20th Feb 2024

GBON National Gap Analysis

Nepal

Systematic Observations
Financing Facility

Weather
and climate
data for
resilience

WEATHER CLIMATE WATER

Screening of the National Gap Analysis (NGA) of Nepal

WMO Technical Authority screens the GBON National Gap Analysis to ensure consistency with the GBON regulations and provides feedback for revisions as needed. *The screening of the NGA is conducted according to the SOFF Operational Guidance Handbook, version: 04.07.2023 and the provisions in Decision 5.7 of the SOFF Steering Committee.*

Following iterations with the peer advisor and beneficiary country, WMO Technical Authority confirms that the National Gap Analysis is consistent with GBON regulations. While the WMO GBON Global Gap Analysis identified the need for 4 surface stations and 1 upper air station over land to meet the GBON horizontal requirement, the **WMO Technical Authority confirms the NGA results which indicate the need for 5 surface land stations and 2 upper air stations based on specific national circumstances.**

Date: 5 August 2025

Signature:

Albert Fischer

Director, WIGOS Branch, Infrastructure Department, WMO

GBON Gap Analysis Report
Nepal

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1. Country information from the GBON Global Gap Analysis

WMO GBON Global Gap Analysis (June 2023)[1] shows that four surface observation stations and one upper-air observation station would cover standard density requirement of GBON in Nepal (Table 1). Currently Department of Hydrology and Meteorology, Nepal is disseminating surface weather observations to the GTS/WIS from 17 synop/aero-synop stations. Existing GBON surface stations are fulfilling GBON horizontal resolution requirement of 200 km but there is lack in GBON temporal resolution due to manual observation system and data transfer (Figure 1). Due to working hours of manual observers' daily data availability of most stations is below 30 % (5 observations/day). In Kathmandu maximum daily data availability is 33 % (8 observations/day). *It's proposed to include/upgrade five (5) DHM's existing surface stations to GTS/WIS*. Existing automatic surface station requires improvements in data transmission system, management and operation to fulfill GBON requirements and manual stations should be upgraded to automatic one (see chapter 3).

Table 1. WMO GBON Global Gap Analysis (June 2023) target[1]. "Gap improved" and "Gap total" based on SOFF Secretariat and WMO Technical Authority confirmation on Dec 2023[2].

GBON horizontal resolution requirements	GBON target	Reporting	Gap improve	Gap new	Gap total
Surface stations **Horizontal resolution**: 200km	4	0	5	0	5
Upper-air stations **Horizontal resolution**: 500km	1	0	1	1	2

[1] SOFF, 2023. WMO GBON Baseline 2023. Sixth Steering Committee 27 November 2023. https://www.un-soff.org/wp-content/uploads/2023/11/INF-6.2-WMO-GBON-Baseline-2023-1.pdf

[2] Personal email 19th Dec 2023

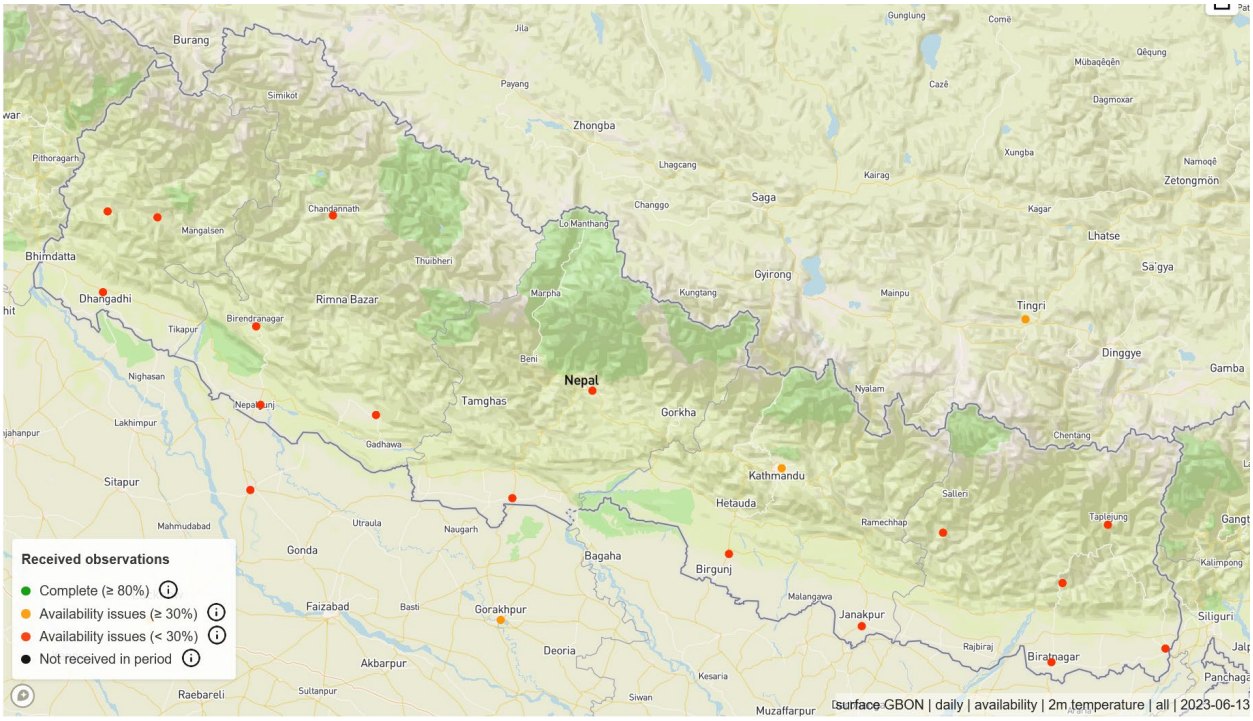


Figure 1. Location and availability of DHM's surface observations in WDQMS on 13th June 2023.

DHM is producing upper-air sounding at Kirtipur, Kathmandu once per day. Kirtipur sounding observations are not disseminated to the GTS/WIS due to data transmission problems. Transmission problems should be solved as easy fix. *To improve horizontal coverage of upper-air soundings one new station is proposed*. The additional sounding station fulfill regional sounding data gap (see Annex 2).

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

Currently DHM is reporting surface observations from 17 stations to the GTS/WIS. Observations at all aero-synop (GBON) stations are produced both, manually and automatically. Only manual observations are disseminated to the GTS. For manual stations observation interval is 30 minutes (METAR) in all aero-synop stations and 3 hours (SYNOP) in all synoptic stations between 00–12 UTC except Kathmandu airport where observations are made 24 hrs per day. *Currently DHM is reporting observations from Kathmandu airport to the GTS/WIS in 3-hour interval, meaning 8 observations/day in WDQMS, and from other stations at 00–12 UTC (5 observations/day in WDQMS) due to working hours of manual observers and lack of real-time data transmission.* This doesn't fulfill the temporal resolution of GBON. Stations are measuring all necessary parameters except snow depth as the number of existing GBON stations over 3000 m are very limited (Table 2, Table 3).

Table 2. Assessment of existent stations as per their operational status and network ownership

GBON Requirements	Existing observation stations (# of stations)			
	NMHS network		Third-party network	
	Reporting	Improve	Reporting	Improve
Surface stations Horizontal resolution: 200km Variables: SLP, T, H, W, P, SD	**0**	**5**	**0**	**0**
Upper-air stations Horizontal resolution: 500km Vertical resolution: 100m, up to 30 hPa Variables: T, H, W	**0**	**1**	**0**	**0**

Table 3. Assessment of existing GBON stations per station characteristic.

Station name	Station type (S/UA)	Owner (NMHS/ third-party)	Funding source	GBON variable measured						Reporting cycle	GBON Compliance (Y/N)
				SLP	T	H	W	P	SD		
Chandragadi Airport	S	NMHS	GoN	x	x	x	x	x	-	5	N
Simara Airport	S	NMHS	GoN	x	x	x	x	x	-	5	N
Janakpur Airport	S	NMHS	GoN	x	x	x	x	x	-	5	N
Okhaldhunga	S	NMHS	GoN	x	x	x	x	x	-	5	N
Dhankuta	S	NMHS	GoN	x	x	x	x	x	-	5	N
Biratnagar Airport	S	NMHS	GoN	x	x	x	x	x	-	5	N
Taplejung	S	NMHS	GoN	x	x	x	x	x	-	5	N
Nepalgunj Airport	S	NMHS	GoN	x	x	x	x	x	-	5	N
Ghorai	S	NMHS	GoN	x	x	x	x	x	-	5	N
Bhairahawa Airport	S	NMHS	GoN	x	x	x	x	x	-	5	N
Dadeldhura	S	NMHS	GoN	x	x	x	x	x	-	5	N
Dhangadhi(Attariya)	S	NMHS	GoN	x	x	x	x	x	-	5	N
Dipayal	S	NMHS	GoN	x	x	x	x	x	-	5	N
Jumla	S	NMHS	GoN	x	x	x	x	x	-	5	N
Surkhet Airport	S	NMHS	GoN	x	x	x	x	x	-	5	N
Pokhara Airport	S	NMHS	GoN	x	x	x	x	x	-	5	N
Kathmandu Airport	S	NMHS	GoN	x	x	x	x	x	-	8	N
Kirtipur	UA	NMHS	GoN		x	x	x			1	N

***Notes*: Assessment of existing GBON stations per station characteristics.** Station type: S: Surface, US: Upper-Air; Owner of the station: NMHS or name of third-party; GBON variables: SLP: Sea-level pressure; T: Temperature; H: Humidity; W: wind; P: Precipitation; SD: Snow depth; 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).

In addition to GBON stations, DHM is operating a total of 88 Automatic Weather Stations (AWS, Map in Annex 1) and many manual stations (194 precipitation, 79 climate and 6 agro-met stations) including GBON stations. Those stations are not reporting to GTS/WIS currently but could be contributed to fulfill GBON requirements instead of current aero-synop stations. All AWS's are measuring necessary GBON variables beside snow depth. Time interval of the observations is 10 minutes. Precipitation and climate stations should be upgraded to automatic ones to fulfill GBON requirements. *Total five (5) existing AWS/manual stations are proposed to be upgraded and included to the GTS/WIS to improve temporal resolution of surface observations and to fulfill GBON requirements.* List of potential stations and location on the map is shown in table 5 and figure 2.

3. Results of the GBON National Gap Analysis

Surface stations:

Current surface stations are fulfilling GBON standard density (200 km) but there is lack in temporal resolution due to manual observation system and data transmission from stations to the DMS and DMS to WMO data center. Time resolution of the GBON observations could be increased by utilizing one existing AWS stations installed by Building Resilience to Climate Related Hazard (BRCH) funded by World Bank (annex 1) and upgrading of four (4) manual stations to automatic ones. Proposed stations with available observations are listed in table 4 and shown in figure 2.

Four manual stations are proposed to be upgraded as automatic under SOFF. These stations should have similar set-up as the existing AWS network to ensure sustainability of stations and allowing further easy-fix possibilities in SOFF. Existing AWS is measuring all GBON parameters except snow depth with 10 minutes time resolution. The station is located above 3000 m where installation of snow sensors is recommended. AWS network has been under annual maintenance by system provider until 2023 February, but regular calibration of sensors has been missed. Thus, replacement of some sensors might be necessary during the first years of SOFF implementation. In addition, some tipping buckets have problems with overflowing. There are no spare parts for stations and thus, those should be procured regularly in case of failure or calibration.

Table 4. List of existing stations proposed to GBON standard (200 km) density network.

Name	Lat	Long	Altitude	Station type	Variables	Reporting
Rakam	28.52453583	82.02147194	565	Precipitation	P	1
Madi Kalyanpur	27.4589827	84.3431641	240	Precipitation	P	1
Chhoser	29.22713194	83.979815	3886	Climate	T, P	2
Syangboche	27.8149	86.713376	3821	AWS	SLP,T,H,P,W, SD	24
Thalara	29.56154	81.07092	2360	Precipitation	P	1

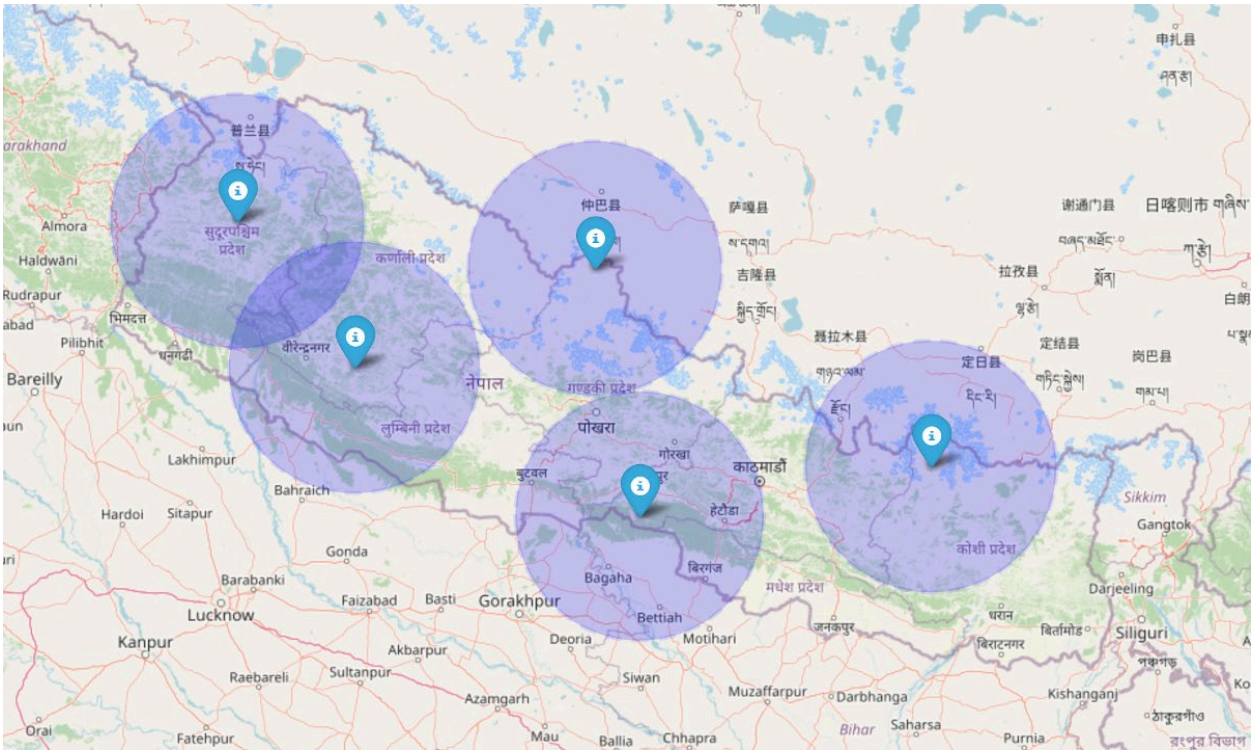


Figure 2. Coverage of proposed GBON surface stations to be supported by SOFF. The diameter of circles is 200 km.

To enhance availability and quality of observations, regular maintenance and calibration procedures should be established in addition to development of data management system (DMS). Due to limited human capacity and governmental funding, outsourced maintenance service is recommended. Regular calibration of temperature, humidity and pressure sensors could be performed in existing calibration laboratory. However, calibration lab has not been carried out in operation due some constraints (need for training, regular maintenance, additional man-power, upgrading of laboratory etc).

In addition to improvement of infrastructure and O&M of stations, development of data transmission and DMS is necessary to fulfill GBON time resolution with reliable observations. Data transmission from station to DMS and to GTS/WIS should be encouraged and e.g. satellite connection would be recommended to high altitude stations. Current AWS supports satellite connection. Also, DMS and operation should be improved e.g. real-time monitoring and quality control of observations. Current DMS does not support WIS 2.0 and should be developed to fulfill GBON.

Due to challenging topography and already existing AWS network the denser GBON network (100 km) with 15 stations[1] should be considered as one easy fix opportunity. This would provide more accurate information for global models from Himalaya region in cost-effective means. Improvement of GBON standard density network (enhanced DMS and data transfer from DMS to GTS/WIS, establishment of calibration laboratory) would also improve regional data gap. Several stations are located near / above 3000 m providing important real-time information on weather conditions from high-altitude Himalaya region for global models as recommended by WMO. To ensure quality data from denser network additional investments would be needed, e.g. upgrading of some sensors, spare parts, satellite connection and sustain funding for O&M.

Upper-air station:

DHM produces upper-air soundings at Kirtipur, Kathmandu. Sounding observations contain temperature, humidity and wind measurements at different pressure levels with minimum of 100 m vertical resolution up to 30 hPa level. This complies with the GBON requirements. Soundings are made once a day due to budgetary reasons. DHM does not disseminate sounding data to the GTS/WIS system due to problems in registering station to OSCAR and transmission problems in suitable format to the GTS/WIS. These problems should be solved as easy fix opportunity (data transferring & time resolution of soundings).

Horizontal coverage of national and regional upper-air sounding could be improved by adding one new sounding station and also improving existing station as easy fix solution. Spatial requirement of upper-air soundings does not cover western Nepal. Nearby stations are located at Lucknow and New Delhi, India. Lucknow locates about 450 km from Kirtipur and ~280 km from proposed new sounding station. Data availability of Lucknow in WDQMS was 50 % in May 2023 meaning GBON temporal resolution was not fulfilled. The nearest GBON compliant upper-air stations are New Delhi, Indian (~800 km from Kirtipur /~340 km from proposed new station) and Guwahati, Indian (~650 km from Kirtipur / > 1000 km from proposed new station). Distance between new station in western Nepal and New Delhi would be ~390 km fulfilling the GBON spatial requirement regionally. In east side of Nepal planned upper-air station in Bhutan would complement spatial resolution requirement regionally. Regional coverage of existing and proposed sounding stations are shown in annex 2. Proposed Nepalese stations are listed in table 5 and shown in figure 3. Operation of two sounding stations would need strengthened communication systems and DMS, budget for O&M, radiosonde accessories with spare parts, capacity building and number of human resources.

Table 5. Proposed sounding stations to be included to GBON.

Name	Lat	Long
Dipayal (new)	29.26209694	80.93690083
Kirtipur (existing)	27.70382	85.35625

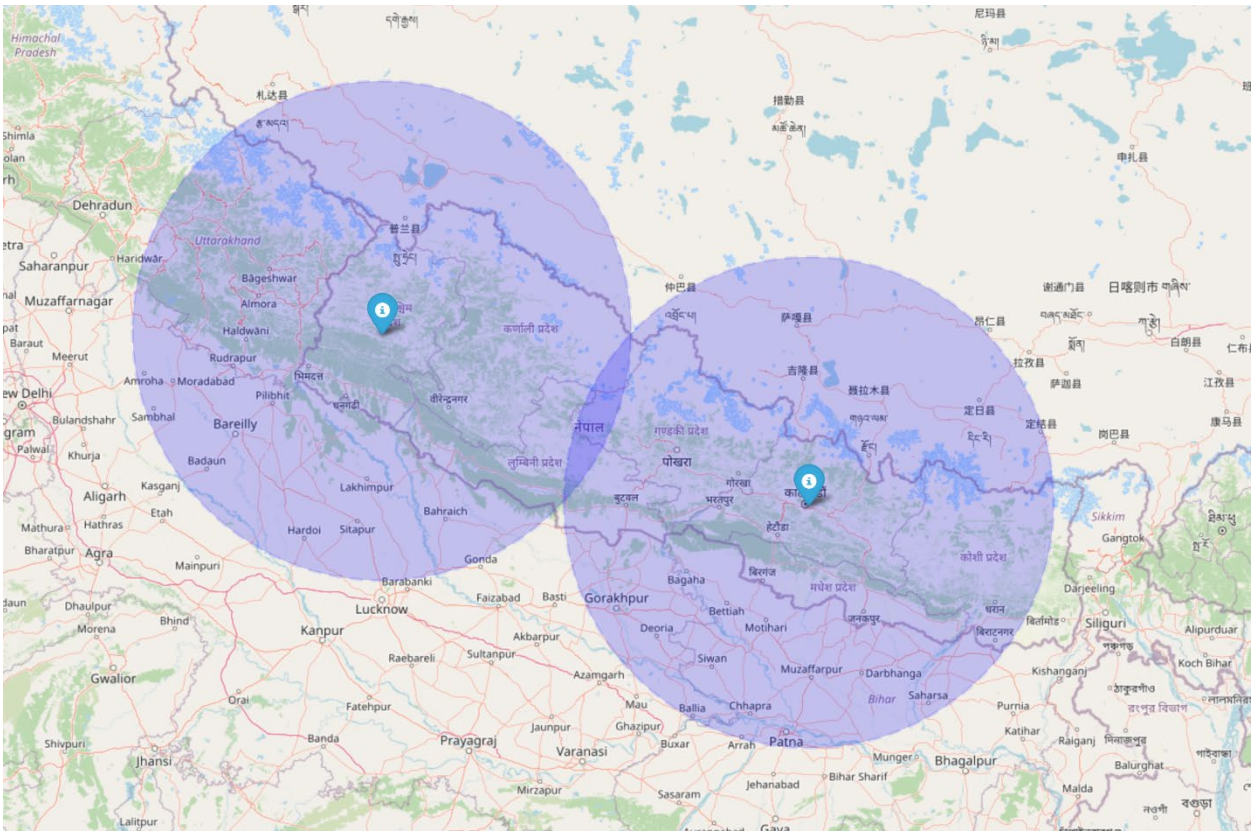
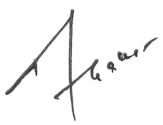


Figure 3. Coverage of the proposed GBON sounding station to be supported by SOFF. Existing Kirtipur is eastern station. Diameter of circles is 500 km.

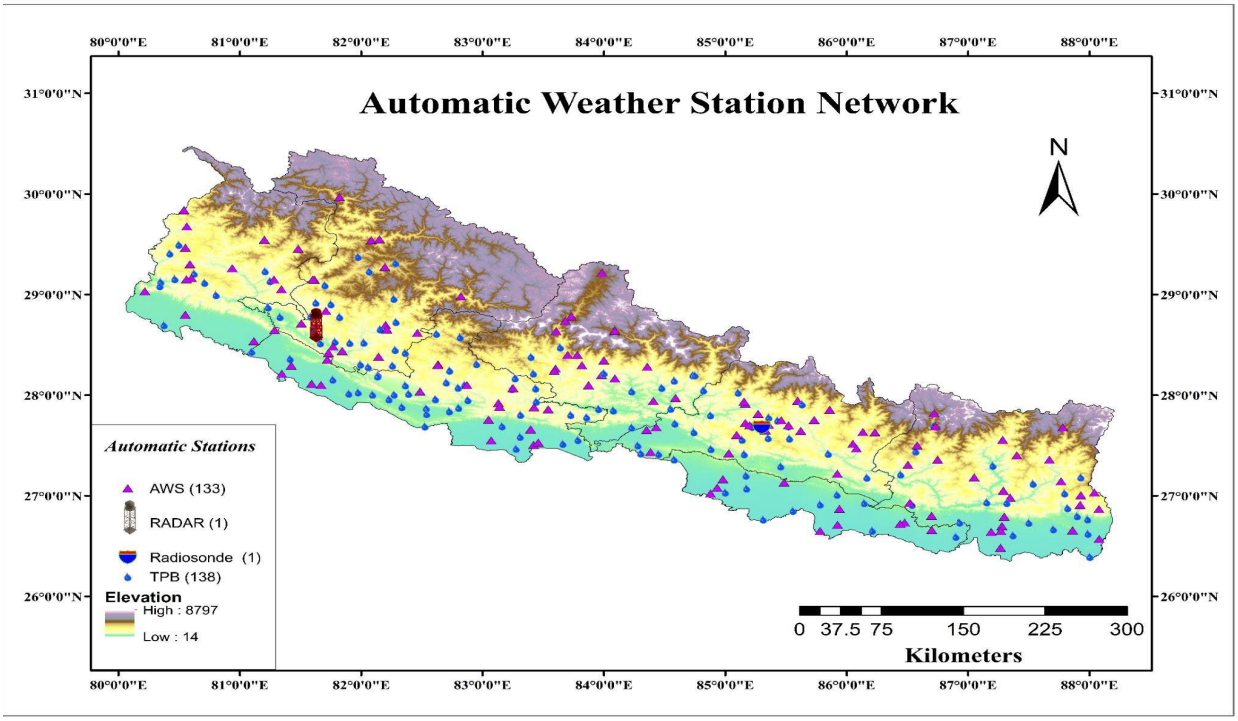
Table 6. Result of GBON Gap Analysis

GBON requirements	Target (# of stations)	GBON Compliant stations (#)	Stations gap	
			New	Improved
Surface stations • **Horizontal resolution**: 200km • **Variables**: SLP, T, H, W, SD • Observation cycle: 1h	**5**	**0**	**0**	**5:** Upgrading of existing stations to fulfill GBON time resolution.
Upper-air stations • **Horizontal resolution**: 500km • **Vertical** resolution: 100m, up to 30 hpa **Variables**: T, H, W • **Reporting cycle**: twice a day	**2**	**0**	**1:** Spatial requirement of upper-air soundings does not cover western Nepal with current Kirtipur station. Additional sounding station in western Nepal would improve spatial coverage of soundings also regionally.	**1:** Improvement of existing Kirtipur station

4. Report completion signatures

Peer Advisor signature 
WMO Technical Authority screening remarks and signature 
Beneficiary Country remarks and signature    

Annex 1. Meteorological Station (Automatic) Network in Nepal



Annex 2. Coverage of existing and proposed sounding stations at Nepal and neighboring countries. Existing Kirtipur station is in eastern blue circle. Existing Indian stations are shown in green circles and proposed Bhutanese station in blue. Diameter of circles 500 km.