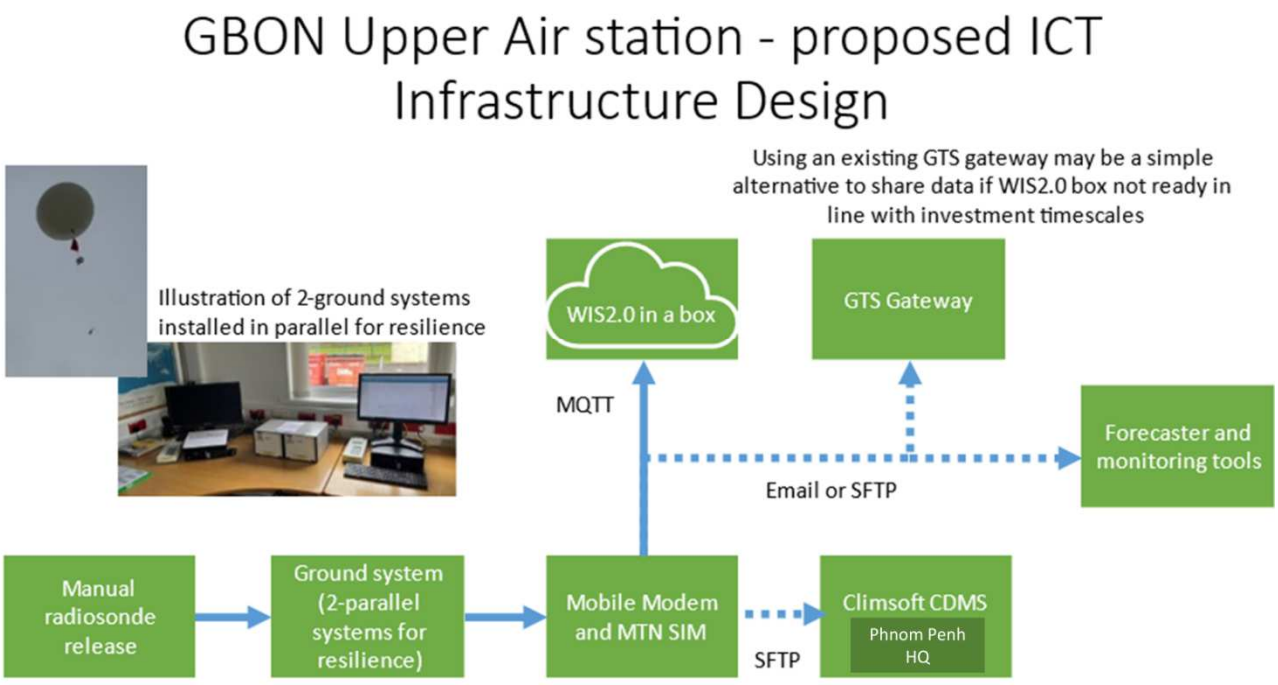



**Figure 8 GBON Upper Air station proposed ICT infrastructure design**




The data architecture is an efficient and resilient solution, as the AWSs can transmit directly to the WIS2.0 via MQTT protocol, as well a central database that is hosted at the DoM headquarters. All of the stations proposed for GBON are powered by a solar panel and battery, connected via an mobile phone modem, and are sited in locations where there is reliable network coverage. This means that the infrastructure is resilient as the provision of the data to WIS2.0 is not reliant on internet connectivity to and from Phnom Penh, maintenance of the server and database at Headquarters, or power supply issues.

DoM have a nominated Oscar National Focal Point (NFP) to manage descriptive metadata on Oscar; Oscar updates regarding the GBON sites will need to be rigorously ensured via embedding in SOPs that whenever a significant change at site occurs (eg exposure, site condition, instrument, etc). In terms of monitoring, DoM will need to nominate a WDQMS NFP and regularly review WDQMS outputs with respect to the GBON stations in order to ensure GBON compliance. Monitoring of station performance can also be undertaken in real-time locally by the forecast/observing shift rosters via proprietary software associated with supplier instrumentation, WIS2BOX visualization and through analysis of an established CDMS or East Asian WIS Centre data availability and timeliness statistics.

### 3.4. Environmental and sustainability considerations

R**ecommendation: 3(8)** We recommend the following considerations are incorporated into installation and operational plans. Environmental and sustainability considerations should be incorporated into the procurement process as part of the specifications including the use of reusable instruments where possible and sustainable methods of observation. Surface instruments should be reusable where appropriate and consideration of the environmental and sustainability impacts of maintenance (including associated travel) should be made as part of the SOP for maintenance and calibration. Similarly, consideration of the use of biodegradable materials for upper air observations should be made where possible as well as the environmental impact of shipping methods and materials. In addition, the operation of the upper air station by staff routinely located on site will reduce unnecessary travel. Local generation of hydrogen, as opposed to sourcing and importing the gas externally will contribute to the environmental sustainability of the station.

# Module 4. GBON Human Capacity Development Modul

## 4.1. Assessment of human capacity gaps

The Cambodia Department of Meteorology has both national and international responsibilities, covering a diverse range of activities. These include making GBON observations for WMO, provision of forecast and warning services to the public and relevant government agencies, and seasonal climate services.

As of March 2023, DoM has 49 staff stationed in their Headquarters in Phnom Penh, of which 37 are male and 12 female – see organisational diagrams below. An estimated 57% of DoM staff are graduates of technical/vocational training, followed by 18% staff (9) with Master's degrees, and 33% staff (15) with Bachelor's degrees.

In terms of field of study, 31 (63%) of DoM staff have masters (4), associate (16) or technical/vocational trainings (11) in meteorology; 5 have degrees in business management, accounting and finance; 2 with degrees in law; while the rest have backgrounds in English, engineering and agriculture. DoM indicated that the majority of those with associate and technical/vocational training in meteorology are senior staff, whose training is associated with technologies, systems and processes in the past. For many new staff, professional and practical experience is limited.

At present, there are no educational programmes or specialized/highly advanced technical training on meteorology in the country except the occasional donor-assisted in-country training such as those provided by external institutions like Korea Meteorological Administration (KMA) and RIMES. Opportunities to join overseas technical training courses are limited to a few personnel. DoM are unable to influence the national government's recruitment process, and while MOWRAM highlighted the relevance of trainings and workshops for capacity enhancement of staff, it is unclear whether annual budgets will effectively cover the required administrative and technical capacity building of DoM staff. To date, DoM does not have any human resource development plan.

At present, the capacity at DoM to adopt and manage significant development projects is limited, due to the lack of staff numbers and skills within the organisation. The skills gaps include strategic management, project management, financial management and resource management. The key technical capacity gaps include skills in maintenance and operation of observing equipment including upper air observations IT and networking management, database management and maintenance, and instrument calibration, repair, and replacement. It is recommended that, in the investment phase a workforce plan Is developed for the DOM and legal arrangements with MOWRAM are reviewed and updated to ensure formal support and ongoing provision for observing staff and recognition of their responsibilities.

**Figure 9 – Department of Meteorology Structure**

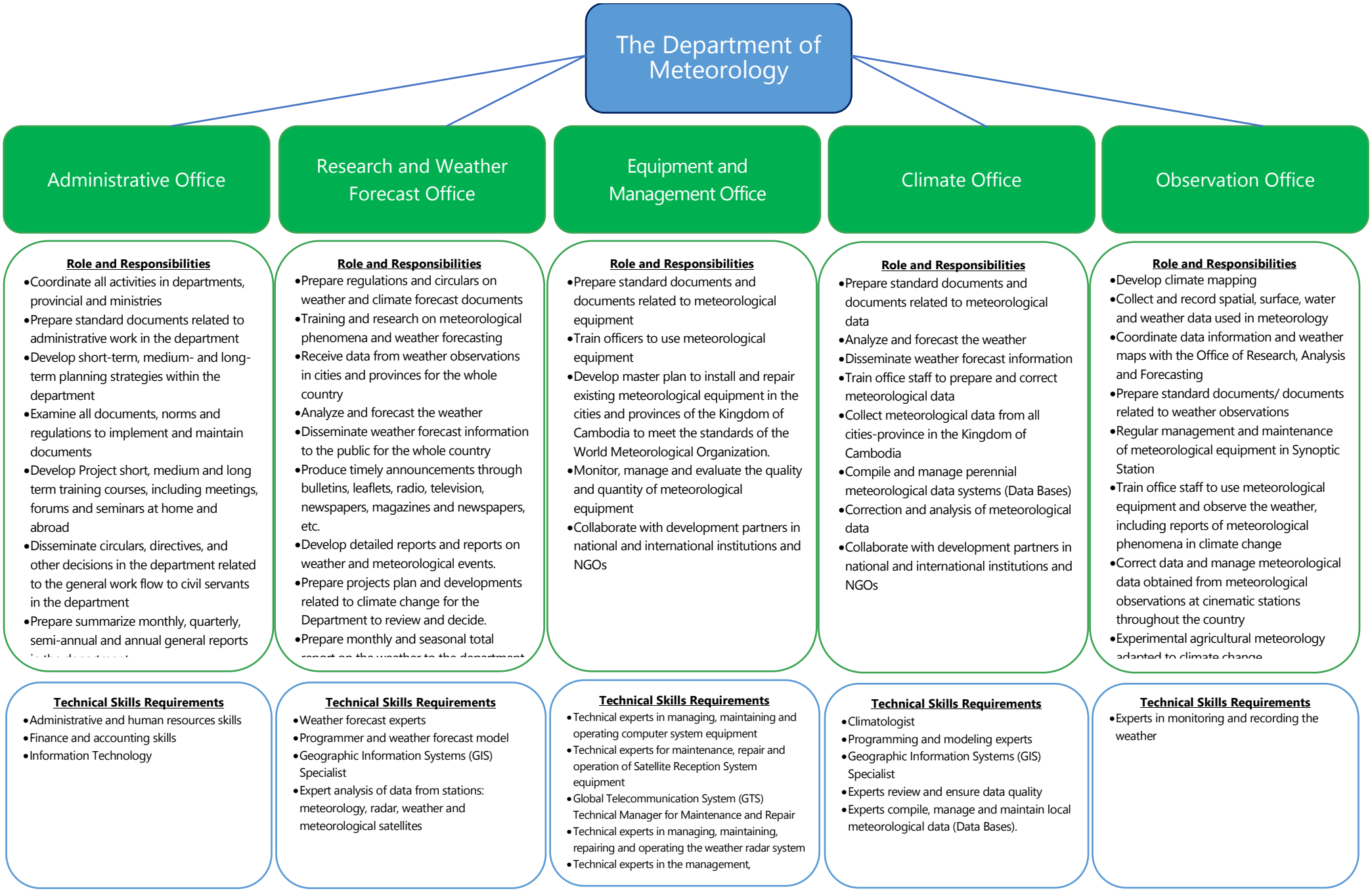


**Figure 10 – Department of Meteorology Staff Background**

| Nº | Degree | Male | Female | Total |
|---|---|---|---|---|
| 1 | Masters | 07 | 02 | 09 |
| 2 | Bachelors | 10 | 05 | 15 |
| 3 | Intermediate Technicians | 13 | 02 | 15 |
| 4 | Primary Technicians | 06 | 00 | 06 |
| 5 | Normal Skills | 01 | 03 | 04 |
| Total | | 37 | 12 | 49 |

In order to deliver the requirements of the SOFF investment phase and future GBON compliance it is proposed that two new roles are established:

1. Project manager: This temporary role will be contracted to the Implementing Agency in order to manage the delivery of the SOFF Investment phase and provide change management support to DoM during this phase where DoM does not have sufficient resource to underpin project management. It is only intended to permanently employ one new role to support this GBON investment going forwards and the GBON Network & Data Manager role (below) will ultimately supersede this headcount addition.

2. GBON Network and Data Manager: This will be a new permanent role within the Information/Technical Systems section of DoM with responsibilities for the initial integration and establishment of the GBON network and data services (including CDMS) during the investment phase, and the ongoing dedicated monitoring and maintenance of this service in the future to ensure GBON compliance. This role should implement and maintain appropriate network management, ICT/data management, CDMS, metadata collection/archiving and calibration/replacement procedures in relation to the GBON investment, building on process efficiencies to expand to the wider DoM-operated network where possible, in tandem with others working in the observations area. As such, this role should have appropriate IT and technical skills to undertake tasks such as configuration of the WIS2BOX, CDMS, etc.

**Recommendation 4 (1):** The SOFF Investment Phase will provide DoM with an opportunity to fill the resource and skills gaps and we recommend a range of training and development for senior managers, technical managers, and staff. We recommend **(recommendation 2(5))** the recruitment of a new Project Manager for the investment phase of SOFF, to support the implementation of SOFF funded activities. This post can be reviewed and revised during the Investment Phase, and potentially become a permanent role in support of the Director.

**Recommendation 4 (2):** We also recommend the recruitment of a Network Manager, a new role that will take full responsibility for the operational observations and ICT networks.

## 4.2. Design capacity development activities for technical staff

To ensure that the GBON observing operations and maintenance of network equipment is consistent and of a high quality, we have recommended the recruitment of a Network Manager – **recommendation 4(2)**.

**Recommendation 4 (3):** We recommend an ongoing programme of formal and informal training is undertaken across the Network Manager and technical staff at DoM, as outlined below. In addition, as the department grows and changes in line with the updated strategic plan it is essential that all new staff are similarly trained.

**Recommendation 4 (4):** We recommend that the initial procurement and deployment of observations equipment is undertaken by the Network Manager and staff from the Equipment and Management office. As the DoM develops, new staff will be identified to be trained and be able to assume responsibility for maintenance of the GBON stations, as required.

Technical staff across the organisation require formal training in the operation and maintenance of the instruments which could be sourced from the manufacturer or supplier of the instruments and coordinated through WMO / JMA. Specific training on the maintenance and observation practices associated with the surface observations should be provisioned for existing technical staff and extended to new staff as necessary.

**Recommendation 4 (5):** We recommend a repository of reusable training materials be developed and made available to ensure consistent training can be efficiently provided in the case of staff turnover.

**Recommendation 4 (6):** We recommend training on the calibration of instruments should be provisioned for the technical staff and updated in the event of staff turnover. This should be coordinated as a regional training workshop activity including other SOFF beneficiary countries in the region and managed by the Network Manager.

Training on the operation and maintenance of the upper air observations must also be provisioned including routine operations of the radiosonde site and the hydrogen generation equipment. It is recommended that this training is managed by the Network Manager and provisioned for all staff with responsibility for upper air observations including those on site at the upper air station and a selection of technical staff from DoM HQ to ensure resilience and sustainability.

**Recommendation 4 (7)**: We recommend that the Network Manager and technical staff utilise existing online resources including WMO training materials in the WMO Education and Training Programme, in particular courses under the Instruments and Methods of Observation section and the available training and workshops on the implementation of WIS2.0.

### 4.3. Design capacity development activities for senior management

The Cambodia DoM have a broad and diverse range of responsibilities, and as awareness of growing climate hazards become more pronounced, demand for more services from the NMS is also increasing. At the same time, the NMS hasn't benefitted from modernisation or commensurate investment since its inception. This situation puts an increasing burden on DoM, especially the Director and the leadership team, and puts their ability to sustain the GBON at risk.

To manage this situation requires a range of interventions that will rapidly satisfy the needs in an effective and sustainable manner. The first recommendation – **recommendation 2(8)** – to refresh the DoM Strategic and Operational plans. These activities will clearly identify the high priority needs and provide relevant evidence to government and investors. Thereafter, it is recommended to provide development in two forms.

**Recommendation 4 (8):** Firstly, we recommend, through off-the-shelf training packages, such as Management and Leadership training, Managing Successful Projects training, Financial Management and Human Resource Management training.

**Recommendation 4 (9)**: Secondly, we recommend, through practical implementation of the NMS Observation Strategy and Operational plans with a peer to deliver GBON compliance. This will include the development of standard operating procedures for quality assurance, maintenance, calibration and sustainability, and their adoption into a Quality Management System (QMS).

In recognition of the existing and excessive tasking on the NMS, it is recommended – **recommendation 2(5)** – a project manager is recruited and established. This post(s) would be responsible for the effective introduction of all SOFF funded outputs to the NMS. As the project

approaches it end, this post could evolve to have more stakeholder engagement responsibilities and ensure sustainability of the GBON is maintained.

### 4.4. Gender and CSOs considerations

DoM recognises the importance of Gender, Equality and Social Inclusion (GESI) and the crucial role of DoM to address the issues of GESI and support people and communities disproportionately impacted by extreme weather, seasonal events and climate change. Proactive support for women, girls and marginalised people who are more likely to be negatively affected by the impacts of a climate and weather-related extreme event is essential.

**Recommendation 4 (10)**: We recommend DoM undertake Gender, Equality and Social Inclusion (GESI) training as part of a broader activity to ensure GESI is mainstreamed in DoM working practices. In addition, the following guidelines (from the WISER GESI Minimum Standards) should be followed and adhered to on all SOFF activities:

1. Is there a GESI context analysis to inform programming which identifies:
    i. Barriers and enablers to people of different gender, ages and ability, social economic constraints, or marginalised groups accessing project services.
    ii. The risks of project activities which might negatively impact GESI and how to mitigate such risks?
2. Can people of different gender, ages and ability, social economic constraints, or marginalised groups with differing abilities meaningfully participate in the design, implementation and Monitoring, Evaluation and cross-Learning (MEL) of the project, so they can build individual agency, change gender and group relations, transform systems and structures
3. How does the project contribute to gender equity, protection, and longer term empowerment of different genders, ages and ability, social economic constraints, or marginalised people?
4. Is there a plan for building the capacity of local partners on GESI using these Minimum Standards and GESI upskilling?
5. Does the MEL system enable analysis of GESI issues and does the project Logframe or results framework integrate qualitative and quantitative:
    i. Gender and social inclusion targets, that capture evidence of leadership, empowerment and meaningful participation in decision-making?
    ii. Sex, age, and differing ability disaggregated data and account for intracommunity diversity and complexity?

**Recommendation 4 (11)**: There was no formal gender assessment of DoM undertaken during the readiness phase, so we recommend DoM conduct a gender self- assessment of their institution and include insights to their modernisation plans. During the Investment Phase, and any further modernisation, recruitment and training should follow these guidelines:

- Women should represent at least 50 % of all participants in SOFF-related and supported training
- Women should represent at least 50 % of all participants in SOFF consultations, planning workshops, etc.
- Women should represent at least 50 % of staff for operating and maintaining GBON stations
- Women should represent at least 50 % of decision-making and project management positions where applicable

It is also recognized that engagement with civil society organisations is an important factor, to raise awareness of DoM and the observation sites and how they play an important role in the value-chain that provides high-impact weather information, especially to women and girls. Existing engagement with Civil Society Organisations (CSOs) is relatively limited at present but includes data sharing with the Cambodian Red Cross, who use products provided for malaria research, and engagement and consultation with various local NGOs to take action on early warnings. . The proposed investment in GBON sites across Cambodia will require cooperation with CSOs in that area and an event will be held to engage with this sector to mitigate against the risk of theft and vandalism.

**Recommendation 4 (12)**: We recommend a consultation event be held with CSOs, including those focused on women's empowerment.

# Module 5. Risk Management Framework

## 5.1 Assess the risks of the observing network and propose mitigation measures

The primary risks to the observation network are set out in the risk register below. The risk owner will monitor and evaluate risks throughout the implementation and compliance phases.

**Recommendation 5 (1)**: We recommend this risk register should be owned and maintained primarily by the DoM Director for operational risks, updated on a quarterly basis.

| **Operational risks to the observations network** | | | | | | |
|---|---|---|---|---|---|---|
| **Risk description** | **Impact description** | **Impact level** | **Probability level** | **Priority level** | **Mitigation** | **Owner** |
| Severe weather / flooding / tropical cyclone | Destroy sensors / infrastructure | Major | Possible | High | Spare / replacement equipment on site Mobile AWS X 4 | So Im Monchoth, DoM; Implemeting Entity (IE) |
| Communications | Lost data for duration of communication outage | Major | Unlikely | Medium | Temporary storage in datalogger | So Im Monchoth, DoM; |
| Surrounding land use change | Development of land surrounding observation sites | Moderate | Unlikely | Medium | Site selection | So Im Monchoth, DoM; |
| Drought | Fire risk | Moderate | Possible | High | Maintain station surroundings through maintenance SOP | So Im Monchoth, DoM; |
| Power outages | Loss of readings | Moderate | Likely | High | Solar panel / battery | So Im Monchoth, DoM; |
| Security | Damage or theft | Moderate | Unlikely | Medium | Government locations, permanent staff on site, Work with local authority close to district office, local security PDWRAM | So Im Monchoth, DoM; |
| Staff leave after training – staff retention | Staff numbers and skills | Moderate | Rare | Medium | Staff engagement. | So Im Monchoth, DoM; Implemeting Entity (IE) |
| Budget | Lack of capacity for system sustainability,both implementation and compliance phase. | Major | Unlikely | Medium | SOFF support for ops + maintenance | So Im Monchoth, DoM; Implemeting Entity (IE) |
| Local staff capacity | Staff unable to be developed to sufficient capacity/capability to implement and sustain observations networks during | Major | Rare | Medium | Training + experience for provincial staff | So Im Monchoth, DoM; Implemeting Entity (IE) |

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| | project and compliance phases | | | | | |
| Recruitment | Unable to recruit sufficiently skilled resourcing during either implementation or compliances phases | Moderate | Rare | Medium | Write suitable job specifications and gauge against market evaluations | So Im Monchoth, DoM; Implemeting Entity (IE) |
| Unexploded Ordnance (UXO) | Health and safety of staff | Extreme | Rare | High | Installation/ enhancement at existing DoM sites and clearance of UXO as required | So Im Monchoth, DoM; Implemeting Entity (IE) |

# Module 6. Transition to SOFF investment phase

**Recommendation 6 (1)**: It is recommended that, on approval of the Investment Phase Funding Request, a workshop including the DoM, World Bank and the Met Office is arranged to review the outputs of the readiness phase and co-develop a project plan for the investment phase.

**Recommendation 6 (2)**: Routine project board meetings undertaken in the readiness phase should continue under the coordination of the World Bank and should include the peer advisor and other relevant partners as necessary.

# Summary of GBON National Contribution Plan

| Components | Recommended activities | Related outputs and technical details |
|---|---|---|
| **Module 2.** GBON business model and institutional development | **2 (1)**: a stakeholder engagement event to highlight the benefits that SOFF will bring and the opportunities for other government agencies. | 2.1 |
| | **2 (2):** routine meetings, frequency to be agreed at the stakeholder event, with Ministry officials to update on progress and provide advocacy for DoM. | 2.1 |
| | **2 (3):** legal arrangements with MOWRAM are reviewed, updated and made suitable as part of the investment phase to ensure formal and ongoing provision for these staff and recognition of their responsibilities (including their international responsibilities) with respect to meteorological observations. | 2.1 |
| | **2 (4):** regional training and procurement with neighbouring countries and regional projects for the installation, operation, maintenance and calibration of the GBON network where feasible. | 2.2 |
| | **2 (5):** Recruit a project manager to take responsibility for project management, financial planning, regional coordination and communication & advocacy with the owning ministry. | 2.2 |
| | **2 (6):** Cambodia DoM collaborate with regional nations on a WIS2.0 implementation and requires dialogue and agreements with other projects and regional partners. | 2.2 |
| | **2 (7):** an event at project initiation with all development partners relevant to SOFF to raise | 2.4 |

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| | awareness of SOFF Cambodia's plans and to ensure coordination, cooperation, and collaboration. | |
| | **2(8)** a new Strategic and Operational Plan is commissioned at an early stage of the Investment Phase. | 2.4 |
| | **2(9):** the specific legislation of relevance to meteorological services in Cambodia are reviewed and revised, that there is advocacy for reform, and that there is consideration of enhanced collaboration with the aviation meteorological service provider. | 2.5 |
| | **2(10):** advocacy communications strategy is developed and presented to the government. | 2.5 |
| **Module 3.** GBON infrastructure development | **3 (1):** we recommended that Cambodia's Department of Meteorology improve five existing surface observation sites to GBON standards. | 3.1 |
| | **3 (2):** Kour Srov at (Phnom Penh) receives the installation of upper air capability and is designated as the GBON upper air site for Cambodia. | 3.1 |
| | **3 (3):** a full store of spares should be procured and maintained at DoM HQ or at an appropriate regional centre. | 3.1 |
| | **3 (4):** training on the safe operation and basic maintenance of the hydrogen generation and storage equipment will be provided by the instrument manufacturer to the DoM staff on site. | 3.1 |
| | **3 (5):** development of robust standard operating procedures for the operation of the upper air station is recommended as an activity in the investment phase – see **recommendation 2(8).** | 3.1 |
| | **3 (6):** calibration of sensing equipment is carried out at regular intervals through the | 3.1 |

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| | manufacturer's regional centre or at an accredited calibration facility – see preface and **recommendation 2(8).** | |
| | **3 (7):** a thorough review of the available software solutions be undertaken in the investment phase in consultation with IT staff at DoM and including third-party contractors to support the design and implementation of the system. | 3.2 |
| | **3 (8):** environmental and sustainability considerations are incorporated in to procurement, installation and operational plans. | 3.4 |
| **Module 4.** GBON human capacity development | **4 (1):** a range of training and development for senior managers, technical managers, and staff. | 4.1 |
| | **4 (2):** recruit a Network Manager, a new role that will take full responsibility for the operational observations network. | 4.1 |
| | **4 (3):** ongoing programme of formal and informal training is undertaken across the Network Manager and technical staff at DoM, as outlined below. In addition, as the department grows and changes in line with the updated strategic plan it is essential that all new staff are similarly trained. | 4.2 |
| | **4 (4):** the initial procurement and deployment of observations equipment is undertaken by the Network Manager and staff from the Equipment and Management office. | 4.2 |
| | **4 (5):** a repository of reusable training materials be developed and made available to ensure consistent training can be efficiently provided in the case of staff turnover. | 4.2 |
| | **4 (6):** training on the calibration of instruments should be provisioned | 4.2 |

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| | for the technical staff and updated in the event of staff turnover. | |
| | **4 (7):** the Network Manager and technical staff utilise existing online resources including WMO training materials in the WMO Education and Training Programme. | 4.2 |
| | **4 (8):** through off-the-shelf training packages, such as Management and Leadership training, Managing Successful Projects training, Financial Management and Human Resource Management training. | 4.3 |
| | **4 (9):** through practical implementation of the NMS Observation Strategy and Operational plans with a peer to deliver GBON compliance. | 4.3 |
| | **4 (10):** DoM undertake Gender, Equality and Social Inclusion (GESI) training as part of a broader activity to ensure GESI is mainstreamed in DoM working practices. | 4.4 |
| | **4 (11):** DoM conduct a gender self-assessment of their institution and include insights to their modernisation plans. | 4.4 |
| | **4 (12):** a consultation event be held with CSOs, including those focused on women's empowerment. | 4.4 |
| **Module 5.** Risk Management | **5 (1)**: risk register should be owned and maintained by DoM Director and updated on a quarterly basis. | 5.1 |
| **Module 6. Transition to SOFF investment phase** | **6 (1)**: on approval of the Investment Phase Funding Request, a workshop including the DoM, World Bank and the Met Office is arranged to review the outputs of the readiness phase and co-develop a project plan for the investment phase. | 6 |
| | **6 (2):** Routine project board meetings undertaken in the readiness phase should continue under the coordination of the World Bank and should include the | 6 |

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| | peer advisor and other relevant partners as necessary. | |

# Report completion signatures

**Peer Advisor signature**

Helen Bye - Head of International Engagement

**Beneficiary Country signature**

SOIM MONICHOTH
Director, Department of Meteorology

**WMO Technical Authority signature**