April 2025

GBON National Gap Analysis

Systematic Observations Financing Facility

Weather and climate data for resilience

WEATHER CLIMATE WATER

Screening of the National Gap Analysis (NGA) of Tonga

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 3 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 4 surface land stations and 1 upper air stations based on specific national circumstances.**

Date: 13 April 2025

Signature:

Albert Fischer

Director, WIGOS Branch, Infrastructure Department, WMO

GBON National Gap Analysis Report

Tonga

Beneficiary Country Focal Point and Institute	Laitia Fifita, Director Tonga Meteorological Service
Peer Advisor Focal Point and Institute	Emma Coombe, Senior Adviser – International Development Meteorological Service of New Zealand

1. Country information from the GBON Global Gap Analysis

Table I. WMO GBON Global Gap Analysis (June 2023). Illustration of the information that the WMO Secretariat provides to each country

A. GBON horizontal resolution requirements	B. Target	C. Reporting (GBON compliant)[1]	D. Gap to improve	E. Gap new	F. Gap total
	[# of stations]				
Surface stations Standard density[2] 200 km	3	0	3	0	3
Upper-air stations over land Standard density[2] 500km	1	0	0	1	1

[1] 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, June 2023). Stations with data availability more than 80% on at least 80% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved.

[2] For SIDS, for the WMO GBON Global Gap Analysis in June 2023, 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.

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

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 (GBON compliant) [3]	To improve	Reporting (GBON compliant) [3]	To improve
Surface land stations Standard density [4] 200km Variables: SLP, T, H, W, P, SD	0	3	0	0
Upper-air stations operated from land Horizontal resolution[4]: 500km Vertical resolution: 100m, up to 30 hPa Variables: T, H, W	0	1	0	0
Surface marine stations in Exclusive Economic Zones:[7] 500 km Variables: SLP, SST	0	0	0	0
Upper-air stations operated in Exclusive Economic Zones:[5] 1000 km Vertical resolution: 100m, up to 30 hPa Variables: T, H, W	0	0	0	0

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: whether the station is GBON compliant or not (see GBON guide on compliance criteria).

[3] 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 during the development of National Gap Analysis Stations with data availability more than 80% on at least 80% of days, are considered as reporting. Other listed stations are counted as having the possibility to be improved.

[4] For SIDS, for the WMO GBON Global Gap Analysis in June 2023, 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.

[5]Although GBON marine stations and stations in EEZ are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g. SIDS, the status of current marine stations for future GBON marine observations investments.

Station name	Station type (S/UA/M)	Owner (NMHS/3rd party)	Funding source	GBON variable measured							Reporting cycle (obs/day)	GBON Compliant (Y/N)
				SLP	T	H	W*	P	SD	SST		
Niuafoou (M)	S	NMHS	TMS	X	X	X	X	X			4	N
Keppel/Mataʻaho (M)	S	NMHS	TMS	X	X	X	X	X			4	N
Lupepauʻu (M)	S	NMHS	TMS	X	X	X	X	X			7	N
Haapai (M)	S	NMHS	TMS	X	X	X	X	X			6	N
Fuaʻamotu (M)	S	NMHS	TMS	X	X	X	X	X			8	N
Niuafoʻou Airport AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Niuatoputapu AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Lupepau'u Airport AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Fatai Ag. Research AWS	S	NMHS	TMS	X	X	X	x				0	N
Longomapu AWS	S	NMHS	TMS	X			x	X			0	N
Fangatongo AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Koloa AWS	S	NMHS	TMS	X			x	X			0	N
Ha'ano TCC Tower AWS	S	NMHS	TMS	X			x	X			0	N
Pilolevu Airport AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Lifuka AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Nomuka AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Kolovai AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Mo'unga Olive AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Nuku'alofa AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Fua'amotu Airport AWS	S	NMHS	TMS	X	X	X	X	X			0	N
Hango Ag. College AWS	S	NMHS	TMS	X	X	X	x	X			0	N
Houma AWS	S	NMHS	TMS	X	X	X	x				0	N
Lapaha AWS	S	NMHS	TMS	X	X	X	x	X			0	N
Toloa AWS	S	NMHS	TMS	X	X	X	x	X			0	N
Atele College AWS	S	NMHS	TMS	X	X	X	X	X			0	N

3. Results of the GBON National Gap Analysis

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	Global GBON target	Approved national target	Reporting	Gap	
				To improve	New
	[# of stations]				
Surface land stations	3	4		4	0
Upper-air stations operated from land	1	1	0	0	1
Surface marine stations in Exclusive Economic Zones:[6] Density 500 km, Variables: SLP, SST Observing cycle: 1h	0	0	0	0	0
Upper-air stations operated in Exclusive Economic Zones: [7] Density 1000 km, Vertical resolution: 100 m, up to 30 hPa, Variables: T, H, W Observing cycle: twice a day	0	0	0	0	0

The proposed GBON stations are as follows:

Station name	Type	Latitude	Longitude
FUA'AMOTU	Surface	-21.2333	-175.15
KEPPEL/MATA'AHO AIRPORT	Surface	-15.9607	-173.7927
LUPEPAU'U	Surface	-18.5858	-173.9689
NIUAFOOU	Surface	-15.5667	-15.5667
FUA'AMOTU	Upper air	-21.2465	-175.1436

[6] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g. SIDS, the need for future GBON marine observations investments according to the GBON requirements.
[7] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g. SIDS, the need for future GBON marine observations investments according to the GBON requirements.

3.1 Recommended existing surface, upper-air and marine[9] stations to be designated to GBON

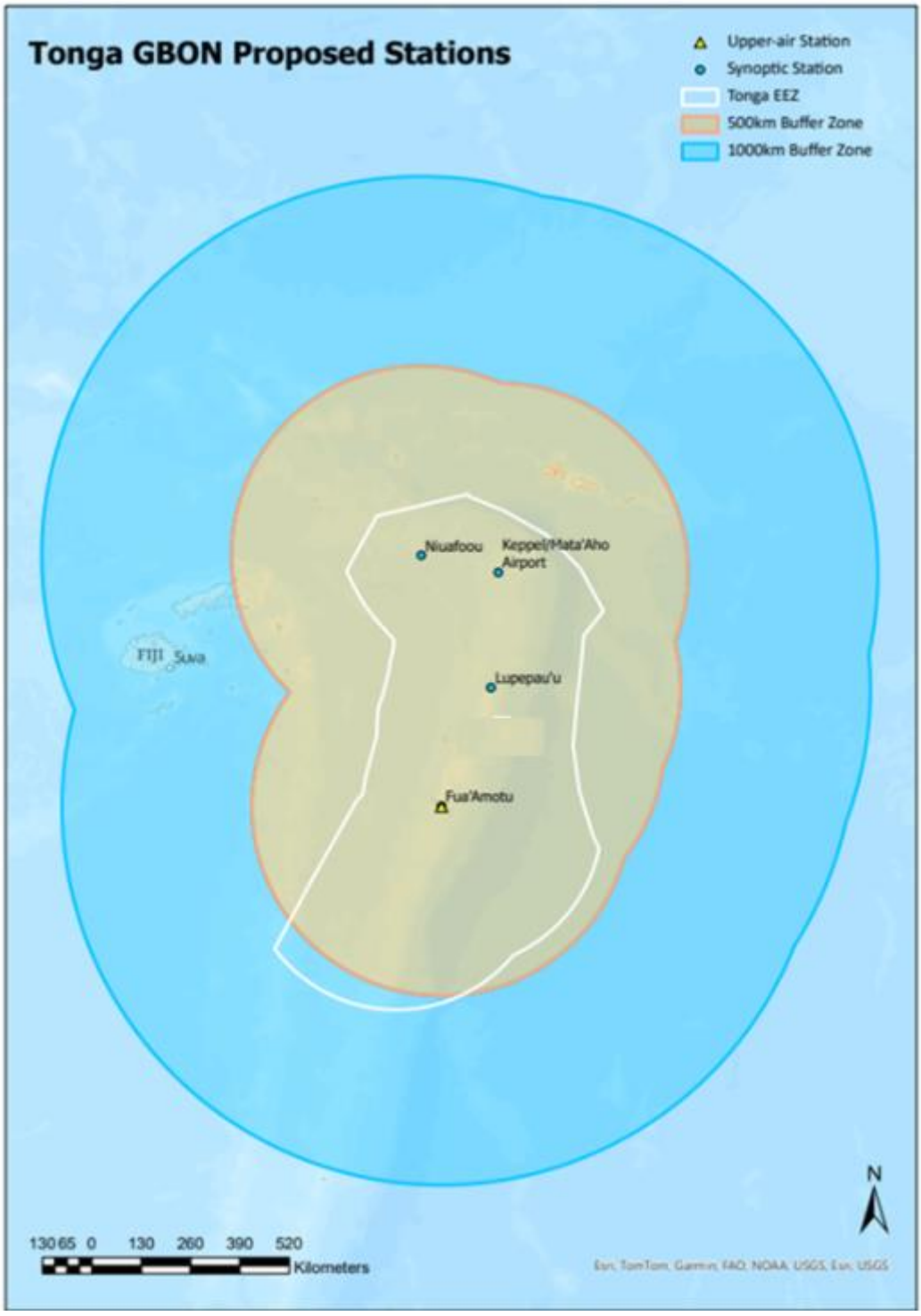
Table V. Recommended existing surface, upper-air and marine stations to be designated to GBON.

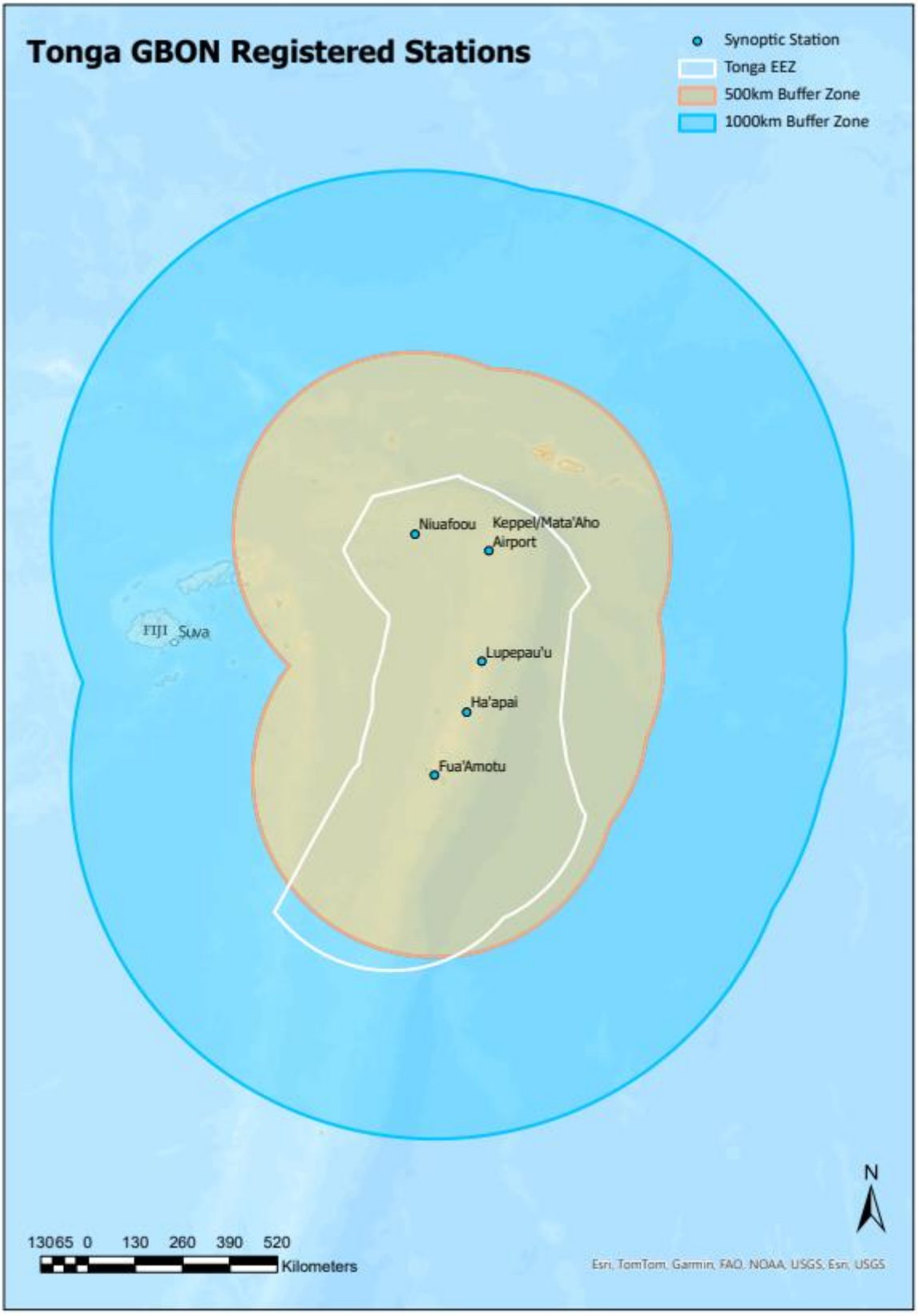
Station name	Station type (S/UA/M[10])
Fua'amotu	UA

[8] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g., SIDS, the need for future GBON marine observations investments according to the GBON requirements.

[9] Although GBON marine stations are not part of initial SOFF scope, peer advisors are encouraged to analyze in this step when considered relevant e.g., SIDS, the need for future GBON marine observations investments according to the GBON requirements.

[10] Please see guidance on marine stations in Section 2 on Scope.


Tonga GBON Proposed Stations
Upper-air Station
Synoptic Station
Tonga EEZ
500km Buffer Zone
1000km Buffer Zone
Niuafoou
Keppel/Mata'Aho Airport
Lupepau'u
Fua'Amotu
FIJI
SUVA
N
130 65 0 130 260 390 520
Kilometers
Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri, USGS


Tonga GBON Registered Stations
Synoptic Station
Tonga EEZ
500km Buffer Zone
1000km Buffer Zone
Niuafoou
Keppel/Mata'Aho
Airport
FIJI
Suva
Lupepau'u
Ha'apai
Fua'Amotu
N
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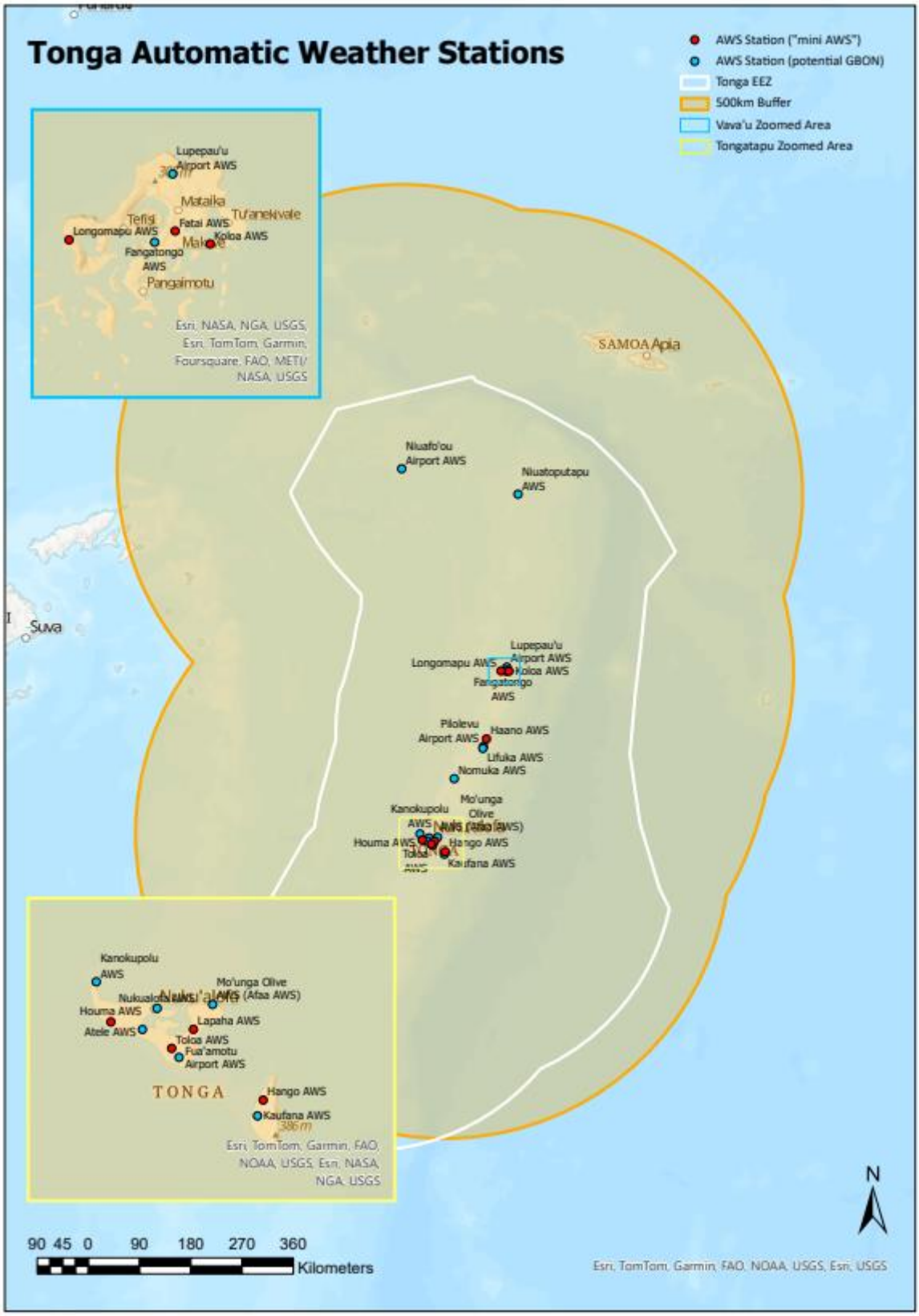
Kilometers
Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri, USGS


Tonga Automatic Weather Stations
AWS Station ("mini AWS")
AWS Station (potential GBON)
Tonga EEZ
500km Buffer
Vava'u Zoomed Area
Tongatapu Zoomed Area
Lupepau'u Airport AWS
Mataika
Tefisi
Tu'anekivale
Fatai AWS
Longomapu AWS
Koloa AWS
Fangatongo AWS
Pangaimotu
Esri, NASA, NGA, USGS, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS
SAMOA Apia
Niuafo'ou Airport AWS
Niuatoputapu AWS
Suva
Pilolevu Airport AWS
Haano AWS
Lifuka AWS
Nomuka AWS
Mo'unga Olive
Kanokupolu AWS
Houma AWS
Hango AWS
Kaufana AWS
Nukualofa AWS
Afaa AWS
Lapaha AWS
Atele AWS
Toloa AWS
Fua'amotu Airport AWS
TONGA
386 m
Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri, NASA, NGA, USGS
N
90 45 0 90 180 270 360
Kilometers
Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri, USGS

4. Report completion signatures

Peer Advisor signature  James Lunny
WMO Technical Authority screening signature 
Beneficiary Country signature  Laitia Fifita Director of Tonga MET Service PR of Tonga to WMO

Appendix

The initial GBON analysis undertaken by WMO indicated that Tonga (land area 748 sq km , EEZ area 659,000 sq km) has a requirement for three surface and one upper air observation station to meet GBON standard requirements.

National Observing Network

The Tonga Meteorological Service (TMS) currently operates an extensive surface observation network comprising 21 automatic and 5 manual observation stations. The manual stations report between 5 and eight times a day and are exchanged internationally,

Twelve automated stations are reporting the required GBON parameters with the exception of snow depth. Observations from the automatic network are reported sub-hourly, though no data from this network are currently exchanged internationally. Five of these stations are collocated at manual observing sites.

A further two AWOS are owned and operated by Tonga Airports Limited at Lupepau'u and Fua'amotu Airports. At the time of the in-country assessment both AWOS were unserviceable.

Tonga also has six operational sea level gauges, but these do not measure air pressure or sea surface temperature.

There is no upper air programme in Tonga.

GBON Requirements

Requirement of basic horizontal resolution of the GBON surface stations (500 km for SIDS) is fulfilled on average with three stations. However, considering Tonga is often the genesis area for severe tropical cyclones, and the scarcity of the observation stations in the surrounding ocean areas, one additional station is recommended to be financed through SOFF to fill this gap.

Supporting Technical Requirements

Manual synoptic observations are sent to the Fua'amotu office from the outer stations by phone, email or HF radio, where they are compiled into message bulletins and sent via email to the Bureau of Meteorology in Melbourne, and MetService in Wellington for relay to the GTS.