 4 July 2023

SOFF Operational Guidance

Handbook

Operational guidance for SOFF beneficiary countries, peer advisors, and Implementing Entities

Systematic Observations   
Financing Facility

***Document review comments***

* Version 2.0 – 4 July 2023
* This document is dynamic, it will be iteratively improved to reflect decisions of the SOFF Steering Committee as well as the feedback on good practices and lessons learned from peer advisors, beneficiary countries, Implementing Entities, and the WMO Technical Authority as SOFF implementation proceeds. The responsibility for maintaining the handbook lies in the SOFF Secretariat with the support of the WMO Technical authority.

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1. **Purpose**

This document provides guidance to the SOFF peer advisors, beneficiary countries, and Implementing Entities for the development of the **GBON National Gap Analysis** (Gap Analysis in short).

The objective of the Gap Analysis is to define the gap between the mandatory requirements of the GBON regulations and the existing country surface and upper-air networks. In other words, it serves as the basis for identifying the number of observing stations that need to be installed or rehabilitated to become compliant with the mandatory requirements of the GBON regulations.

The Gap Analysis is one of the outputs of the SOFF Readiness Phase. The peer advisors should complete the Analysis on behalf of and in collaboration with the beneficiary country. The guidance in this document is based on the GBON Guide[[1]](#footnote-2) developed by the World Meteorological Organization (WMO) Commission for Observation, Infrastructure, and Information Systems (INFCOM) for implementing GBON by all WMO Members. The peers should follow this guidance along with WMO standard practices, provisions, and technical guidance material for the implementation of observing systems, data management and exchange (information) systems, and GBON.[[2]](#footnote-3)

The WMO Secretariat, INFCOM and SOFF Secretariat stand available to respond to questions, provide support, and share good practices in every phase of GBON implementation.

# **Scope**

The guidance provided in this document focuses on the scope of SOFF support. The following aspects define the scope of SOFF support and Table 1 summarizes the standard practices of the GBON regulations included in the scope of SOFF.

* **GBON regulations:** The GBON regulations consist of two types of requirements: standard practices, mandatory and identified in WMO regulations by using the verb "shall" and recommended practices, identified by using the verb "should". Since SOFF support initially covers the GBON standard practices, this document focuses on the guidance needed for those requirements. It is up to beneficiary countries to explore and assess ways and resources to meet the recommended GBON practices.

SOFF supports establishing and operating the GBON standard density (200km). However, in countries with high-density networks (100km), peer advisors are encouraged to assess whether the existing high-density network can also benefit from the SOFF interventions for the standard network, e.g., information and communications technology improvements for data exchange.

* **Station types:** GBON standard practices establish a required minimum number of stations for each country (depending on the surface of the respective Member) of primarily two specific types: surface and upper-air and, where appropriate, marine meteorological observing stations or platforms. SOFF focuses initially on surface and upper air stations.
* **GBON marine stations:** Marine meteorological stations may be considered by SOFF at a later stage, including potentially through sub-regional/regional cooperation modalities. Therefore, SOFF peer advisors are encouraged to include in their GBON National Gap Analysis the assessment of country marine stations and related GBON requirements when considered relevant.

**Table 1. Summary of the standard practices of the GBON regulations.** SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth, SST: Sea surface temperature.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GBON requirements per station type** | | **GBON Variables** | | | | | | |
|  | **SLP** | **T** | **H** | **W** | **P** | **SD** | **SST** |
| * **Surface land stations** Horizontal resolution[[3]](#footnote-4): 200km * Observing cycle: 1h * Real-time data exchange to WIS | | X | X | X | X | X | X |  |
| * **Upper-air stations operated from land** Horizontal resolution:3 500km * Vertical resolution: 100m, up to 30 hPa * Observing cycle: twice a day * Real-time data exchange to WIS |  | X | X | X |  |  |  |
| * **Surface marine stations in Exclusive Economic Zones**:[[4]](#footnote-5) 500 km | X |  |  |  |  |  | X |
| * **Upper-air stations operated in Exclusive Economic Zones**:[[5]](#footnote-6) 1000 km * **Vertical resolution:** 100m, up to 30 hPa |  | X | X | X |  |  |  |

# **Roles and responsibilities**

**Beneficiary country National Meteorological and Hydrological Service**

* Is responsible for implementing the activities of the Readiness phase with the support from the peer advisor and the prospective Implementing Entity.
* Prepares the Assignment Terms of Reference following the standard Terms of Reference provided by the SOFF Secretariat, in collaboration with the peer advisor and in coordination with the prospective Implementing Entity.
* Submits the funding request for the SOFF Readiness phase support using the standardized template provided by the SOFF Secretariat.
* Is responsible for collaborating with the peer advisor to provide all the necessary information and participate in and facilitate the national activities the peer advisor needs to conduct in order to develop the Readiness phase outputs.
* Confirms receipt of the peer advisors' report with the Readiness phase outputs and provides comments on the outputs as needed.

**Peer advisor**

* Is accountable to the beneficiary country.
* In dialogue with the beneficiary country, provides independent technical advice, analysis and recommendations to support the beneficiary country in implementing the activities of the Readiness phase.
* Develops the Readiness phase outputs and is responsible for their quality and timely delivery. Communicates regularly with the beneficiary country and the Implementing Entity.
* Engages with the civil society, including on the identification of stakeholders of relevance for GBON implementation.
* Submits the final report with the Readiness phase outputs to the country for comments and to the prospective Implementing Entity for feedback.
* Submits the final report including the beneficiary country's comments and the prospective Implementing Entity's feedback to the SOFF Secretariat.
* Notifies the SOFF Secretariat and the prospective Implementing Entity of any delays that may impede the timely delivery of the outputs, and for assignments for which the delivery takes more than six months submits a semi-annual progress report.

**Implementing Entity**

* Participates in the Readiness phase activities and collaborates with the beneficiary country and the peer advisor to ensure a common understanding of the Readiness phase outputs and that they address the technical needs for the design and implementation of the Investment phase.
* Contributes to the definition of the Terms of Reference and provides feedback on the outputs delivered by the peer advisor
* Based on its experience in the beneficiary country, supports the work of the peer advisor, e.g. by sharing its knowledge and facilitating access to the network of relevant stakeholders.

**WMO Technical Authority**

* Provides basic technical support to the beneficiary country, peer advisor, and prospective Implementing Entity on GBON regulations.
* Is responsible for the technical screening of the draft GBON National Gap Analysis and the draft GBON National Contribution Plan against the GBON regulations.
* Is responsible for establishing and administering the pass-through mechanism for contracting and funding of the technical assistance provided by the peer advisors.

**SOFF Secretariat**

* Facilitates communication, coordination and collaboration between the beneficiary country, the peer advisor, the prospective Implementing Entity and WMO Technical Authority.
* Reviews the Readiness funding request, including the Terms of Reference, for compliance and consistency with the information requirements in the template and provides feedback as needed. Transmits the funding request to the SOFF Steering Committee for its decision.
* Confirms receipt of the peer advisors' report with the Readiness phase outputs.
* Organizes exchange of knowledge and experiences and captures lessons learned.

# **GBON National Gap Analysis steps**

The following four steps guide the development of the GBON National Gap Analysis:

**4.1** **Step 1 – Country information from the GBON Global Gap Analysis**

In this step, the peer advisor reviews the GBON national gap based on a global gap analysis developed and provided by WMO to the beneficiary country.

The country information in the WMO GBON Global Gap Analysis provides a "default" assessment of the status of the observational data exchange measured against GBON requirements and the total number of stations that need to be improved or newly installed.

Table 2 illustrates the information provided by the WMO Secretariat that the peer advisor and the country will use as the starting point for the GBON National Gap Analysis.

1. **GBON horizontal resolution requirements:** The GBON regulations as published in the [Manual on WIGOS (WMO-No. 1160)](https://library.wmo.int/index.php?lvl=notice_display&id=19223#.Y-oACHbMJjE);
2. **GBON target**: Number of surface and upper-air stations required based on the GBON global gap analysis completed by the WMO Secretariat;
3. **Reporting (to requirements)**: The rationale for classifying surface and upper-air stations as reporting is based on the WIGOS Data Quality Monitoring System (WDQMS) for the chosen time period (for WMO GBON Global Gap analysis, January 2022). Stations that were either green (GBON compliant), or orange (“potentially GBON compliant”) on at least 60% of days, are considered as reporting. Other listed stations are counted as having the possibility to be **improved;**
4. **Gap to improve:** Number of surface and upper-air stations that could a priori be improved to meet GBON requirements, for example, by increasing the number of shared observations (as default per the WMO Global Gap Analysis);
5. **Gap new:** Number of new surface and upper-air stations that need to be established and installed (as default per the WMO Global Gap Analysis);
6. **Gap total:** The total of how many stations need to, either be improved, or newly installed (as default per the Global Gap Analysis), to meet the GBON target. SOFF will only provide support for the number of stations that does not exceed this target. Deviations from the Global Gap Analysis should be explained (i.e., the end of previous development projects) with links to supporting information.

**Table 2. GBON Gap Analysis.** Illustration of the information that the WMO Secretariat provides to each country.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **A. GBON horizontal resolution requirements** | **B. Target** | **C. Reporting to req.[[6]](#footnote-7)** | **D. Gap to improve** | **E. Gap new** | **F. Gap total** |
| **Surface stations**  Standard density[[7]](#footnote-8) 200 km |  |  |  |  |  |
| **Upper-air stations over land**  Standard density7 500km |  |  |  |  |  |

The WMO Global Gap Analysis only provides an initial top-down estimation based on the WDQMS web tool. In the next step, the peer advisor and the country take a deeper look into the country's actual situation. This includes looking at stations that could contribute to GBON but are not captured in the WMO Global Gap Analysis.

**4.2** **Step 2 - Analysis of existing GBON stations and their status against GBON requirements**

In this step, the peer advisor assesses existing stations in the country that could contribute to GBON. This includes stations operated by the National Meteorological and Hydrological Service (NMHS), other governmental agencies, and the private sector, which could contribute to GBON. The peer assesses the operational status of the stations, including the variables they measure and report, and provides a geographical visualization of the distribution of the stations. The networks are evaluated based on the mandatory GBON requirements.

The elements to be analyzed in step 2 are:

1. **NMHS network:** Number of stations managed by the NMHS and their reporting status against GBON requirements, i.e., reporting or to be improved.
2. **Third-party networks:** Number of surface and upper-air stations operated by the third party which could contribute to or become GBON stations and their reporting status against GBON requirements, i.e., reporting or to be improved.
3. **Station information:** Name, owner, and funding source of a station, and which variables a station is reporting and how regularly (see Table 4).

The status of existing stations is defined as follows:

* **Reporting to requirements:** The rationale for classifying surface and upper-air stations as reporting is based on the WIGOS Data Quality Monitoring System (WDQMS) for the chosen time period (WMO GBON Global Gap analysis, January 2022). Stations that were either green (GBON compliant), or orange (“potentially GBON compliant”) on at least 60% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved.
* **Improve:** Whether the station exists but is not fully operational and can be improved to report internationally as per the GBON requirements (e.g., the station is out of service, has broken instruments, reports on only some variables, or not as often as required, the observations are not exchanged internationally via WIS or other issues with the data transmission system). The actions for improvements should be assessed and outlined in the GBON National Contribution Plan.

**Table 3. Assessment of existent stations per their operational status and network ownership.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **GBON Requirements** | **Existing observation stations (# of stations)** | | | |
| **NMHS network** | | **Third-party network** | |
| **Reporting to req.** **[[8]](#footnote-9)** | **To improve** | **Reporting to req.**8 | **To improve** |
| **Surface land stations** Standard density[[9]](#footnote-10) 200km Variables: SLP, T, H, W, P, SD | **55ooo5** |  |  |  |
| **Upper-air stations operated from land** Horizontal resolution9: 500km  Vertical resolution: 100m, up to 30 hPa  Variables: T, H, W |  |  |  |  |
| **Surface marine stations in Exclusive Economic Zones**: 500 km  Variables: SLP, SST |  |  |  |  |
| **Upper-air stations operated in Exclusive Economic Zones**:**[[10]](#footnote-11)** 1000 km.  Vertical resolution: 100m, up to 30 hPa  Variables: T, H, W |  |  |  |  |

Secondly, the status of the existing stations is analysed in terms of the GBON variables and international reporting cycle requirements. The reporting cycle is assessed per station with respect to one-hour reporting frequency for surface stations and twice a day for upper-air stations.

**Table 4. Assessment of existing GBON stations per station characteristics.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Station name** | **Station type (S/UA/M[[11]](#footnote-12))** | **Owner (NMHS/3rd party)** | **Funding source** | **GBON variable measured** | | | | | | | **Reporting cycle (obs/day)** | **GBON Compliant (Y/N)** |
| **SLP** | **T** | **H** | **W** | **P** | **SD** | **SST** |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |

Station type: S: Surface, UA: Upper-Air; M: Marine; Owner of the station: NMHS or name of third-party; GBON variables: SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: Wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature; Reporting cycle: Number of observation reports exchanged internationally per day (0-24); GBON compliance: weather the station is GBON compliant or not (see GBON guide[[12]](#footnote-13) on compliance criteria).

**4.3** **Step 3 - GBON National Gap Analysis results**

In step 3, the peer compares the information provided by WMO in the GBON Global Gap Analysis with the results of the in-country assessment performed in step 2.

As a result, step 3 defines the GBON national stations gap against the target number of GBON stations as provided by the WMO in the Global Gap Analysis.

**Table 5. Results of the GBON national gap analysis.** SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **GBON requirements** | **GBON target**  **(# of stations)** | **GBON Compliant stations (#)** | **Stations gap** | |
| **To improve** | **New** |
| **Surface land stations** Standard density[[13]](#footnote-14) 200km  Variables: SLP, T, H, W, SD  Observing cycle: 1h |  |  |  |  |
| **Upper-air stations operated from land** Standard density15500km.  Vertical resolution: 100m,  up to 30 hpa  Variables: T, H, W  Observing cycle: twice a day |  |  |  |  |
| **Surface marine stations in Exclusive Economic Zones:[[14]](#footnote-15)**  Density: 500 km  Variables: SLP, SST  Observing cycle: 1h |  |  |  |  |
| **Upper-air stations operated in Exclusive Economic Zones: [[15]](#footnote-16)**  Density: 1000 km  Vertical resolution: 100 m, up to 30 hPa  Variables: T, H, W  Observing cycle: twice a day |  |  |  |  |

A list of surface, upper-air and marine stations compliant with the GBON regulations and recommended to designate to GBON should be summarized in Table 6.

**Table 6. Recommended existing surface, upper-air and marine stations to be designated to GBON.**

|  |  |
| --- | --- |
| **Station name** | **Station type (S/UA/M[[16]](#footnote-17))** |
|
|  |  |
|  |  |
|  |  |

**4.4** **Step 4 – Country endorsement and integration into National Contribution Plan**

In step 4, WMO Technical Authority screens the draft GBON National Gap Analysis Report to ensure consistency with the GBON regulations, provides feedback as needed, and submits a final satisfactory note once the revisions are addressed.

The gap analysis results provide the basis and starting point for the development of the GBON National Contribution Plan. As part of the Contribution Plan, the peer advisor and the beneficiary country further assess and, as needed, adjust the GBON target to consider national circumstances and geography, sub-regional optimization of network design, feasibility, and a phased approach.

**Annex I. Template for GBON National Gap Analysis Report by the Peer Advisor**

**GBON National Gap Analysis Report**

**[Country Name]**

|  |  |
| --- | --- |
| **Beneficiary Country Focal Point and Institute** |  |
| **Peer Advisor Focal Point and Institute** |  |

**1.** **Country information from the GBON Global Gap Analysis**

Please provide in this Table the country information as provided by the WMO Global GBON Gap Analysis.

**Table I. GBON Gap Analysis.** Illustration of the information that the WMO Secretariat provides to each country

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **A. GBON horizontal resolution requirements** | **B. Target** | **C. Reporting to req. [[17]](#footnote-18)** | **D. Gap to improve** | **E. Gap new** | **F. Gap total** |
| **Surface stations**  Standard density[[18]](#footnote-19) 200 km |  |  |  |  |  |
| **Upper-air stations over land**  Standard density21500km |  |  |  |  |  |

**2.** **Analysis of existing GBON stations and their status against GBON requirements**

Please complete the two tables below and add remarks and Annexes with technical details as needed.

**Table II. Assessment of existent stations per their operational status and network ownership**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **GBON Requirements** | **Existing observation stations (# of stations)** | | | |
| **NMHS network** | | **Third-party network** | |
| **Reporting to req. [[19]](#footnote-20)** | **To improve** | **Reporting to req. 21** | **To improve** |
| **Surface land stations** Standard density [[20]](#footnote-21) 200km Variables: SLP, T, H, W, P, SD |  |  |  |  |
| **Upper-air stations operated from land** Horizontal resolution23: 500km  Vertical resolution: 100m, up to 30 hPa  Variables: T, H, W |  |  |  |  |
| **Surface marine stations in Exclusive Economic Zones**:7 500 km  Variables: SLP, SST |  |  |  |  |
| **Upper-air stations operated in Exclusive Economic Zones**:**[[21]](#footnote-22)** 1000 km  Vertical resolution: 100m, up to 30 hPa  Variables: T, H, W |  |  |  |  |

**Table III. Assessment of existing GBON stations per station characteristics.** Station type: S: Surface, UA: Upper-Air; M: Marine; Owner of the station: NMHS or name of third-party; GBON variables: SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature; Reporting cycle: Number of observation reports exchanged internationally per day (0-24); GBON compliance: weather the station is GBON compliant or not (see GBON guide on compliance criteria).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Station name** | **Station type (S/UA/M[[22]](#footnote-23))** | **Owner (NMHS/3rd party)** | **Funding source** | **GBON variable measured** | | | | | | | **Reporting cycle (obs/day)** | | **GBON Compliant (Y/N)** |
| **SLP** | **T** | **H** | **W** | **P** | **SD** | **SST** |  | |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |
|  |  |  |  |  |  |  |  |  |  |  |  |  | |

**3.** **Results of the GBON National Gap Analysis**

Please complete the two tables below and add remarks and technical details in Annexes as needed.

**Table IV. Results of the GBON national gap analysis.** SLP: Atmospheric pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature**.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **GBON requirements** | **GBON target**  **(# of stations)** | **GBON Compliant stations (#)** | **Stations gap** | |
| **To improve** | **New** |
| **Surface land stations** Standard density[[23]](#footnote-24) 200km  Variables: SLP, T, H, W, SD  Observing cycle: 1h |  |  |  |  |
| **Upper-air stations operated from land** Standard density27500km  Vertical resolution: 100m,  up to 30 hpa  Variables: T, H, W  Observing cycle: twice a day |  |  |  |  |
| **Surface marine stations in Exclusive Economic Zones:[[24]](#footnote-25)**  Density 500 km  Variables: SLP, SST  Observing cycle: 1h |  |  |  |  |
| **Upper-air stations operated in Exclusive Economic Zones: [[25]](#footnote-26)** Density 1000 km  Vertical resolution: 100 m,  up to 30 hPa  Variables: T, H, W  Observing cycle: twice a day |  |  |  |  |

**3.1** **[[26]](#footnote-27)Recommended existing surface, upper-air and marine[[27]](#footnote-28) stations to be designated to GBON**

**Table V. Recommended existing surface, upper-air and marine stations to be designated to GBON.**

|  |  |
| --- | --- |
| **Station name** | **Station type (S/UA/M[[28]](#footnote-29))** |
|
|  |  |
|  |  |
|  |  |

***[\*\*Add here (i) a map of existing surface and upper-air stations with 200km/500 (diameter) km circles (500km/1000km for SIDS) to indicate the coverage of existing stations; and (ii) optional: Include newly proposed stations in the map in (i) \*\*]***

**4. Report completion signatures**

|  |
| --- |
| **Peer Advisor signature** |
| **WMO Technical Authority screening signature** |
| **Beneficiary Country signature** |

1. GBON National Contribution Plan

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**Glossary**

**Beneficiary countries:** In its initial three-year implementation period, SOFF will prioritize support to SIDS and LDCs for all phases of support. All other OECD ODA- eligible developing countries will be eligible for SOFF support under the Readiness phase only.

**Climate Data Management System (CDMS):** An integrated computer-based system that facilitates the effective archival, management, analysis, delivery, and utilization of a wide range of integrated climate data.

**GBON Gap Analysis:** Defines the gap between the mandatory requirements of the GBON regulations and the existing country surface - and upper-air station networks. In other words, it serves as the basis for identifying the number of observing stations that need to be installed or rehabilitated to become compliant with the mandatory requirements of the GBON regulations.

**Global Basic Observing Network (GBON):** Internationally agreed standard specifying obligations of WMO Members to acquire and internationally exchange certain observations: which parameters to measure, how often, at what horizontal and vertical resolution, when and how to exchange them, and which measurement techniques are appropriate to use.

**Implementing Entities:** Entities that serve as SOFF Implementing Entities for the investment phase – these include the major multilateral development partners that play a role in hydromet project implementation. All Implementing Entities must be members of the Alliance for Hydromet Development.

**National Meteorological and Hydrological Services (NMHS):** NMHS own and operate most of the infrastructure that is needed for providing the weather, climate, hydrological and related environmental services for the protection of life and property, economic planning and development, and for the sustainable exploitation and management of natural resources. The NMHSs from the SOFF beneficiary countries are the focal points for SOFF support.

**Numerical Weather Prediction (NWP):** A series of processes to predict future atmospheric conditions by solving dynamics and physics equations that explain the movements and changes of the atmosphere.

**Peer advisors:** NMHSs that are members of WMO are eligible to serve as peer advisors for SOFF. NMHSs interested in becoming SOFF peer advisors must demonstrate (i) substantial expertise in the areas of advisory services required for SOFF, (ii) a track record in partnering with and supporting other NMHSs, and (iii) a commitment to make available adequate human resources.

**SOFF Secretariat:** The Secretariat is responsible for the administration, reporting, monitoring and evaluation, communications, and resource mobilization of the SOFF UNMPTF. The SOFF Secretariat is accountable to the Steering Committee and supports its functioning as well as the functioning of the Advisory Board. It is administratively hosted by WMO in Geneva, Switzerland, and follows WMO administrative policies and procedures.

**The Commission for Observation, Infrastructure and Information Systems (Infrastructure Commission) (INFCOM):** Contributes to the development and implementation of globally coordinated systems for acquiring, processing, transmitting, and disseminating Earth system observations, and related standards; coordination of the production and use of standardized analysis and model forecast fields; and development and implementation of sound data and information management practices for all WMO programmes and their associated application and services areas.

**Global Telecommunication System (GTS):** The communications and data management component, as a key component within the WMO Information System (WIS), allows the World Weather Watch (WWW) to collect and distribute information critical to its processes. It is implemented and operated by National Meteorological and Hydrological Services of members and by international organizations.

**WMO Information System (WIS):** Connects all National Meteorological and Hydrological Services and regions together for data exchange, management, and processing.

**WIS 2.0:** WIS2 in a box (wis2box) is a Free and Open Source (FOSS) Reference Implementation of a WMO WIS2 Node. The project provides a plug and play toolset to ingest, process, and publish weather/climate/water data using standards-based approaches in alignment with the WIS2 principles. wis2box also provides access to all data in the [WIS2 network](https://community.wmo.int/en/activity-areas/wis). wis2box is designed to have a low barrier to entry for data providers, providing enabling infrastructure and services for data discovery, access, and visualization. Please refer to the Manual on the WMO Information System (WMO-No-1060 ): Annex VII to the WMO Technical Regulations, [here](https://library.wmo.int/index.php?lvl=notice_display&id=9254#.Y9KHpnbMKUk). For more general information on WIS and WIS 2.0 please refer to the [here](https://community.wmo.int/en/activity-areas/wis).

**WMO Observing Systems Capability Analysis and Review Tool (OSCAR):** Contains quantitative user-defined requirements for observation of physical variables in application areas of WMO (i.e. related to weather, water, and climate). OSCAR also provides detailed information on all earth observation satellites and instruments, and expert analyses of space-based capabilities.

**WMO Technical Authority:** WMO serves as SOFF Technical Authority and provides basic technical support to the peer advisors, IEs and beneficiary countries on GBON regulations. WMO is also responsible for the technical screening of the GBON Gap Analysis and the National Contribution Plan against the GBON regulations and the independent verification of the status of beneficiary countries' stations against the GBON regulations.

**1. Introduction**

The GBON National Contribution Plan ("the Plan") and the GBON National Gap Analysis constitute the analytical basis for implementing GBON. These two products underpin the support provided by the Systematic Observations Financing Facility (SOFF) and are the main outputs of the SOFF Readiness phase. On a demand basis, they are complemented by the Country Hydromet Diagnostics (CHD).[[29]](#footnote-30)

The GBON National Contribution Plan identifies the infrastructure, human and institutional capacity needed to achieve a progressive target toward GBON compliance. This includes activities required to ensure the sustained operation and maintenance of the national observing network contributing to GBON. The Plan should be designed to respond to the country's circumstances and geographical constraints and based on progressive but realistic ambition toward full GBON compliance. The objective of the GBON National Contribution Plan is to ensure that through the implementation of its proposed activities, the SOFF beneficiary country has the capacity to generate and internationally exchange GBON observations sustainably. Ultimately, the Plan should focus on optimizing the investments and activities that can achieve the largest impact on the Numerical Weather Prediction (NWP) models.

The guidance contained in this document is structured in six modules that constitute the building blocks of a GBON National Contribution Plan. The modules are: (i) GBON National Contribution Target; (ii) GBON business model and institutional development: partnerships and business model needed to operate and maintain the observing network; (iii) Infrastructure development: investments needed to increase or improve the observing network and its related infrastructure; (iv) Human capacity: technical and managerial capacities required to operate and maintain the observing network; (v) risk management: mitigation measures to address risks to the sustainability of the observing network; and (vi) Transition to SOFF investment phase: support the beneficiary country and the Implementing Entity (IE) in preparing for the SOFF investment phase.

**2. Purpose**

This document provides operational guidance to SOFF peer advisors, beneficiary countries, and IEs to develop a GBON National Contribution Plan. The Plan constitutes the technical basis of the funding request for the SOFF Investment phase or other funding sources, as applicable.[[30]](#footnote-31)

To ensure consistency and standardization of SOFF implementation, SOFF requires peer advisors, beneficiary countries, and IE to follow the guidance provided in this note to develop the GBON National Contribution Plan, including using the template in Annex I, to deliver the final report.[[31]](#footnote-32)

This document is based on the GBON Guide[[32]](#footnote-33) developed by the World Meteorological Organization (WMO) Commission for Observation, Infrastructure and Information Systems (INFCOM) to implement GBON by all WMO Members.

The peers should follow this guidance along with WMO standard practices, provisions, and technical guidance material for the implementation of observing networks and GBON.[[33]](#footnote-34) The WMO Secretariat, INFCOM, and SOFF Secretariat are available to respond to questions, provide support, and share good practices in every phase of GBON implementation.

**3. Scope**

The guidance in this document focuses on the scope of SOFF support and the following aspects:

* **GBON regulations**: The GBON regulations consist of two types of requirements: *standard practices*, mandatory and identified in WMO regulations by using the verb "shall"; and recommended practices, identified by using the verb "should." Since SOFF support covers the GBON standard practices, this document focuses on the guidance needed for those requirements. Table 1 below presents a summary of the GBON standard practices.

SOFF only supports establishing and operating the GBON standard density (200km). However, in countries with high-density networks (100km), peer advisors are encouraged to assess whether the existing high-density network can also benefit from the SOFF "easy wins" interventions and support for the standard network, e.g., telecommunications improvements for data exchange.

Table 1. Summary of the standard practices of the GBON regulations.

SLP: Atmospheric pressure (Sea-level pressure); T: Temperature; H: Humidity; W: Wind; P: Precipitation; SD: Snow depth; SST: Sea surface temperature

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **GBON requirements per station type** | | **GBON Variables** | | | | | | |
|  | **SLP** | **T** | **H** | **W** | **P** | **SD** | **SST** |
| * **Surface land stations** Horizontal resolution[[34]](#footnote-35): 200km * Observing cycle: 1h * Real-time data exchange to WIS | | X | X | X | X | X | X |  |
| * **Upper-air stations operated from land** Horizontal resolution34: 500km * Vertical resolution: 100m, up to 30 hPa * Observing cycle: twice a day * Real-time data exchange to WIS |  | X | X | X |  |  |  |
| * **Surface marine stations in Exclusive Economic Zones**:[[35]](#footnote-36) 500 km | X |  |  |  |  |  | X |
| * **Upper-air stations operated in Exclusive Economic Zones**:[[36]](#footnote-37) 1000 km * **Vertical resolution:** 100m, up to 30 hPa |  | X | X | X |  |  |  |

* **Station types:** GBON standard practices establish a required minimum number of stations for each country (depending on the surface of the respective WMO Member[[37]](#footnote-38)) of primarily two specific types: surface and upper-air and, where appropriate, marine meteorological observing stations or platforms. SOFF focuses initially on surface and upper air stations.
* **GBON marine stations:** Marine meteorological stations may be considered by SOFF at a later stage, including potentially through sub-regional/regional cooperation modalities. Therefore, SOFF peer advisors are encouraged to include in their GBON National Contribution Plan the assessment of country marine stations and related GBON requirements when considered relevant.
* **Phased approach:** The guidance in this document provides the flexibility to prioritize and plan activities in line with countries' circumstances and the feasibility of the proposed activities. The Plan allows for a phased GBON implementation with progressive targets toward GBON compliance. This flexibility is critical for successfully implementing new or upgraded observing systems and operational practices in countries with challenging circumstances like Small Island Developing States (SIDS) and Least Developed Countries (LDCs). The activities defined in the Plan should aim to meet the GBON National Contribution Target set in module one.

**4.** **Development of the Plan**

**4.1 Collaboration**

Development of the Plan requires good collaboration among the beneficiary country, its peer advisor, and the IE that will support the implementation of the Plan (when applicable). To ensure a common understanding of the Plan's final recommended activities and their use for the SOFF Investment phase, the collaboration between peer advisors, beneficiary countries, the IEs, and WMO Technical Authority starts early. The section below outlines the roles and responsibilities of each partner related to the development of the Plan.

**4.2 Roles and responsibilities**

**Beneficiary country National Meteorological and Hydrological Service**

* Is responsible for implementing the activities of the Readiness phase with the support from the peer advisor and the prospective Implementing Entity.
* Prepares the Assignment Terms of Reference following the standard Terms of Reference provided by the SOFF Secretariat, in collaboration with the peer advisor and in coordination with the prospective Implementing Entity.
* Submits the funding request for the SOFF Readiness phase support using the standardized template provided by the SOFF Secretariat.
* Is responsible for collaborating with the peer advisor to provide all the necessary information and participate in and facilitate the national activities the peer advisor needs to conduct in order to develop the Readiness phase outputs.
* Confirms receipt of the peer advisors' report with the Readiness phase outputs and provides comments on the outputs as needed.

**Peer advisor**

* Is accountable to the beneficiary country.
* In dialogue with the beneficiary country, provides independent technical advice, analysis and recommendations to support the beneficiary country in implementing the activities of the Readiness phase.
* Develops the Readiness phase outputs and is responsible for their quality and timely delivery. Communicates regularly with the beneficiary country and the Implementing Entity.
* Engages with the civil society, including on the identification of stakeholders of relevance for GBON implementation.
* Submits the final report with the Readiness phase outputs to the country for comments and to the prospective Implementing Entity for feedback.
* Submits the final report including the beneficiary country's comments and the prospective Implementing Entity's feedback to the SOFF Secretariat.
* Notifies the SOFF Secretariat and the prospective Implementing Entity of any delays that may impede the timely delivery of the outputs, and for assignments for which the delivery takes more than six months submits a semi-annual progress report.

**Implementing Entity**

* Participates in the Readiness phase activities and collaborates with the beneficiary country and the peer advisor to ensure a common understanding of the Readiness phase outputs and that they address the technical needs for the design and implementation of the Investment phase.
* Contributes to the definition of the Terms of Reference and provides feedback on the outputs delivered by the peer advisor.
* Based on its experience in the beneficiary country, supports the work of the peer advisor, e.g. by sharing its knowledge and facilitating access to the network of relevant stakeholders.

**WMO Technical Authority**

* Provides basic technical support to the beneficiary country, peer advisor, and prospective Implementing Entity on GBON regulations.
* Is responsible for the technical screening of the draft GBON National Gap Analysis and the draft GBON National Contribution Plan against the GBON regulations.
* Is responsible for establishing and administering the pass-through mechanism for contracting and funding of the technical assistance provided by the peer advisors.

**SOFF Secretariat**

* Facilitates communication, coordination and collaboration between the beneficiary country, the peer advisor, the prospective Implementing Entity and WMO Technical Authority.
* Reviews the Readiness funding request, including the Terms of Reference, for compliance and consistency with the information requirements in the template and provides feedback as needed. Transmits the funding request to the SOFF Steering Committee for its decision.
* Confirms receipt of the peer advisors' report with the Readiness phase outputs.
* Organizes exchange of knowledge and experiences and captures lessons learned.

**4.3 Modules**

The guidance in this document describes, for each module, a set of assessments/activities that the peer advisor needs to perform and the expected outputs. The outputs represent the activities and corresponding technical details the peer advisor recommends for the beneficiary country to undertake during the Investment Phase. The peer-recommended activities should ensure harmonized and sustained operation and maintenance of the network after the closure of the Investment phase.

The assessments/activities indicated in this document are all considered essential and describe the minimum requirements for implementing GBON based on the technical guidance from WMO. However, it is up to the peer advisor and the beneficiary country in collaboration with the Implementing Entity to decide what other activities and assessments are required to complete the Plan.

The six modules should be undertaken in parallel so that the final Plan is consistent across all the modules. Each module references WMO Technical Regulations and other guidance material of relevance.

**4.4 Final report**

Annex I provides the template for the final report to be delivered by the peer advisors. The final report contains the Plan in the form of peers' recommended activities and corresponding technical details for each module.

**5. GBON National Contribution Plan**

The modules of the Plan are:

* **Module 1. GBON National Contribution Target:** Establishment of a progressive national target toward GBON compliance
* **Module 2. GBON business model and institutional development**: public-private business model, partnerships, and institutional and financial arrangements needed to operate and maintain the observing network
* **Module 3. GBON infrastructure development**: infrastructure investments required to increase or improve the observing network and its Information and Communications Technology (ICT)
* **Module 4. GBON human capacity development**: Human technical and managerial capabilities required to operate and maintain the observing network
* **Module 5. Risk Management:** Operational risks of the observing network and required mitigation measures
* **Module 6.** **Transition to SOFF investment phase:** Support the beneficiary country and the IE in preparing the Investment phase funding request.

**5.1 Module 1: National target toward GBON compliance**

Based on the results of the GBON National Gap Analysis,[[38]](#footnote-39) the SOFF peer advisor, in collaboration with the beneficiary country and in coordination with the IE, recommends a GBON National Contribution Target. The target expresses the number of new and improved upper-air and surface-based stations the country needs to operate and maintain to meet the GBON standard density requirements and to contribute to the international data exchange, as requested in Table 2. The GBON guide, section 4 on GBON compliance and compliance criteria,[[39]](#footnote-40) should guide the definition of the GBON National Contribution Target.

The target reflects the country's ambition level, considering the national circumstances and the feasibility of implementing the activities to achieve such a target. Ultimately, the target ambition must focus on activities that are expected to provide the most significant impact on NWP skill and for which long-term sustainability can be assured.

The peer should recommend management practices to monitor results periodically and explore options to increase the national target in a phased approach.

Table 2. GBON National Contribution Target.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Type of station** | **Baseline (Results of the GBON National Gap Analysis)** | | | | **GBON National Contribution Target** | | |
| **Target (# of stations)[[40]](#footnote-41)** | **GBON-compliant stations (#)** | **Gap** | | **To improve** | | **New** |
| **New** | **To improve** |
| **Surface** |  |  |  |  |  |  |  |
| **Upper-air** |  |  |  |  |  |  |  |
| **Marine** | **\*When applicable** | | | | | | |

Table 3. Compliance criteria for GBON Surface – land and – marine meteorological stations

|  |  |  |  |
| --- | --- | --- | --- |
| **Mark** | **Name** | **Description** | **Criteria** |
| **SSL 1** | **Monthly Availability (%)** | No. of received monthly reports[[41]](#footnote-42) / (Days per month \* 24) Monthly[[42]](#footnote-43) | **≥ 80%** |
| **SSL 2** | **Timeliness (%)** | No. of late reports[[43]](#footnote-44) / (Days per month \* 24) | **< 5%** |
| **SSL 3** | **Monthly Quality (%)** | No. of rejected monthly reports[[44]](#footnote-45)/ (Days per month \* 24) | **< 5%** |

Table 4. Compliance criteria for GBON Upper-air – land and -marine observing station/platform and SOFF threshold.

|  |  |  |  |
| --- | --- | --- | --- |
| **Mark** | **Name** | **Description** | **Criteria** |
| **SUA 1** | **Monthly Availability (%)** | No. of received monthly profile (to 30hPa) reports[[45]](#footnote-46) / (Days per month \* 2)[[46]](#footnote-47) | **≥ 80%** |
| **SUA 2** | **Vertical Resolution[[47]](#footnote-48) (Y/N)** | Vertical resolution is at least 100 m | **Yes** |
| **SUA 3** | **Timeliness (%)** | No. of late reports[[48]](#footnote-49)/ (Days per month \*2) | **< 5%** |
| **SUA 4** | **Monthly Quality (%)** | No. of rejected monthly reports[[49]](#footnote-50)/ (Days per month\*2) | **< 5%** |

Activities and outputs for module 1 are summarized in Table 5.

Table 5. Peer advisor activities and outputs for Module 1.

|  |  |  |  |
| --- | --- | --- | --- |
| **Activity item** | **Activity** | **Outputs** | **Relevant guidance material** |
| 1.1 | National GBON Gap Analysis | * Results of the GBON national gap analysis as the country baseline | GBON National Gap Analysis guidance note tailored for SOFF |
| 1.2 | Establishment of the GBON National Contribution Target | * **Recommendation on the GBON National Contribution Target following Table 2** | GBON guide[[50]](#footnote-51) |

**5.2** **Module 2: GBON business model and institutional development**

In module 2, the peer advisor assesses the institutional capabilities of the National Meteorological and Hydrological Service (NMHS), other relevant governmental institutions and local and sub-regional GBON stakeholders, and potential private partners. Based on this assessment, the peer advisor, in dialogue with the beneficiary country and in coordination with the IE, recommends a public-private business model and other institutional strengthening activities and partnerships required for the sustainable operation and maintenance of the observing network.

This module also includes assessing existing national strategies, national legislation, and ongoing development cooperation programmes related to GBON. In collaboration with the IE, the peer advisor should assess existing development cooperation projects related to GBON and propose activities to ensure consistency/complementarity of these activities. Activities and outputs for module 2 are summarized in Table 3.

Table 6. Peer advisor activities and outputs for Module 2.

|  |  |  |  |
| --- | --- | --- | --- |
| **Activity item** | **Activity** | **Outputs** | **Relevant guidance material** |
| 2.1 | Assessment of national governmental and private organizations of relevance for the operation and maintenance of GBON | * Identified governmental stakeholders operating and acquiring meteorological observations or with the potential to support GBON * Identified private sector operators providing meteorological observations and data services in the country (for ship-based observations, identify fleet of ships government-owned or private and research owned) to install instrument packages) * **Recommendation on how they could contribute to the implementation of the Plan** and required activities to materialize the proposed partnerships:  1. Existing partners and relationships; 2. Potential new partners and their roles | [*Guide to the WMO Integrated Global Observing System*](https://library.wmo.int/index.php?lvl=notice_display&id=20026) (WMO‑No. 1165), Chapter 6[[51]](#footnote-52) |
| 2.2 | Assessment of potential GBON sub-regional collaboration | * Identified neighboring countries and regional organizations of relevance for potential sub-regional collaboration * **Recommendations for potential optimization of the observing network through sub-regional network design** and other sub-regional partnerships for the implementation of the Plan |  |
| 2.3 | Assessment of a  business model to operate and maintain the network | * Assessment of the current funding sources, budget allocations and financial status related to operations of the NMHS-owned observing network * **Recommendation of a business model for public-private collaboration** for the implementation of the Plan, based on the SOFF private sector business models,[[52]](#footnote-53) including:  1. Recommendation of a business model to operate and maintain the GBON infrastructure, considering arrangements for SOFF financial support during the Compliance phase 2. Identify potential private sector operators depending on the proposed business model 3. Develop a financial plan for operating the modernized infrastructure, including considerations on the total cost of ownership | SOFF private sector business models[[53]](#footnote-54)  World Bank. Recommendations for the Design of Sustainable  Meteorological Observation  Networks and Systems in Developing Countries[[54]](#footnote-55)  [*Guidelines for Public-Private Engagement*](https://library.wmo.int/index.php?lvl=notice_display&id=21858) (WMO‑No. 1258) |
| 2.4 | Assessment of existing national strategies and projects related to observing networks | * Review of the national strategies for establishing and improving observing networks * Review of existing or planned hydromet development projects related to GBON * **Recommendation on activities to ensure consistency and complementarity of current and planned investments** and development projects of relevance for GBON |  |
| 2.5 | Review of the national legislation of relevance for GBON | * Review of national legislation related to responsibility for measuring and providing weather observations related to GBON * Review of the legislation related to procurement, importation and customs processes of relevance for the proposed Plan's activities and investments * **Recommendation on how to address any constraints related to the national legislation required to implement GBON** |  |

**5.3 Module 3: Infrastructure development**

In module 3, based on the gaps identified in the GBON National Gap Analysis, the peer advisor assesses and recommends the investments in infrastructure required to meet the national target toward GBON compliance.

The choice of initial investments should focus on strengthening the network, so it provides the largest impact on NWP skill, i.e., (i) through the installation or rehabilitation of upper air (radiosonde) stations, (ii) installation of surface stations in significantly under-observed regions (far from currently reporting stations), (iii) sub-regional optimization of the network design.

The recommendations provided in this module should be in line with the GBON regulations requirements for network design and data exchange and other requirements critical for sustainable and high-quality operations of the observing network (e.g., timeliness of data in international use, correct data format standards in data exchange, and quality of data values). The Manual on the WMO Integrated Global Observing System (WMO-No. 1160),[[55]](#footnote-56) the Manual on Codes (WMO-No. 306), Volumes *I.1*,[[56]](#footnote-57) [*I.2*](https://library.wmo.int/index.php?lvl=notice_display&id=10684)[[57]](#footnote-58) and *I.3*[[58]](#footnote-59) the Manual on the WMO Information System (WMO-No. 1060),[[59]](#footnote-60) and Manual on the Global Telecommunication System (WMO-No. 386)[[60]](#footnote-61) are the key WMO Technical Regulations to be followed for the establishment of a new network, and for reporting and making observations and metadata internationally available through the WMO Information System (WIS) and WMO OSCAR/Surface metadata management system.

The recommendations for the design of the observing network and the required infrastructure should follow the national strategy for the development and management of observing networks so that the components of the modernized infrastructure and operation practices are harmonized with the existing network. The focus must be on GBON regulations while maximizing additional benefits for other observing networks and applications, e.g., for climatological applications, as feasible. As much as possible, the peer advisor and beneficiary country are encouraged to leapfrog to the latest technological developments in the framework of the WMO Technical Regulations, including through the implementation of WIS 2.0.

The network should respond to the country's circumstances, e.g., the situation in fragile and conflict-affected countries, need for resilient infrastructure in places facing severe weather hazards. Lessons learned from previous hydromet development projects and the current state of the infrastructure are good indicators of the potential challenges that need to be considered.

Table 7. Peer advisor activities and outputs for Module 3.

|  |  |  |  |
| --- | --- | --- | --- |
| **Activity**  **item** | **Activity** | **Outputs** | **Relevant guidance material** |
| 3.1 | Design the surface and upper-air observing network and observational practices | * **Recommendation on a harmonized observing network design**, including siting and instrumentation of new and improved stations, including:  1. A map of observing network distribution and a list of the required new or rehabilitated GBON stations; 2. A list of observation instruments and systems per site; and 3. Investments and activities needed for the installation of new stations and the improvement of existing stations 4. Observational practices defined per network 5. Preliminary maintenance plan for existing and improved/new stations, including calibration practices 6. Technical specification for new instruments and observing systems for the procurement process | WIGOS Manual (WMO-No.1160)  Manual on the WMO Integrated Global Observing System (WMO No. 1160)[[61]](#footnote-62)  Guide to the WMO Integrated Global Observing System (WMO No. 1165)[[62]](#footnote-63)  Guide to Instruments and Methods of Observation (WMO No. 8)[[63]](#footnote-64)  WMO IOM Report No. 136: Generic Automatic Weather Station (AWS) Tender Specifications[[64]](#footnote-65)  SOFF-tailored guidance on the GBON Tender Specifications[[65]](#footnote-66) |
| 3.2 | Design of the ICT infrastructure and services | * **Recommendation on ICT infrastructure and services design and solutions on data transmission** from an observing station to the national real-time data management system and GTS and WIS 2.0, including:  1. Detailed description of the ICT infrastructure and services design 2. Technical specifications for the data collection system from the observing station to the collection point 3. Technical specifications of the data services (compatible with the requirements of WIS 2.0) 4. Detailed description of the measures to ensure resilience and continuity of the full data processing chain | Manual on Codes (WMO-No. 306) Volumes *I.1*,[[66]](#footnote-67) [*I.2*](https://library.wmo.int/index.php?lvl=notice_display&id=10684)[[67]](#footnote-68) and *I.3*[[68]](#footnote-69)  Manual on the WMO Information System (WMO-No. 1060)[[69]](#footnote-70)  Manual on the Global Telecommunication System (WMO-No. 386)[[70]](#footnote-71)  WIS 2.0 requirements https://docs.wis2box.io |
| 3.3 | Design the data management system | * **Recommendation on requirements for a data management system** aimed to provide access to data used by operational applications on a real-time basis and the capability to deliver data to a Climate Data Management System (CDMS) for long-term archiving purposes. The system should provide the following:  1. Short-term data storage and access through the services and protocols required by applications for national and international operational activities 2. Acquisition of data to and from WIS/GTS, WIS 2.0 and other national or international sources required for operational activities 3. Data delivery to the national CDMS 4. Discovery and descriptive metadata management 5. Monitoring of data, processing and services | Manual on the WMO Integrated Global Observing System (WMO No. 1160)[[71]](#footnote-72)  Manual on Codes (WMO No. 306), Volumes *I.1*,[[72]](#footnote-73) [*I.2*](https://library.wmo.int/index.php?lvl=notice_display&id=10684)[[73]](#footnote-74) and *I.3*[[74]](#footnote-75)  Manual on the WMO Information System (WMO No. 1060)[[75]](#footnote-76)  Manual on the Global Telecommunication System (WMO No. 386)[[76]](#footnote-77)  Climate Data Management System Specifications (WMO-No. 1131)[[77]](#footnote-78) |
| 3.4 | Environmental and sustainability considerations | * **Recommend pragmatic approaches and measures for environmentally responsible design and evolution of the national networks** to achieve GBON requirements, including:  1. Development and use of specifications that consider environmental sustainability for procurement of measurement instrument equipment to meet the GBON requirements 2. Integration of sustainability considerations for the management of operations of GBON stations, including installation, calibration, and maintenance 3. Careful material selection for the development, shipping and day-to-day operations of GBON stations, with a focus on developing and using reusable instruments and sustainable methods of observation (e.g., elimination of single-use plastics). | Recommendations related to environmental sustainability will be considered for future amendments to WIGOS regulatory material and GBON guidance, with the long-term goal of advancing more environmentally-friendly weather and climate observing systems, technologies and practices. These recommendations will evolve and become more detailed over time as new information is gathered, analysed and translated into requirements. |

**5.4 Module 4: Human capacity development**

In module 4, the peer advisor assesses the human capacity development gaps and related activities needed to close the gap. The capacity development activities should target both technical staff to operate and maintain the observing network and staff to manage the implementation of the Plan.

The type of human expertise and training needs depend on the infrastructure chosen and the country's circumstances. In the case of opting for a public-private partnership, it is essential to ensure that the country has the expertise and capacity to engage in, monitor, and manage the contractual relationships and control the quality of the services delivered. Capacity development activities identified in the Plan should systematically promote women's empowerment and Civil Society Organizations (CSOs) involvement.

Table 8. Peer advisor activities and outputs for Module 4.

|  |  |  |  |
| --- | --- | --- | --- |
| **Activity item** | **Activity** | **Outputs** | **Relevant guidance material** |
| 4.1 | Assessment of human capacity gaps | * A summary of staff skills, education levels, and capacity gaps for technicians, experts, and management, including Port Meteorological Officers (PMO) when applicable, gender balance and gender opportunities | Guide to Competency (WMO-No. 1205)[[78]](#footnote-79)  Guidelines for Trainers in Meteorological, Hydrological and Climate Services (WMO- No. 1114)[[79]](#footnote-80) |
| 4.2 | Design capacity development activities for technical staff | * **Recommendation on training activities and recruitment for technical staff, including:**  1. Instrument and station maintenance at site 2. Calibration and maintenance at the workshop 3. Network monitoring 4. ICT system operations | Guide to the Implementation of Education and Training Standards in Meteorology and Hydrology, (WMO- No. 1083)[[80]](#footnote-81) |
| 4.3 | Design capacity development activities for senior management | * **Recommendation on training activities and recruitment for management in**  1. Strategic and financial planning 2. Project management | Guidelines for Applying for a WMO Fellowship (WMO- No. 1104)[[81]](#footnote-82)  A Compendium of Topics to Support Management Development in NMHSs (ETR-24)[[82]](#footnote-83) |
| 4.4 | Gender and CSOs considerations | * **Recommendations on activities, consultations, and areas of collaboration for the implementation of the Plan** to ensure active CSOs participation and promotion of gender balance and gender opportunities | Gender Equality and Women's Empowerment in Disaster Recovery. Disaster Recovery Guidance Series, Global Facility for Disaster Reduction and Recovery (GFDRR), 2018[[83]](#footnote-84)  Gender, adaptation and disaster risk reduction. Policy Brief, UNDP and GGCA, 2017[[84]](#footnote-85)  Annex to draft Decision 9/1 (INFCOM-2). Priorities for the INFCOM Gender Team[[85]](#footnote-86) |

**5.5 Module 5. Risk Management Framework**

In module 5, the peer advisor, in collaboration with the country and in coordination with the IE anticipates operational risks for the implementation of the Plan and the sustained operation and maintenance of the observing network and recommends mitigation actions.

Table 9. Peer advisor activities and outputs for Module 5.

|  |  |  |  |
| --- | --- | --- | --- |
| **Activity item** | **Activity** | **Outputs** | **Relevant guidance material** |
| 5.1 | Assess the risks of the observing network and propose mitigation measures | Based on the SOFF Risk Management Framework, identify risks and **recommend a risks management framework**, including:   1. Identification and analysis of risks 2. Mitigating measures and responsible 3. Monitor and evaluation | SOFF Risk Management Framework[[86]](#footnote-87)  Guide to the Implementation of Quality Management Systems for National Meteorological and Hydrological Services and Other Relevant Service Providers (WMO-No. 1100) |

**5.6 Module 6. Transition to SOFF investment phase**

This module involves supporting the beneficiary country and the IE in preparing the Investment phase funding request based on the recommendations provided in the Plan. Further details on the activities required in this module will be provided once the Investment Phase funding request template is defined and adopted by the SOFF Steering Committee.

**Annex I. Template for the GBON National Contribution Plan Report**

**GBON National Contribution Plan**

**[Country Name]**

|  |  |
| --- | --- |
| **SOFF Beneficiary country focal point and institution** |  |
| **SOFF Peer advisor focal point and institution** |  |

1. **GBON National Contribution Target**

Please summarize the national target toward GBON compliance in the Table below and provide the technical details in annexes as needed.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Type of station** | **Baseline (Results of the GBON National Gap Analysis)** | | | | **GBON National Contribution Target** | |
| **Target (# of stations)[[87]](#footnote-88)** | **GBON-compliant stations (#)** | **Gap** | | **To improve** | **New** |
| **New** | **To improve** |
| **Surface** |  |  |  |  |  |  |
| **Upper-air** |  |  |  |  |  |  |
| **Marine** | **\*when applicable** | | | | | |

Table I. GBON National Contribution Target.

***[\*\*Add here a map of existing and proposed surface and upper-air stations with 200km/500 (diameter) km circles (500km/1000 km for SIDS) to indicate the coverage of the stations\*\*]***

1. **Summary of GBON National Contribution Plan**

Please summarize in the table below the Plan (recommended activities and corresponding technical outputs/details in the form of Annexes) for each module.

Table II. Summary of GBON National Contribution Plan.

|  |  |  |
| --- | --- | --- |
| **Components** | **Recommended activities** | **Related outputs and technical details** |
| **Module 2.** GBON business model and institutional development | 1. | Annex XX |
| 2. | Annex XX |
| 3. | Annex XX |
| 4. | Annex XX |
| 5. | Annex XX |
| **Module 3.** GBON infrastructure development | 1. | ... |
| 2. |  |
| 3. |  |
| 4. |  |
| 5. |  |
| **Module 4.** GBON human capacity development | 1. |  |
| 2. |  |
| 3. |  |
| 4. |  |
| 5. |  |
| **Module 5.**  Risk Management | 1. |  |
| 2. |  |
| 3. |  |
| 4. |  |
| 5. |  |
| **Module 6.** Transition to SOFF investment phase |  |  |

**3. Report completion signatures**

|  |
| --- |
| **Peer Advisor signature** |
| **Beneficiary Country signature** |
| **WMO Technical Authority signature** |

1. Country Hydromet Diagnostics

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**1. Introduction**

The CHD[[88]](#footnote-89) aims to inform investments and capacity development in the whole meteorological value chain by developing a high-level assessment of National Meteorological and Hydrological Services (NMHS), their operating environment, and their contribution to high-quality weather, climate, hydrological and environmental services, and warnings. It integrates existing approaches, standards, and data provided by WMO and partners using a peer review approach. The CHD has been developed by the Alliance for Hydromet Development[[89]](#footnote-90) under WMO leadership and with the guidance of a multi-party Working Group. The consolidated results of CHDs contribute to assessing regional and global gaps and progress.

Through the CHD, countries and their partners get an initial understanding of the support and capacity building needed to make effective use of the outputs and outcomes of SOFF for activities in the downstream part of the value chain, i.e., local data processing, forecast, early warning, advisory products, and delivery of services and effective decision making for adaptation, disaster risk management, and resilient development.

**2. Purpose**

This document provides tailored guidance to the SOFF peer advisors, beneficiary countries, and Implementing Entities (IE) for the undertaking of the Country Hydromet Diagnostics (CHD).[[90]](#footnote-91)

The CHD is an optional but recommended output of the SOFF Readiness Phase. It can be completed parallel with the GBON Gap Analysis and the GBON National Contribution Plan. Peer advisors should conduct the CHD in collaboration with the beneficiary country and in coordination with the respective SOFF IE or other funding agency as applicable.

**3. Scope**

The CHD provides a maturity assessment of the NMHS, its operating environment, and its contribution to high-quality hydromet services, with ten elements assessed (Figure 1). The elements are grouped into four categories, helping to identify where additional focus and support may be needed. Behind each element sit various indicators, which are informed by data sources and by direct interviews and observation for validation purposes.

In the context of SOFF support, the CHD elements and indicators related to GBON are assessed in detail through the GBON National Gap Analysis and the GBON National Contribution Plan.

The CHD does not provide detailed solutions but indicates the focus areas for deeper consideration for all potential projects in-country. National and international partners supporting hydromet activities in the country are encouraged to collaborate in their thinking and sharing of insights while conducting and using the CHD.

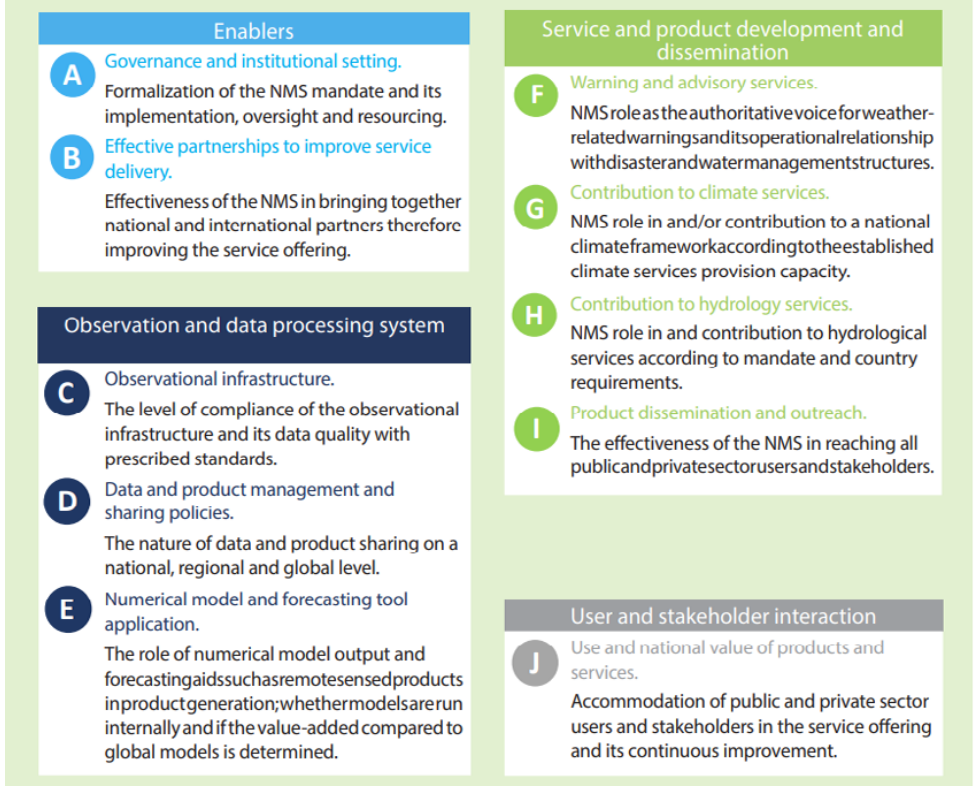


Figure 1 - The 10 elements assessed in the CHD

**4. Roles and responsibilities**

**Peer advisors.** The peer advisor is responsible for performing the CHD on behalf of and in collaboration with the beneficiary country and, where applicable, in coordination with the Implementing Entity. The peers should deliver the results of the CHD as a report following the template provided in Annex II.

**SOFF beneficiary country**. The beneficiary country is responsible for collaborating with the peer advisor to provide all the necessary information and facilitate and participate in the national activities the peer needs to conduct to complete the CHD.

**WMO Secretariat.** The WMO Secretariat provides guidance on the application of the CHD, provides country information from the WMO Community Platform, and screens the CHD Report to ensure consistency with the CHD approach and provides feedback as needed. WMO uses the results of the CHD to contribute to the national information in the WMO Community Platform and facilitate global knowledge sharing.

**SOFF Secretariat.** The SOFF Secretariat facilitates the coordination, dialogue and exchanges between the peer advisors, countries and WMO Secretariat and with the IE.

**Implementing Entity.** The IE collaborates with the peer advisor and the beneficiary country by providing information on ongoing or planned partnerships to strengthen the country's hydromet capacity.

**5. CHD delivery principles**

* **CHD delivery period:** The CHD is expected to be completed within three months, as feasible
* **In-country work:** While the CHD is expected to be conducted in the country, there may be circumstances when in-country assessments are not feasible. On some occasions, an in-country visit may not be required because of the extent of knowledge of the peer advisor about the respective beneficiary country. The process outlined in section 6 assumes that the early steps of the CHD can be performed remotely to minimize the cost and time of in-country attendance.
* **Degree of specificity of recommendations in the CHD**: The CHD includes the assessment of the maturity levels of the 10 *Elements* and general recommendations on how to advance maturity. More detailed recommendations and proposed activities to improve maturity levels need to occur through specific project preparation follow-up work.
* **Continuous improvement:** Based on the feedback of the peer advisors and beneficiary countries, WMO regularly reviews the CHD tool and its implementation to capture lessons learned and improve the CHD approach.

**6. Country Hydromet Diagnostics**

Based on the Table provided in Annex I, the peer advisor should follow the following stages and steps to assess the level of maturity of each one of the elements and indicators as stated in Annex I.

Table 1. Stages and steps to access maturity level of CHD elements and indicators.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Stage 1**  **Information Gathering** | | **Stage 2**  **Validation & Analysis** | | | **Stage 3**  **Closure** | |
| **Step 1**  Data review | **Step 2**  Synthesis & Investigation | **Step 3**  Draft CHD | **Step 4** Refine draft CHD | **Step 5** Finalize CHD | **Step 6**  Share CHD results | **Step 7**  Lessons learned & improvement |

**Stage 1 – Information gathering (performed remotely)**

**Step 1 – Data review**. Using the CHD matrix in Annex I, the peer advisor undertakes an initial desk review using the following sources and any other considered of relevance:

* WMO Community Platform country profile information, including the 2021 data campaign results.
* WMO Checklist for Climate Services Implementation and WMO Hydrology Survey, noting that these checklists contain information beyond the specific focus of the CHD.
* Agency reports (e.g., Annual Reports to Government)
* Information on current projects aiming at building NMHS capacity, as required through briefings from project partners (including Alliance members)
* Internal and external reviews and evaluations – copies of reports to be requested as needed, including expert reports from current and previous capacity-building projects involving Alliance members.
* Information on key partnerships in-country relevant to NMHS functions.
* Distribution of NMHS functions across agencies (e.g., hydrology, aviation, climate services, observations).

This step ensures that a) available information is used efficiently without duplication of effort, b) the burden on NMHSs is reduced by avoiding redundant information requests, and c) conflicting information is resolved into a definitive report that can be trusted by all parties. The step is not intended to be exhaustive but rather to ensure due diligence.

**Step 2 – Synthesis and investigation.** During this step, the peer synthesizes existing material (non-interactive desktop approach), evaluates gaps and conflicts in the information available, and as needed and as feasible, closes existing data and information gaps and resolves ambiguities in existing information (interactive). For cost-effectiveness, begin this process remotely if possible, understanding that in-country follow-up may be required. Activities should include:

* Work with NMHS to evaluate Service Delivery Progress Model based on WMO-No. 1129 survey (use the most appropriate WMO language version as a base for discussion). This is a recommended input tool for Elements 9 and 10 and can either be done offline as a self-assessment or interactively online with the NMHS
* Work through any missing/ambiguous WMO Community Platform and related information, including the 2021 data campaign, WMO Checklist for Climate Services Implementation and WMO Hydrology Survey

**Step 3 – Draft Country Hydromet Diagnostics report.** The CHD report (see Annex II) consists of an overview table with the maturity level for each of the ten *elements* of the meteorological value cycle and a narrative of each component describing critical capacity gaps.

* With the information from the previous steps, the peer advisor prepares a draft CHD report to be discussed with the beneficiary country
* The WMO Secretariat screens the draft report and provides feedback and, as needed, technical support to the peer advisor to ensure that their reviews are consistent with the CHD guidance.

**Stage 2 – Validation and analysis (performed in-country if feasible)**

**Step 4 – Refine the draft CHD report**

* Interview selected stakeholders (include a range of strong and weak relationships, including key users and sponsors)
* Interview NMHS's operational and technical staff
* Discuss the draft CHD with the head of the NMHS, including possible areas for clarification and any sensitive matters
* Submit draft report to WMO Secretariat for screening against CHD tool requirements

**Step 5 – Finalize the CHD report**

* Present revised CHD report to the beneficiary country and the respective IE when applicable, focusing on key issues from the validation process and any sensitive matters
* Agree on the finalization process
* Complete the CHD report, including feedback received
* Share the final CHD report (following the template in Annex II) with the beneficiary country and the IE for follow-up advisory services and integration in consequent project preparation support, and with WMO and SOFF Secretariat for completion of the Assignment.

**Stage 3 – Closure**

**Step 6 – Share CHD results****.** The WMO Secretariat updates the WMO Community Platform with the CHD results. The CHD results will be made public.

**Step 7 – Capture lessons learned and continuous improvement.** The WMO Secretariat seeks feedback on the process from the beneficiary country and the peer advisor and the Implementing Entity.

| **Annex 1. Country Hydromet Diagnostics matrix.**  **Table I. Country Hydromet Diagnostic matrix.** | | | | |
| --- | --- | --- | --- | --- |
| **Critical Hydromet Value Cycle Element** | | **Maturity level** | **Indicators** | **Suggested additional data sources (Note: for all indicators, WMO will provide any available relevant information based on data submitted by Members)** |
| **Element** | **Description** |  |  |  |
| **1. GOVERNANCE AND INSTITUTIONAL SETTING** | The level of formalization of the NMHS mandate and its implementation, oversight, and resourcing. | **Level one:** Weakly defined mandate; serious funding challenges; essential skills lacking; little formalized governance and future planning.  **Level two:** Effort ongoing to formalize mandate, introduce improved governance, management processes and address resource challenges.  **Level three:** Moderately well mandated, managed and resourced and clear plans for, and sufficient capacity to address operational gaps.  **Level four:** An effective service but with a few shortcomings related to its mandate, governance, and resourcing and in the process to address the gaps.  **Level five:** Strong and comprehensive mandate, highly effective governance, secure funding, and readily available skills base. | 1.1. Existence of Act or Policy describing the NMHS legal mandate and its scope. | * Available acts or policies |
|  |  |  | 1.2. Existence of Strategic, Operational and Risk Management plans and their reporting as part of oversight and management. | * Operational & Risk Management Plans. |
|  |  |  | 1.3. Government budget allocation consistently covers the needs of the NMHS in terms of its national, regional, and global responsibilities and based, among others, on cost-benefit analysis of the service. Evidence of sufficient staffing to cover core functions. | * Agency reports, evidence from capacity building projects, interviews. |
|  |  |  | 1.4. Proportion of staff (availability of in-house, seconded, contracted- out) with adequate training in relevant disciplines, including scientific, technical, and information and communication technologies (ICT). Institutional and policy arrangements in-country to support training needs of NMHS. | * Any supplementary evidence of in-country institutional arrangements aligned with NMHS functions and aspirations. |
|  |  |  | 1.5. Experience and track record in implementing internationally funded hydromet projects as well as research and development projects in general. | * Institutional reports identified during Data review step, evidence from capacity-building project. |
| **2. EFFECTIVE PARTNERSHIPS TO IMPROVE SERVICE DELIVERY** | The level of effectiveness of the NMHSs in bringing together national and international partners to improve the service offering. | **Level one:** Works in isolation and does not value or promote partnerships.  **Level two:** Limited partnerships and mostly excluded from relevant finance opportunities.  **Level three:** Moderately effective partnerships but generally regarded as the weaker partner in such relationships, having little say in relevant financing initiatives.  **Level four:** Effective partnerships with equal status in most relationships and approaching relevant funding opportunities in a coordinated manner.  **Level five:** NMHS is regarded as a major national and regional role player. It has extensive and productive partnerships and is viewed as an honest broker in bringing parties together and provide national leadership on relevant finance decisions. | 2.1. Effective service delivery partnerships in place with other government institutions. | * Data Collection Campaign 2021：Part 1, Q8 (consultative platform), Part 4, Q3) (WIGOS partnerships) * Partnerships identified in the Data review Step. |
|  |  |  | 2.2. Effective partnerships in place at the national and international level with the private sector, research centres and academia, including joint research and innovation projects. | * Data Collection Campaign 2021: Part 7 Q 5-8,11 * WMOCP: (i) legislation on private sector providing information and services along the value chain (ii) Formal agreements between the public and private sector in relation to service delivery, operation, and maintenance of networks, observation data; (iii) consultative platform for the public sector, private sector, academia, and civil society to foster regular cooperative dialogue. |
|  |  |  | 2.3. Effective partnerships in place with international climate and development finance partners | * Partnerships and arrangements are identified in the Data review Step. * Data Collection Campaign 2021： Part 7, Q8 (sources of research funding) |
|  |  |  | 2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products or services that culminated from these relationships | * Partner reports identified during the Data review step, validated by NMHS interview. |

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| **3.** **OBSERVATIONAL INFRASTRUCTURE** | The level of compliance of the observational infrastructure and its data quality with prescribed WMO regulations and guidance. | **Level one:** No or limited, basic surface observations and no upper-air observations.  **Level two:** Basic network, large gaps, mostly manual observations with severe challenges and data quality issues.  **Level three:** Moderate network with some gaps with respect to WMO regulations and guidance and with some data quality issues.  **Level four:** Comprehensive mostly automated network providing good traceable quality data fully compliant with WMO regulations and guidance.  **Level five:** Comprehensive and highly automated advanced network including additional measurements and remote sensing platforms providing excellent data fully compliant with WMO regulations and  Guidance. | 3.1. Average horizontal resolution in km of both synoptic surface and upper-air observations, including compliance with the Global Basic Observing Network (GBON) regulations.[[91]](#footnote-92) | * WMO Observing Systems Capability Analysis and Review (OSCAR) database. |
| 3.2. Additional observations used for nowcasting and specialized purposes. | * OSCAR database * Evidence from WMO Checklist for Climate Services Implementation and WMO Hydrology Survey. |
| 3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations and quality assurance of the observational  network. | * External reviews and NMHS interview * Data Collection Campaign 2021**：**   Part 4, Questions 2-6 (WIGOS)   * Evidence from Climate checklist and WMO Hydrology Online Survey. |
| 3.4 Implementation of sustainable newer approaches to observations. | * Data Collection Campaign 2021**：**Part 2, Q 4, Part 4, Q 6-8, Part 7, Q 12,15-17 |
|  |  |  | 3.5. Percentage of the surface observations that depend on automatic techniques. | * OSCAR database |

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| **4. DATA AND PRODUCT SHARING AND POLICIES** | The level of data and product sharing on a national, regional and global level. | **Level one:** No observational data is shared internationally, either because not available to be shared or due to the lack of data sharing policies or practices, or the existing infrastructure does not allow data sharing.  **Level two:** A limited amount of GBON compliant data is shared internationally. The existing data sharing policies or practices or the existing infrastructure severely hamper two-way data sharing.  **Level three:** GBON data sharing compliance with regards to either surface or upper-air data and a data policy and practices and infrastructure in place that promote the free and open use of data for research and academic purposes as well as the in-house use of external data.  **Level four**: Fully meeting GBON data sharing compliance with a data policy and practices and infrastructure in place. These support free and open sharing of data nationally and, for some products, regionally or internationally as well as the in-house use of external data.  **Level five:** Exceeding GBON data sharing compliance and additional data (marine, radar, etc.) contributing to regional and international initiatives with policies that promote free and open two-way sharing of data and products on a national, regional and global basis. | 4.1. Percentage of GBON compliance – for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional  WIGOS centres. | * Data Collection Campaign 2021**：**   Part 4, Questions 2-6 (WIGOS)   * GBON regulations and WIGOS Data Quality Monitoring System, which provide real-time statistics on data exchange at an hourly resolution. |
| 4.2. A formal policy and practice for the free and open sharing of observational data. | * WMOCP Part 5 data and Data Collection Campaign 2021**：**   Part 4, Questions 2-6 (WIGOS)   * Data Policy Survey also contains information on cost recovery policies; Res 60 Survey: data available on provision of climate data and products on a commercial basis; type of users; the basis for the price established; who retains the revenue; approx. net annual revenue. |
| 4.3. Main data and products received from external sources in a national, regional and global context, such as model and satellite data. | * Reports identified during the Data review step, NMHS interview (preferably validated with in-person staff interviews). * Data Policy Survey * WMOCP Part 5 data and Data Collection Campaign 2021**：**Part 4, Questions 9-14 |

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| **5. NUMERICAL WEATHER PREDICTION MODEL AND FORECASTING TOOL APPLICATION** | The role of numerical weather prediction model output and other forecasting tools in product generation. Whether local modelling is sustainably used to add value to model output from WMO Global Data-processing and Forecasting System (GDPFS) centres. | **Level one:** Forecasts are based on classical forecasting techniques without model guidance and only cover a limited forecast time range.  **Level two:** Basic use of external model output and remote sensed products in the form of maps and figures, covering only a limited forecast time range.  **Level three:** Prediction based mostly on model guidance from external and limited internal sources (without data assimilation) and remoted sensed products in the form of maps, figures and digital data and cover nowcasting, short and medium forecast time ranges.  **Level four:** Digitized model output from internal (with data assimilation) and/or external (regional) sources and remote sensed products and data used and value-added through post-processing techniques extended into longer ranges.  **Level five:** Optimal combination of global, regional and local models, remote sensed data, post-processing techniques and automated probabilistic product generation over weather and climate time scales with minimal human intervention supported by up-to-date verification statistics. | 5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales. | * Reports identified during the Data review step, supplemented by direct interview with NMHS (preferably in-person discussion with forecasters). * For internal modelling, look for 'operational' aspects, including model verification, robust ICT processes including change processes, case studies, and continuous improvement processes. * See also WMO-No.485, Manual on the Global Data-processing and Forecasting System, and WMO-NO. 305, Guide on the Global Data-processing and Forecasting System (GDPFS) (revised version expected during 2022-23). * For 5.2 – 5.3, use Data Collection Campaign 2021: Part 4, Q 17-21 (models) |
| 5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution. |
| 5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions. |

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| **6. WARNING AND ADVISORY SERVICES** | NMHS' role as the authoritative voice for weather-related warnings and its operational relationship with disaster and water management structures. | **Level one:** Warning service not operational for public preparedness and response.  **Level two:** Basic warning service is in place and operational but with limited public reach and lacking integration with other relevant institutions and services.  **Level three:** Weather-related warning service with modest public reach and informal engagement with relevant institutions, including disaster management agencies.  **Level four:** Weather-related warning service with strong public reach and standard operational procedures driving close partnership with relevant institutions, including disaster management agencies.  **Level five:** Comprehensive, impact-based warning service taking hazard, exposure and vulnerability information into account, with strong public reach. It operates in close partnership with relevant national institutions, including disaster management agencies and registered Common Alerting Protocol alerting authorities. | 6.1. Warning and alert service cover 24/7. | * Data Collection Campaign 2021   Part 6: Q3  (Does the warning and alert Service of your NMHS cover 24/7?) |
| 6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings. | * Data Collection Campaign 2021:   Part 6 Q16-27 (MHEWS)   * Reports identified during the Data review step |
| 6.3. Common alerting procedures in place based on impact-based services and scenarios taking hazard, exposure and vulnerability information into account and with registered alerting authorities. | * Data Collection Campaign 2021:   Part 1 Q 13, Part 6 Q16-27   * Reports identified during the Data review step |
| **7. CONTRIBUTION TO CLIMATE SERVICES** | NMHS role in and  contribution to a national climate framework according to the established climate services provision capacity. | **Not Applicable**: Climate Services provided by another party  **Level one**: Less than basic Capacity to provide Climate Services  **Level two**: Basic Capacity for Climate Services Provision  **Level three**: Essential Capacity for Climate Services Provision  **Level four**: Full Capacity for Climate Services Provision  **Level five**: Advanced Capacity for Climate Services Provision | 7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate services. | * Data Collection Campaign 2021:   Part 2 Q4, Part 4 Q18, Part 5 Q2, 11, 16-17, Part 7 Q11   * Drawing on the WMO Checklist for Climate Services Implementation |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **8. CONTRIBUTION TO HYDROLOGY** | NMHS role in and contribution to hydrological services according to mandate and country requirements. | **Level one:** No or very little meteorological input in hydrology and water resource management.  **Level two:** Meteorological input in hydrology and water resource management happens on an ad hoc basis and or during times of disaster  **Level three**: There is a moderately well-functioning relationship between the meteorological, hydrological and water resources communities but considerable room for formalizing the relationship and SOPs.  **Level four:** The meteorological, hydrological and water resources sectors have a high-level formal agreement in place and an established working relationship and data sharing take place, but institutions still tend to develop products and services in isolation.  **Level five:** The meteorological, hydrological and water resources sectors have robust SOPs and agreements in place to work closely in developing new and improved products and providing  seamless and advanced services. | 8.1. Where relevant, standard products such as quantitative precipitation estimation and forecasts are produced on a routine basis according to the requirements of the hydrological community. | * Data Collection Campaign 2021:   Part 5 Q 5. Part 6 Q2, 10   * Detailed data on hydrology has been collected through the WMO Hydrology Online Survey (2020). * Other evidence collected during the Data review step showing the maturity of the NMHS contribution to hydrological services. |
| 8.2. SOPs in place to formalize the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed. |
| 8.3. Data sharing agreements (between local and national agencies, and across international borders as required) on hydrological data in place or under development. |
| 8.4. Joint projects/initiatives with hydrological community designed to build hydrometeorological cooperation. |
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| **9. PRODUCT**  **DISSEMINATION AND OUTREACH** | The level of effectiveness of the NMHS in reaching all public and private sector users and stakeholders. | **Level one:** Dissemination using only limited traditional channels such as daily newspapers and the national broadcaster and with little control over messaging and/or format.  **Level two:** Traditional communication channels and a basic dedicated website is used to disseminate forecasts and basic information.  **Level three:** A moderately effective communication and dissemination strategy and practices are in place, based only on in- house capabilities and supported by user-friendly website.  **Level four:** A large fraction of the population is reached using various communication techniques and platforms, in collaboration with partners, and a user-friendly and informative website and apps. Outreach and education activities occur regularly.  **Level five:** Advanced education, awareness and communication strategy, practices and platforms in place using various technologies tailored to reach even marginalized communities and in close cooperation with several partners. | 9.1 Channels used for user-centred communication and ability to support those channels (for example, does the NMHS operate its own television, video or audio production facilities? Does it effectively use cutting-edge techniques?). | * WMOCP: communication channels used to disseminate products and services (TV, radio, printed media, web app, social media, mobile phone app, others)   Data Collection Campaign 2021:   Part 5 Q9 |
| 9.2 Education and awareness initiatives in place. | * Data review and interview NMHS * Service Delivery Progress Model results (Q1b) |
| 9.3 Special measures in place to reach marginalized communities, indigenous people, the youth and the elderly. | * Data review and interview NMHS |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **10. USE AND NATIONAL VALUE OF PRODUCTS AND SERVICES** | Accommodation of public and private sector users and stakeholders in the service offering and its continuous improvement. | **Level one:** Service development lacks any routine stakeholder feedback practice.  **Level two:** Service development draws on informal stakeholder input and feedback.  **Level three:** Services development draws on regular dialogue with major stakeholders.  **Level four:** Service development draws on survey data and regular dialogue based on formal relationships with major stakeholders to ensure continuous improvement.  **Level five:** Strong partnerships, formal and objective survey and review processes exist with all major stakeholders enabling service co-design and continuous  Improvement. | 10.1 Formalized platform to engage with users in order to co-design improved services. | * Service Delivery Progress Model results (Q1) * Data Collection Campaign 2021 (Part 5 Q6) * 10.1 WMOCP: only in relation to climate products |
| 10.2 Independent user satisfaction surveys are conducted, and the results used to inform service improvement. | * Service Delivery Progress Model results (Q1-4) * NMHS interview |
| 10.3 Quality management processes that satisfy key user needs and support continuous improvement. | * Data Collection Campaign 2021 (Part 5 13-21 Part 6 Q23-27) * Service Delivery Progress Model results (Q4) * Key user interviews (e.g., aviation, marine, other industry) |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **2. EFFECTIVE PARTNERSHIPS TO IMPROVE SERVICE DELIVERY** | The level of effectiveness of the NMHSs in bringing together national and international partners to improve the service offering. | **Level one:** Works in isolation and does not value or promote partnerships.  **Level two:** Limited partnerships and mostly excluded from relevant finance opportunities.  **Level three:** Moderately effective partnerships but generally regarded as the weaker partner in such relationships, having little say in relevant financing initiatives.  **Level four:** Effective partnerships with equal status in most relationships and approaching relevant funding opportunities in a coordinated manner.  **Level five:** NMHS is regarded as a major national and regional role player. It has extensive and productive partnerships and is viewed as an honest broker in bringing parties together and provide national leadership on relevant finance decisions. | 2.1. Effective service delivery partnerships in place with other government institutions. | * Data Collection Campaign 2021：Part 1, Q8 (consultative platform), Part 4, Q3) (WIGOS partnerships) * Partnerships identified in the Data review Step. |
| 2.2. Effective partnerships in place at the national and international level with the private sector, research centres and academia, including joint research and innovation projects. | * Data Collection Campaign 2021: Part 7 Q 5-8,11 * WMOCP: (i) legislation on private sector providing information and services along the value chain (ii) Formal agreements between the public and private sector in relation to service delivery, operation, and maintenance of networks, observation data; (iii) consultative platform for the public sector, private sector, academia, and civil society to foster regular cooperative dialogue. |
| 2.3. Effective partnerships in place with international climate and development finance partners | * Partnerships and arrangements are identified in the Data review Step. * Data Collection Campaign 2021： Part 7, Q8 (sources of research funding) |
| 2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products or services that culminated from these relationships | * Partner reports identified during the Data review step, validated by NMHS interview. |

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| **3.** **OBSERVATIONAL INFRASTRUCTURE** | The level of compliance of the observational infrastructure and its data quality with prescribed WMO regulations and guidance. | **Level one:** No or limited, basic surface observations and no upper-air observations.  **Level two:** Basic network, large gaps, mostly manual observations with severe challenges and data quality issues.  **Level three:** Moderate network with some gaps with respect to WMO regulations and guidance and with some data quality issues.  **Level four:** Comprehensive mostly automated network providing good traceable quality data fully compliant with WMO regulations and guidance.  **Level five:** Comprehensive and highly automated advanced network including additional measurements and remote sensing platforms providing excellent data fully compliant with WMO regulations and  Guidance. | 3.1. Average horizontal resolution in km of both synoptic surface and upper-air observations, including compliance with the Global Basic Observing Network (GBON) regulations.[[92]](#footnote-93) | * WMO Observing Systems Capability Analysis and Review (OSCAR) database. |
| 3.2. Additional observations used for nowcasting and specialized purposes. | * OSCAR database * Evidence from WMO Checklist for Climate Services Implementation and WMO Hydrology Survey. |
| 3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations and quality assurance of the observational  network. | * External reviews and NMHS interview * Data Collection Campaign 2021**：**   Part 4, Questions 2-6 (WIGOS)   * Evidence from Climate checklist and WMO Hydrology Online Survey. |
| 3.4 Implementation of sustainable newer approaches to observations. | * Data Collection Campaign 2021**：**Part 2, Q 4, Part 4, Q 6-8, Part 7, Q 12,15-17 |
|  |  |  | 3.5. Percentage of the surface observations that depend on automatic techniques. | * OSCAR database |

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| **4. DATA AND PRODUCT SHARING AND POLICIES** | The level of data and product sharing on a national, regional and global level. | **Level one:** No observational data is shared internationally, either because not available to be shared or due to the lack of data sharing policies or practices, or the existing infrastructure does not allow data sharing.  **Level two:** A limited amount of GBON compliant data is shared internationally. The existing data sharing policies or practices or the existing infrastructure severely hamper two-way data sharing.  **Level three:** GBON data sharing compliance with regards to either surface or upper-air data and a data policy and practices and infrastructure in place that promote the free and open use of data for research and academic purposes as well as the in-house use of external data.  **Level four**: Fully meeting GBON data sharing compliance with a data policy and practices and infrastructure in place. These support free and open sharing of data nationally and, for some products, regionally or internationally as well as the in-house use of external data.  **Level five:** Exceeding GBON data sharing compliance and additional data (marine, radar, etc.) contributing to regional and international initiatives with policies that promote free and open two-way sharing of data and products on a national, regional and global basis. | 4.1. Percentage of GBON compliance – for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional  WIGOS centres. | * Data Collection Campaign 2021**：**   Part 4, Questions 2-6 (WIGOS)   * GBON regulations and WIGOS Data Quality Monitoring System, which provide real-time statistics on data exchange at an hourly resolution. |
| 4.2. A formal policy and practice for the free and open sharing of observational data. | * WMOCP Part 5 data and Data Collection Campaign 2021**：**   Part 4, Questions 2-6 (WIGOS)   * Data Policy Survey also contains information on cost recovery policies; Res 60 Survey: data available on provision of climate data and products on a commercial basis; type of users; the basis for the price established; who retains the revenue; approx. net annual revenue. |
| 4.3. Main data and products received from external sources in a national, regional and global context, such as model and satellite data. | * Reports identified during the Data review step, NMHS interview (preferably validated with in-person staff interviews). * Data Policy Survey * WMOCP Part 5 data and Data Collection Campaign 2021**：**Part 4, Questions 9-14 |

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| **5. NUMERICAL WEATHER PREDICTION MODEL AND FORECASTING TOOL APPLICATION** | The role of numerical weather prediction model output and other forecasting tools in product generation. Whether local modelling is sustainably used to add value to model output from WMO Global Data-processing and Forecasting System (GDPFS) centres. | **Level one:** Forecasts are based on classical forecasting techniques without model guidance and only cover a limited forecast time range.  **Level two:** Basic use of external model output and remote sensed products in the form of maps and figures, covering only a limited forecast time range.  **Level three:** Prediction based mostly on model guidance from external and limited internal sources (without data assimilation) and remoted sensed products in the form of maps, figures and digital data and cover nowcasting, short and medium forecast time ranges.  **Level four:** Digitized model output from internal (with data assimilation) and/or external (regional) sources and remote sensed products and data used and value-added through post-processing techniques extended into longer ranges.  **Level five:** Optimal combination of global, regional and local models, remote sensed data, post-processing techniques and automated probabilistic product generation over weather and climate time scales with minimal human intervention supported by up-to-date verification statistics. | 5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales. | * Reports identified during the Data review step, supplemented by direct interview with NMHS (preferably in-person discussion with forecasters). * For internal modelling, look for 'operational' aspects, including model verification, robust ICT processes including change processes, case studies, and continuous improvement processes. * See also WMO-No.485, Manual on the Global Data-processing and Forecasting System, and WMO-NO. 305, Guide on the Global Data-processing and Forecasting System (GDPFS) (revised version expected during 2022-23). * For 5.2 – 5.3, use Data Collection Campaign 2021: Part 4, Q 17-21 (models) |
| 5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution. |
| 5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions. |

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| **6. WARNING AND ADVISORY SERVICES** | NMHS' role as the authoritative voice for weather-related warnings and its operational relationship with disaster and water management structures. | **Level one:** Warning service not operational for public preparedness and response.  **Level two:** Basic warning service is in place and operational but with limited public reach and lacking integration with other relevant institutions and services.  **Level three:** Weather-related warning service with modest public reach and informal engagement with relevant institutions, including disaster management agencies.  **Level four:** Weather-related warning service with strong public reach and standard operational procedures driving close partnership with relevant institutions, including disaster management agencies.  **Level five:** Comprehensive, impact-based warning service taking hazard, exposure and vulnerability information into account, with strong public reach. It operates in close partnership with relevant national institutions, including disaster management agencies and registered Common Alerting Protocol alerting authorities. | 6.1. Warning and alert service cover 24/7. | * Data Collection Campaign 2021   Part 6: Q3  (Does the warning and alert Service of your NMHS cover 24/7?) |
| 6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings. | * Data Collection Campaign 2021:   Part 6 Q16-27 (MHEWS)   * Reports identified during the Data review step |
| 6.3. Common alerting procedures in place based on impact-based services and scenarios taking hazard, exposure and vulnerability information into account and with registered alerting authorities. | * Data Collection Campaign 2021:   Part 1 Q 13, Part 6 Q16-27   * Reports identified during the Data review step |
| **7. CONTRIBUTION TO CLIMATE SERVICES** | NMHS role in and  contribution to a national climate framework according to the established climate services provision capacity. | **Not Applicable**: Climate Services provided by another party  **Level one**: Less than basic Capacity to provide Climate Services  **Level two**: Basic Capacity for Climate Services Provision  **Level three**: Essential Capacity for Climate Services Provision  **Level four**: Full Capacity for Climate Services Provision  **Level five**: Advanced Capacity for Climate Services Provision | 7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate services. | * Data Collection Campaign 2021:   Part 2 Q4, Part 4 Q18, Part 5 Q2, 11, 16-17, Part 7 Q11   * Drawing on the WMO Checklist for Climate Services Implementation |

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| **8. CONTRIBUTION TO HYDROLOGY** | NMHS role in and contribution to hydrological services according to mandate and country requirements. | **Level one:** No or very little meteorological input in hydrology and water resource management.  **Level two:** Meteorological input in hydrology and water resource management happens on an ad hoc basis and or during times of disaster  **Level three**: There is a moderately well-functioning relationship between the meteorological, hydrological and water resources communities but considerable room for formalizing the relationship and SOPs.  **Level four:** The meteorological, hydrological and water resources sectors have a high-level formal agreement in place and an established working relationship and data sharing take place, but institutions still tend to develop products and services in isolation.  **Level five:** The meteorological, hydrological and water resources sectors have robust SOPs and agreements in place to work closely in developing new and improved products and providing  seamless and advanced services. | 8.1. Where relevant, standard products such as quantitative precipitation estimation and forecasts are produced on a routine basis according to the requirements of the hydrological community. | * Data Collection Campaign 2021:   Part 5 Q 5. Part 6 Q2, 10   * Detailed data on hydrology has been collected through the WMO Hydrology Online Survey (2020). * Other evidence collected during the Data review step showing the maturity of the NMHS contribution to hydrological services. |
| 8.2. SOPs in place to formalize the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed. |
| 8.3. Data sharing agreements (between local and national agencies, and across international borders as required) on hydrological data in place or under development. |
| 8.4. Joint projects/initiatives with hydrological community designed to build hydrometeorological cooperation. |
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| **9. PRODUCT**  **DISSEMINATION AND OUTREACH** | The level of effectiveness of the NMHS in reaching all public and private sector users and stakeholders. | **Level one:** Dissemination using only limited traditional channels such as daily newspapers and the national broadcaster and with little control over messaging and/or format.  **Level two:** Traditional communication channels and a basic dedicated website is used to disseminate forecasts and basic information.  **Level three:** A moderately effective communication and dissemination strategy and practices are in place, based only on in- house capabilities and supported by user-friendly website.  **Level four:** A large fraction of the population is reached using various communication techniques and platforms, in collaboration with partners, and a user-friendly and informative website and apps. Outreach and education activities occur regularly.  **Level five:** Advanced education, awareness and communication strategy, practices and platforms in place using various technologies tailored to reach even marginalized communities and in close cooperation with several partners. | 9.1 Channels used for user-centred communication and ability to support those channels (for example, does the NMHS operate its own television, video or audio production facilities? Does it effectively use cutting-edge techniques?). | * WMOCP: communication channels used to disseminate products and services (TV, radio, printed media, web app, social media, mobile phone app, others)   Data Collection Campaign 2021:   Part 5 Q9 |
| 9.2 Education and awareness initiatives in place. | * Data review and interview NMHS * Service Delivery Progress Model results (Q1b) |
| 9.3 Special measures in place to reach marginalized communities, indigenous people, the youth and the elderly. | * Data review and interview NMHS |

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| **10. USE AND NATIONAL VALUE OF PRODUCTS AND SERVICES** | Accommodation of public and private sector users and stakeholders in the service offering and its continuous improvement. | **Level one:** Service development lacks any routine stakeholder feedback practice.  **Level two:** Service development draws on informal stakeholder input and feedback.  **Level three:** Services development draws on regular dialogue with major stakeholders.  **Level four:** Service development draws on survey data and regular dialogue based on formal relationships with major stakeholders to ensure continuous improvement.  **Level five:** Strong partnerships, formal and objective survey and review processes exist with all major stakeholders enabling service co-design and continuous  Improvement. | 10.1 Formalized platform to engage with users in order to co-design improved services. | * Service Delivery Progress Model results (Q1) * Data Collection Campaign 2021 (Part 5 Q6) * 10.1 WMOCP: only in relation to climate products |
| 10.2 Independent user satisfaction surveys are conducted, and the results used to inform service improvement. | * Service Delivery Progress Model results (Q1-4) * NMHS interview |
| 10.3 Quality management processes that satisfy key user needs and support continuous improvement. | * Data Collection Campaign 2021 (Part 5 13-21 Part 6 Q23-27) * Service Delivery Progress Model results (Q4) * Key user interviews (e.g., aviation, marine, other industry) |

1. Private sector support for SOFF implementation - archetypal business models

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1. Context

The NMHSs in every country have the primary responsibility for the generation, analysis and provision of observational data as well as for the operation and maintenance of the observation infrastructure. However, NMHSs face significant challenges, particularly in developing countries, where the lack of resources, basic infrastructure, and technical capacity hinder the provision of high-quality hydromet services.

The role of the private sector is rapidly growing, particularly in developed countries. Technological advances and open data policies have created space for a broader role of the private sector in the provision of hydromet services. Private businesses are not just consumers of data that are essential for various sectors reliant on weather and climate, they also play an important role as technology providers as well as providers of information and services to parts of the public sector, other businesses and the wider society.

Services generated within the meteorological value chain have significant economic implications. The socio-economic benefits of a well-functioning value chain can be underestimated by governments, especially in developing countries. Leveraging private sector capabilities, without jeopardizing the provision of public services is a key condition to maximize socio-economic benefits.

Recognizing this opportunity, the Geneva Declaration was approved in 2019 by the 193 WMO Member States and territories and highlights the “need to strengthen the entire weather, climate and water services value chain – from acquisition and exchange of observations and information, through to data processing and forecasting, and service delivery – to meet growing societal needs”, taking into consideration the “evolving capabilities and growing engagement of the private sector in contributing to all links of the value chain and accelerating innovation”.

The policy framework in the backdrop is the WMO Data Policy. The new Unified WMO Data Policy (World Meteorological Congress, October 2021) benefits the private sector by providing access to a much broader suite of Earth system monitoring and prediction data, allowing businesses to generate value-added products and provide tailored services to specific users. The policy provides clarity about which types of data must be exchanged on a free and open basis (“core data”). GBON data are defined as core data. Achieving and sustaining GBON compliance is a national responsibility and SOFF supports GBON compliance for countries with limited resources and capacities.

This note explores the role of the private sector in the first part of the meteorological value chain – the generation and exchange of observations – and, more precisely, in the implementation of SOFF. Four archetypal business models have been developed in collaboration with HMEI. They constitute basic models that will be applied with variations in a manner tailored to country circumstances.

1. Archetypal business models

Four potential archetypal business models are being considered for the implementation of SOFF. The decision as to which model or variations of models a country uses depends on the country-specific context including considerations about:

* WMO Member roles and responsibilities that can vary from country to country
* local incentives for the private sector to engage with SOFF investments
* required pre-conditions for the model to work e.g., governance, regulatory framework, etc.

Depending on the country-specific context, variations of the archetypal business models could be pursued. Regardless of the model, WMO member countries and territories have to internationally exchange GBON on a free and open basis. SOFF does not advocate for a specific model but engage with countries to identify the most suitable model to achieve the objective: achieving sustained GBON compliance, i.e. international exchange of GBON data. Through its peer advisors and technically supported by WMO, SOFF supports countries in identifying the best option. The private partner may also be a not- for-profit entity or social enterprise. Each of these models is discussed below.

* 1. **Public model - Fully State/NMHS owned and operated**

In many countries, the State has full control of the hydromet services, including the generation of observations. In this model, single components of the observing system can be outsourced to commercial entities. However, in developing countries, this model often results in the lack of adequate funding and capacity to operate, leading to gaps in data.

* 1. **Observation as a service model**

State/NMHS owned – Private Partner operated (BOT: Build – Operate – Transfer) Under this model, the State contracts a private partner to design, construct and operate the basic observations infrastructure, which is fully publicly funded. The partner is in charge of operation and maintenance. Data ownership remains with the State/NMHS. Data are in the public domain without usage fees. The commercial use of data by the contracted partner is possible. The data can be used to develop commercial activities using economies of scale. Under such arrangements, country-tailored agreements are necessary.

In this model, the State has a significant amount of control over the setup, operation and data delivery via the contract with the private sector and can take a long view concerning the sustainability of the system. It also provides incentives for private sector partners to provide quality products to have the opportunity to engage long-term contracts.

* 1. **Concession model**

State/NMHS and Private Partner owned– BOOT (Build – Own – Operate – Transfer) Under this model, at least partial investments by the contracted private partner enable the observation system to be built, unlike under model 2 which is funded upfront by the public sector. The contractor is responsible for operation and maintenance. Data ownership is with the contractor. The State pays the contractor to make data available in the public domain free of charge. Payment occurs after data delivery. Data have to be delivered in a form that fulfills GBON criteria. The contractor has an incentive to build commercial services on the data gathered. Country-tailored agreements are necessary.

For such a model to be successful, the partner from the private sector needs to have enough confidence in its own ability to capitalize on the available opportunities in order to make upfront investments and ensure timely delivery of quality approved data. This model can be particularly beneficial to overcome the temporary shortcomings of an NHMS.

* 1. **Data as a service model**

Fully private owned and operated by a private partner with a direct contract with the State/NMHS This model would typically be used where there are already existing observation systems operated by private entities which adapt or enlarge their systems to meet the GBON criteria. The contractor is responsible for operation and maintenance. Data ownership is with the contractor. A concession is required for the NMHS to use and share the data free of charge in the public domain. The contracted partner can provide further commercial services. This model encourages a competitive market. Country-tailored agreements are necessary.

An increasing number of private sector participants run observation systems that could be upgraded or adapted to GBON/SOFF standards. This model makes use of existing infrastructure and capacity and spurs innovation.

1. Risk management

Table 1. Risk management.

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|  | Public Model | | Observation as a service model | | Concession model | | Data as a service model | |
| Public | Partner | Public | Partner | Public | Partner | Public | Partner |
| Implementation | X |  |  | X |  | X |  | X |
| Operation | X |  |  | X |  | X |  | X |
| Force Majeure | X |  |  | X |  | X |  | X |
| GBON-  compliance | X |  |  | X |  | X |  | X |
| (Pre)finance | X |  | X | X |  | X |  | X |
| Regulation | X |  | X |  | X |  | X |  |
| Political risk | X |  | X |  |  | X |  | x |

Depending on the model selected, countries would undertake country-specific tenders with support of the SOFF implementing entity and approval by the SOFF Steering Committee. The selection criteria could include amongst others: skills and experience (including in the local environment) and financial capabilities. Care would be given to avoid structures with a potential for future monopolistic market domination by single entities (either from the public or private sector side).

SOFF provides capacity development support for the NMHS in all four models. The type of support depends on the model chosen and the country’s situation. Emphasis is put on ensuring that the NMHS maintains basic capacity related to generation and exchange of observations and, for models 2-4, that the State has the expertise and capacity to engage in, monitor and manage the contractual relationships. This includes strengthening regulatory capacity and the ability to supervise the contracts.

1. Guide to The Global Basic Observing Network. (WMO-No. 1314), Seventy-Sixth Session World Meteorological Organization Executive Council - final report in progress. Provisionally available as an approved document at: [https://meetings.wmo.int/EC-76/\_layouts/15/WopiFrame.aspx?sourcedoc={06B12BCB-0094-451B-9BF2-65D47D6ED4D1}&file=EC-76-d03-2(3)-GBON-GUIDE-ANNEX-approved\_en.docx&action=default](https://meetings.wmo.int/EC-76/_layouts/15/WopiFrame.aspx?sourcedoc=%7b06B12BCB-0094-451B-9BF2-65D47D6ED4D1%7d&file=EC-76-d03-2(3)-GBON-GUIDE-ANNEX-approved_en.docx&action=default). [↑](#footnote-ref-2)
2. https://community.wmo.int/en/activity-areas/wigos/gbon/implementation-global-basic-observing-network-gbon/defining-initial-composition-gbon/references-gbon-material. [↑](#footnote-ref-3)
3. For SIDS, for the WMO GBON Global Gap Analysis in January 2022, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations. [↑](#footnote-ref-4)
4. Although GBON marine stations are not part of SOFF initial scope, peer advisors are encouraged to analyse in this step when considered relevant e.g., SIDS, the status of current marine stations for future GBON marine observations investments. [↑](#footnote-ref-5)
5. Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g., SIDS, the status of current marine stations for future GBON marine observations investments. [↑](#footnote-ref-6)
6. The rationale for classifying surface and upper-air stations as reporting is based on the WIGOS Data Quality Monitoring System (WDQMS) for the chosen time period (WMO GBON Global Gap analysis, January 2022). Stations that were either green (GBON compliant), or orange (“potentially GBON compliant”) on at least 60% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved. [↑](#footnote-ref-7)
7. For SIDS, for the WMO GBON Global Gap Analysis in January 2022, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations. [↑](#footnote-ref-8)
8. The rationale for classifying surface and upper-air stations as reporting is based on the WIGOS Data Quality Monitoring System (WDQMS) for the chosen time period (WMO GBON Global Gap analysis, January 2022) . Stations that were either green (GBON compliant), or orange (“potentially GBON compliant”) on at least 60% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved. [↑](#footnote-ref-9)
9. For SIDS, for the WMO GBON Global Gap Analysis in January 2022, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations. [↑](#footnote-ref-10)
10. Although GBON marine stations and stations in EEZ are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g., SIDS, the status of current marine stations for future GBON marine observations investments. [↑](#footnote-ref-11)
11. Please see guidance on marine stations in Section 2 on Scope. [↑](#footnote-ref-12)
12. Guide to The Global Basic Observing Network. (WMO-No. 1314), Seventy-Sixth Session World Meteorological Organization Executive Council - final report in progress. Provisionally available as an approved document at: [https://meetings.wmo.int/EC-76/\_layouts/15/WopiFrame.aspx?sourcedoc={06B12BCB-0094-451B-9BF2-65D47D6ED4D1}&file=EC-76-d03-2(3)-GBON-GUIDE-ANNEX-approved\_en.docx&action=default](https://meetings.wmo.int/EC-76/_layouts/15/WopiFrame.aspx?sourcedoc=%7b06B12BCB-0094-451B-9BF2-65D47D6ED4D1%7d&file=EC-76-d03-2(3)-GBON-GUIDE-ANNEX-approved_en.docx&action=default). [↑](#footnote-ref-13)
13. For SIDS, for the WMO GBON Global Gap Analysis in January 2022, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations. [↑](#footnote-ref-14)
14. Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g., SIDS, the need for future GBON marine observations investments according to the GBON requirements. [↑](#footnote-ref-15)
15. Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g. SIDS, the need for future GBON marine observations investments according to the GBON requirements. [↑](#footnote-ref-16)
16. Please see guidance on marine stations in Section 2 on Scope. [↑](#footnote-ref-17)
17. The rationale for classifying surface and upper-air stations as reporting is based on the WIGOS Data Quality Monitoring System (WDQMS) for the chosen time period (WMO GBON Global Gap analysis, January 2022) . Stations that were either green (GBON compliant), or orange (“potentially GBON compliant”) on at least 60% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved. [↑](#footnote-ref-18)
18. For SIDS, for the WMO GBON Global Gap Analysis in January 2022, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations. [↑](#footnote-ref-19)
19. The rationale for classifying surface and upper-air stations as reporting is based on the WIGOS Data Quality Monitoring System (WDQMS) for the chosen time period (WMO GBON Global Gap analysis, January 2022) . Stations that were either green (GBON compliant), or orange (“potentially GBON compliant”) on at least 60% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved. [↑](#footnote-ref-20)
20. For SIDS, for the WMO GBON Global Gap Analysis in January 2022, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations. [↑](#footnote-ref-21)
21. Although GBON marine stations and stations in EEZ are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g. SIDS, the status of current marine stations for future GBON marine observations investments. [↑](#footnote-ref-22)
22. Please see guidance on marine stations in Section 2 on Scope. [↑](#footnote-ref-23)
23. For SIDS, for the WMO GBON Global Gap Analysis in January 2022, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations. [↑](#footnote-ref-24)
24. Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g. SIDS, the need for future GBON marine observations investments according to the GBON requirements. [↑](#footnote-ref-25)
25. Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g. SIDS, the need for future GBON marine observations investments according to the GBON requirements. [↑](#footnote-ref-26)
26. Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g., SIDS, the need for future GBON marine observations investments according to the GBON requirements. [↑](#footnote-ref-27)
27. Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g., SIDS, the need for future GBON marine observations investments according to the GBON requirements. [↑](#footnote-ref-28)
28. Please see guidance on marine stations in Section 2 on Scope. [↑](#footnote-ref-29)
29. See more information on SOFF support in the SOFF Operational Manual at <https://alliancehydromet.org/wp-content/uploads/2022/11/Decision-item-2.2-Adoption-of-the-SOFF-Operational-Manual.pdf> [↑](#footnote-ref-30)
30. Other ODA-DAC eligible countries are not eligible for SOFF Investment Phase funding. These group of countries are supported only with the Readiness Phase. [↑](#footnote-ref-31)
31. See more details on the requirements for the delivery of Readiness phase outputs in the SOFF Operational Manual. [↑](#footnote-ref-32)
32. Guide to The Global Basic Observing Network. (WMO-No. 1314), Seventy-Sixth Session World Meteorological Organization Executive Council - final report in progress. Provisionally available as an approved document at: [https://meetings.wmo.int/EC-76/\_layouts/15/WopiFrame.aspx?sourcedoc={06B12BCB-0094-451B-9BF2-65D47D6ED4D1}&file=EC-76-d03-2(3)-GBON-GUIDE-ANNEX-approved\_en.docx&action=default](https://meetings.wmo.int/EC-76/_layouts/15/WopiFrame.aspx?sourcedoc=%7b06B12BCB-0094-451B-9BF2-65D47D6ED4D1%7d&file=EC-76-d03-2(3)-GBON-GUIDE-ANNEX-approved_en.docx&action=default). [↑](#footnote-ref-33)
33. https://community.wmo.int/en/activity-areas/wigos/gbon/implementation-global-basic-observing-network-gbon/defining-initial-composition-gbon/references-gbon-material. [↑](#footnote-ref-34)
34. For SIDS, for the WMO GBON Global Gap Analysis in January 2022, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations. [↑](#footnote-ref-35)
35. Although GBON marine stations are not part of SOFF initial scope, peer advisors are encouraged to analyse in this step when considered relevant e.g., SIDS, the status of current marine stations for future GBON marine observations investments. [↑](#footnote-ref-36)
36. Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyse in this step when considered relevant e.g., SIDS, the status of current marine stations for future GBON marine observations investments. [↑](#footnote-ref-37)
37. <https://public.wmo.int/en/about-us/members> [↑](#footnote-ref-38)
38. See Chapter 1 in this document. [↑](#footnote-ref-39)
39. Find the Global Basic Observing Network (GBON) guide [here.](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/English/3.%20SESSION%20ARCHIVE/INFCOM-2-d06-1(12)-GBON-GUIDE-INITIAL-VERSION-draft1_en.docx&action=default&Source=%2FINFCOM%2D2%2F%5Flayouts%2F15%2Fmobile%2Fviewa%2Easpx%3FList%3D11b7bba5%2De63f%2D4756%2D9e7e%2Dec1e5b358e84%26View%3Ddbbc48fa%2Dbee2%2D4a94%2D8905%2Dfbe98b87e342%26RootFolder%3D%252FINFCOM%2D2%252FEnglish%252F3%2E%2BSESSION%2BARCHIVE%26wdFCCState%3D1)  [↑](#footnote-ref-40)
40. [↑](#footnote-ref-41)
41. Monthly aggregation of observed variables from surface observation reports, received by at least one of the NWP centres monitored by WDQMS web tool [↑](#footnote-ref-42)
42. If a station is manually operated but is not operational 24 hours, this number can be reduced to the operational hours (hourly reporting i.e. 0800 – 1700 = 10 reports) as recorded in OSCAR/Surface. This needs to be registered as an exception to GBON regulations [↑](#footnote-ref-43)
43. Monthly aggregation of reports that missed time cut-off from NWP centres/WIS [↑](#footnote-ref-44)
44. Monthly aggregation of rejected reports from NWP centres, could also be gross errors or outside of OB-FG threshold [↑](#footnote-ref-45)
45. Monthly aggregation of observed variables from upper-air observation reports, received by at least two of the NWP centres monitored by WDQMS web tool [↑](#footnote-ref-46)
46. If a radiosonde station is only able to undertake one sounding per day, this number can be reduced to the scheduled as recorded in OSCAR/Surface. This needs to be registered as an exception to GBON regulations [↑](#footnote-ref-47)
47. High Resolution data (BUFR) being received confirmed by at least one of the NWP centres monitored by WDQMS web tool [↑](#footnote-ref-48)
48. Monthly aggregation of reports that missed time cut-off from NWP centres/WIS [↑](#footnote-ref-49)
49. Monthly aggregation of rejected reports from NWP centres, could also be gross errors or outside of OB-FG threshold [↑](#footnote-ref-50)
50. Find the Global Basic Observing Network (GBON) guide [here.](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/English/3.%20SESSION%20ARCHIVE/INFCOM-2-d06-1(12)-GBON-GUIDE-INITIAL-VERSION-draft1_en.docx&action=default&Source=%2FINFCOM%2D2%2F%5Flayouts%2F15%2Fmobile%2Fviewa%2Easpx%3FList%3D11b7bba5%2De63f%2D4756%2D9e7e%2Dec1e5b358e84%26View%3Ddbbc48fa%2Dbee2%2D4a94%2D8905%2Dfbe98b87e342%26RootFolder%3D%252FINFCOM%2D2%252FEnglish%252F3%2E%2BSESSION%2BARCHIVE%26wdFCCState%3D1)  [↑](#footnote-ref-51)
51. https://library.wmo.int/index.php?lvl=notice\_display&id=20026#.Y-ou0HbMJjE [↑](#footnote-ref-52)
52. See chapter 4 on SOFF private sector archetypal business models [↑](#footnote-ref-53)
53. idem [↑](#footnote-ref-54)
54. <https://www.worldbank.org/en/news/feature/2022/10/11/charting-a-course-for-sustainable-hydrological-and-meteorological-networks> [↑](#footnote-ref-55)
55. https://library.wmo.int/index.php?lvl=notice\_display&id=19223#.Y-oxynbMJjE [↑](#footnote-ref-56)
56. https://library.wmo.int/index.php?lvl=notice\_display&id=13617#.Y-oyHXbMJjE [↑](#footnote-ref-57)
57. https://library.wmo.int/index.php?lvl=notice\_display&id=10684#.Y-oyQXbMJjE [↑](#footnote-ref-58)
58. https://library.wmo.int/index.php?lvl=notice\_display&id=19508#.Y-oyS3bMJjE [↑](#footnote-ref-59)
59. https://library.wmo.int/index.php?lvl=notice\_display&id=9254 [↑](#footnote-ref-60)
60. https://library.wmo.int/index.php?lvl=notice\_display&id=21811 [↑](#footnote-ref-61)
61. https://library.wmo.int/index.php?lvl=notice\_display&id=19223#.Y-oxynbMJjE [↑](#footnote-ref-62)
62. https://library.wmo.int/?lvl=notice\_display&id=20026#.Y-o0uXbML-o [↑](#footnote-ref-63)
63. https://library.wmo.int/index.php?id=12407&lvl=notice\_display#.Y-o04XbML-o [↑](#footnote-ref-64)
64. https://library.wmo.int/index.php?lvl=notice\_display&id=22031#.Y-o1I3bML-o [↑](#footnote-ref-65)
65. Link to be added [↑](#footnote-ref-66)
66. https://library.wmo.int/index.php?lvl=notice\_display&id=13617#.Y-oyHXbMJjE [↑](#footnote-ref-67)
67. https://library.wmo.int/index.php?lvl=notice\_display&id=10684#.Y-oyQXbMJjE [↑](#footnote-ref-68)
68. https://library.wmo.int/index.php?lvl=notice\_display&id=19508#.Y-oyS3bMJjE [↑](#footnote-ref-69)
69. https://library.wmo.int/index.php?lvl=notice\_display&id=9254 [↑](#footnote-ref-70)
70. https://library.wmo.int/index.php?lvl=notice\_display&id=21811 [↑](#footnote-ref-71)
71. https://library.wmo.int/index.php?lvl=notice\_display&id=19223 [↑](#footnote-ref-72)
72. https://library.wmo.int/index.php?lvl=notice\_display&id=13617#.Y-oyHXbMJjE [↑](#footnote-ref-73)
73. https://library.wmo.int/index.php?lvl=notice\_display&id=10684#.Y-oyQXbMJjE [↑](#footnote-ref-74)
74. https://library.wmo.int/index.php?lvl=notice\_display&id=19508#.Y-oyS3bMJjE [↑](#footnote-ref-75)
75. https://library.wmo.int/index.php?lvl=notice\_display&id=9254 [↑](#footnote-ref-76)
76. https://library.wmo.int/index.php?lvl=notice\_display&id=21811 [↑](#footnote-ref-77)
77. https://library.wmo.int/index.php?lvl=notice\_display&id=16300 [↑](#footnote-ref-78)
78. https://library.wmo.int/index.php?lvl=notice\_display&id=16300 [↑](#footnote-ref-79)
79. https://library.wmo.int/index.php?lvl=notice\_display&id=15292 [↑](#footnote-ref-80)
80. https://library.wmo.int/index.php?lvl=notice\_display&id=10770 [↑](#footnote-ref-81)
81. https://library.wmo.int/index.php?lvl=notice\_display&id=15227 [↑](#footnote-ref-82)
82. https://library.wmo.int/index.php?lvl=notice\_display&id=20744 [↑](#footnote-ref-83)
83. https://www.gfdrr.org/sites/default/files/publication/gender-equality-disaster-recovery.PDF [↑](#footnote-ref-84)
84. https://www.undp.org/publications/gender-adaptation-and-disaster-risk-reduction [↑](#footnote-ref-85)
85. Annex to draft Decision 9/1 (INFCOM-2) https://meetings.wmo.int/INFCOM-2/\_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/INFCOM-2-d09-GENDER-ISSUES-approved\_en.docx&action=default [↑](#footnote-ref-86)
86. Reference to be added after Steering Committee approval [↑](#footnote-ref-87)
87. For SIDS, for the WMO GBON Global Gap Analysis in January 2022, the EEZ area has been added to the total surface area which is the basis for the target number of stations. The standard density requirements for SIDS have been calculated with 500 km for surface stations and 1000 km for upper-air stations. [↑](#footnote-ref-88)
88. https://alliancehydromet.org/country-hydromet-diagnostics/ [↑](#footnote-ref-89)
89. https://alliancehydromet.org/ [↑](#footnote-ref-90)
90. The generic guidance for the implementation of the CHD can be found at https://alliancehydromet.org/country-hydromet-diagnostics/ [↑](#footnote-ref-91)
91. In the context of SOFF support, the GBON-related indicators of the CHD will be assessed in detail through the GBON National Gap Analysis and the GBON National Contribution Plan. [↑](#footnote-ref-92)
92. In the context of SOFF support, the GBON-related indicators of the CHD will be assessed in detail through the GBON National Gap Analysis and the GBON National Contribution Plan. [↑](#footnote-ref-93)