COUNTRY HYDROMET DIAGNOSTICS

Informing policy and investment decisions for high-quality weather forecasts, early warning systems, and climate information in developing countries.

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South Sudan Peer Review Report

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Disclaimer

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Executive Summary

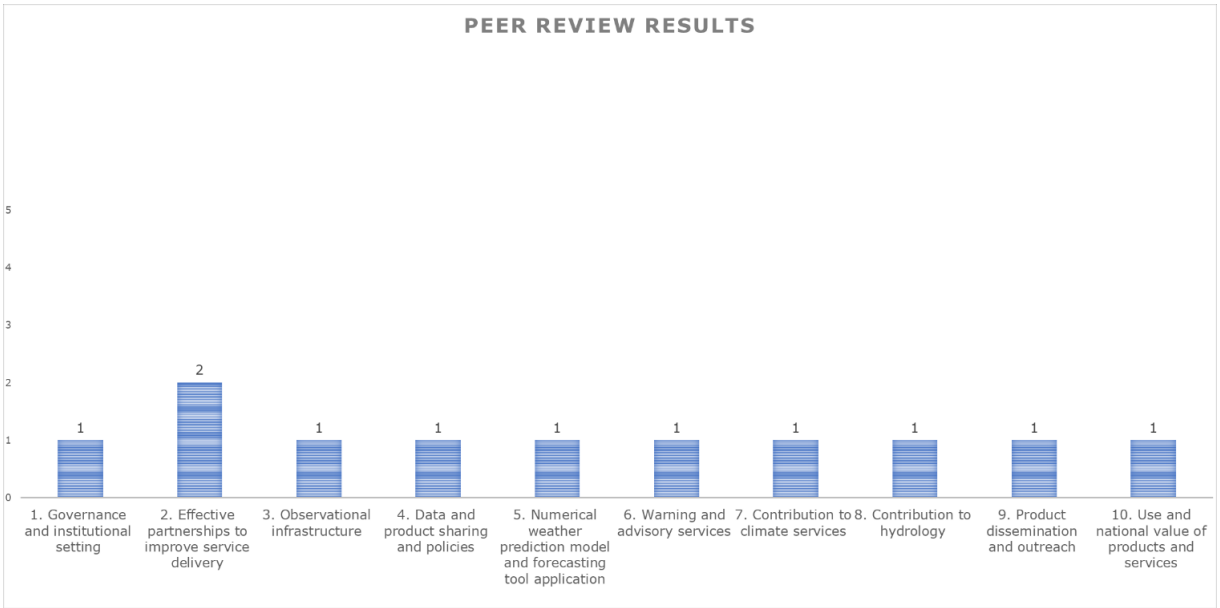
The South Sudan Meteorological Department (SSMS) is a relatively new entity, established immediately after the country gained its independence in 2011. Presently, the SSMS operates as a directorate under the Civil Aviation Authority of South Sudan (SSCAA) and primarily focuses on providing meteorological services for aviation. However, it is important to note that the institution lacks a formal mandate for this activity at this moment. In addition, the SSMS provides limited climate and weather forecasting services for the public and Governmental Agencies.

Broadly speaking, the SSMS faces significant limitations in terms of its capacity regarding observations and IT infrastructure, human resources, and know-how. This is exacerbated by the fact that the institution lacks adequate facilities to accommodate its personnel to perform their duties. Despite SSMS having been supported in the past through projects of different international organizations, not much progress has been achieved due to the political issues the country faced ever since its independence.
The main critical gaps identified, and the corresponding recommendations are:

a. A formal mandate – the institution is currently operating without a formal mandate for its activities. The establishment of a legal entity and respective government mandate for the provision of meteorological services, with a clear and wide scope of activities, is highly recommended and critical for sustained operations.
b. Human resources – there is a clear shortage of qualified personnel with the right expertise. The establishment of a formalized entity should be also capitalized to facilitate the needed process of staffing and its associated training.
c. Education and Training – in order to develop qualified personnel, the strategy has to start at the education levels. Therefore, it is recommended to strengthen the Meteorology department at the Juba University while at the same time formalizing the relation with SSMS.
d. Observations capacity – the country and the institution suffer from a very limited observations capacity. It is recommended to gradually expand, through different international initiatives like WMO's SOFF, the network at a limited number of strategical locations, and to commence sustained operations as the backbone of the strategic plan.
e. The SSMS facilities – and institution requires proper and fit for purpose facilities to support the daily activities. Currently, SSMS is facing very limited working space with limited to no infrastructure. It is of utmost importance to provide the SSMS with an adequate working space, with appropriate technical infrastructure, systems and all the logistical components that will enable the institution to run the daily operations in a robust and effective manner.
f. IT infrastructure – following on the basic facilities, proper IT infrastructure is a prerequisite for any operational weather service. IT infrastructure is needed to perform routine activities that involve data collection, data analysis, access to third party sources etc. Therefore, modernization of existing and deployment of new infrastructure needs to be addressed.
g. Data curation – data curation is essential especially when it comes to historical data archival, collection, validation and general management. The current situation is far from ideal with very limited capacity. It is strongly recommended to recover the raw historical data from the SMA, digitize the entire dataset and ensure sufficient backup for proper data preservation and exploitation. A properly resourced approach to enhance data management and processing is needed for many, if not all, activities of a weather service.

Collaboration and cooperation with international organizations – currently the SSMS external and international visibility is rather poor. Roundtables, standing committees and other regular meetings with representatives of national and international organizations should be scheduled and led by the SSMS. A specific international agenda should be drafted with the support of the key international actors to enhance visibility to a wider

community while at the same time open new opportunities for funding. The Peer reviewed results are presented in the Fig 1 below.



Element	Maturity level score
1. Governance and institutional setting	1
2. Effective partnerships to improve service delivery	2
3. Observational infrastructure	1
4. Data and product sharing and policies	1
5. Numerical weather prediction model and forecasting tool application	1
6. Warning and advisory services	1
7. Contribution to climate services	1
8. Contribution to hydrology	1
9. Product dissemination and outreach	1
10. Use and national value of products and services	1

Fig 1.: the maturity level scores for the SSMS, according to the CHD Methodology

1. General information

Introduction

Sudan, officially known as the Republic of South Sudan, is a landlocked country in East-Central Africa. It lies between latitudes 3° and 13°N, and longitudes 24° and 36°E. The country has gained its independence from Sudan in 2011. Its capital and largest city is Juba. South Sudan is bounded on the north by Sudan; on the east by Ethiopia; on the south by Kenya, Uganda, and the Democratic Republic of the Congo; and on the west by the Central African Republic. The country has an area of approximately 620,000 km2 and a population of approximately 13 million inhabitants (Source: Wikipedia.

About 17% of the population lives in urban areas, concentrated in the largest towns, while the remaining 83% live in rural areas, where households depend to a large extent on subsistence farming.

The country has gained its independence from Sudan in 2011, after a two-decade civil war. Ever since its independence, it has suffered from political instability, resulting in a civil strife between 2013 and 2015, with further outbreaks till 2020, which halted and even reverted much of the progress achieved beforehand. The recent crisis in Sudan started in April 2023 has triggered a large wave of refugees to South Sudan.

South Sudan is covered by a plateau, which has an altitude between 400 and 700 meters (ASL) above the sea level in the center-north, and between 700 and 1,000 meters (ASL) in the south. The predominant vegetation is the savannah, but the country is also dominated by expansive grassland and tropical rain forest straddling both banks of the White Nile including swamps. The terrain gradually rises from plains in the north and center, to southern highlands along the border with Uganda and Kenya. The White Nile, flowing north out of the uplands of East Africa, is the major geographic feature of the country supporting agriculture and an extensive wildlife population.

Given its geographical location, South Sudan has a climate ranging from tropical semi-humid with a short rainy season in the north, to tropical wet-dry and Tropical Rainy climates with longer wet seasons in the south followed by a drier season. The rainy season observed between May and October is influenced by the annual shift of the inter-tropical Convergence Zone (ITCZ), where rainfall is heaviest in the upland areas of the south and gradually diminishes to the north (Figure 1).

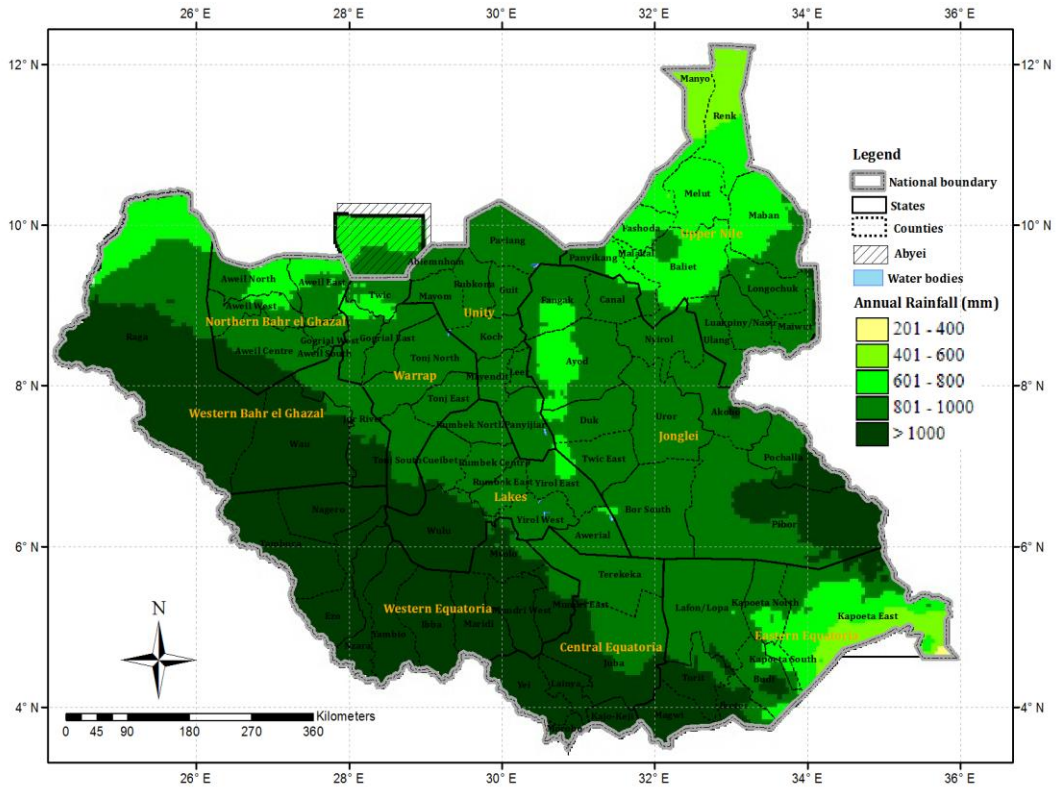


Figure 1. Mean Annual rainfall for South Sudan (Source: SSMS)

South Sudan experiences annual average temperatures above 25 C in most parts of the country. The coolest month is December with average temperatures ranging between 21 C and 30 C and the warmest month is March with average temperatures ranging between 22 C and 37 C (Figure 2).

The South Sudan Meteorological Department (the SSMS)

The South Sudan Meteorological Department (SSMS) is a relatively new entity, established immediately after the country gained its independence in 2011 and became a Member of WMO in 2012. Presently, the SSMS operates as a directorate under the Civil Aviation Authority of South Sudan (SSCAA). In its beginning, most staff members were directly transferred from the Sudan Meteorological Authority (SMA). Despite the recruitment of new staff to address the employee turnover in the years after foundation, the lack of robust job competencies is still an issue in some areas.

Moreover, the non-official mandate of the SSMS is the provision of meteorological services for civil aviation; in addition, the SSMS provides weather and climate services to the public and governmental authorities.

Before the establishment of SSMS, upon South Sudan's secession, the only meteorological services in what was then the Southern Sudan region consisted of meteorological observations at five weather stations. This means that the SSMS had to be created from scratch.

The missing of basic infrastructure is and has been a major issue. The SSMS Headquarters, initially consisted of a relatively small office located in the tower of the Juba International Airport, which hosted operational staff. Only recently the Director General has been assigned a separate office inside the newly constructed SSCAA Headquarters in Juba (2 kms from the other staff) whereas the operational staff working at Juba airport is in the process of being transferred to another office inside the new airport tower, to be finalised by the end of 2023.

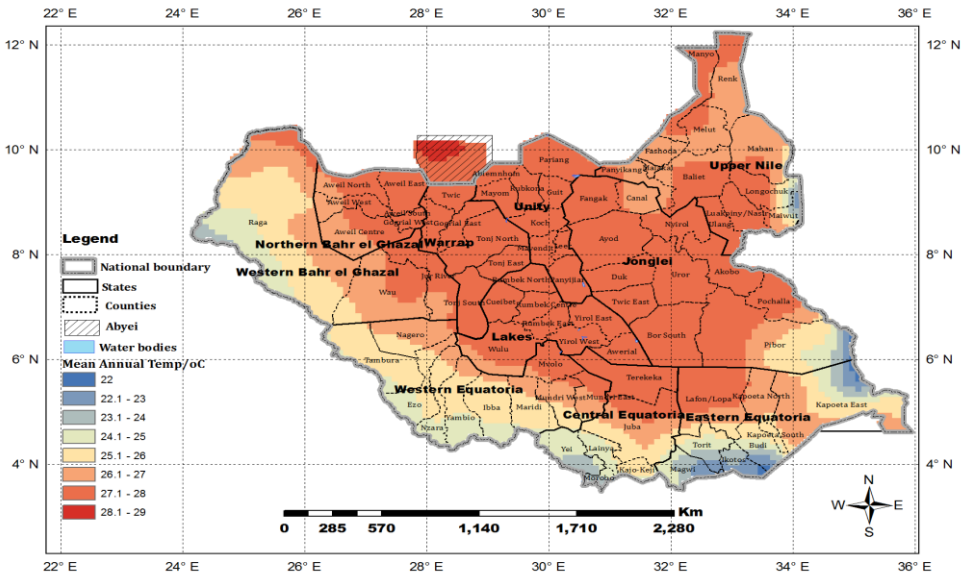


Figure 2. Annual Average Temperature in South Sudan (source: SSMS)

CHD methodology

This report has been prepared using the methodology described in the 2022 update of the Country Hydromet Diagnostics. This report has been prepared using the methodology described in the 2022 update of the Country Hydromet Diagnostics (CHD). An initial desktop review was performed, using information supplied by the South Sudan Meteorological Service, World Meteorological Organization (WMO), other international organizations (FAO, WFP, UNDP, etc.) and other partners. An in-country was then undertaken, followed by a report revision and an approval. This visit has included meetings in the capital Juba, as well a visit to the Juba Airport Meteorological Station. Unfortunately, due to security issues, the mission was not able to travel beyond the capital, in order to visit additional sites.

This document will provide crucial information for the SOFF initiative implementation phase, which in South Sudan is coordinated by GeoSphere Austria together with the African Development Bank (AfDB), as well as informing the ambitious EW4all initiative. The assessment by GeoSphere Austria has been facilitated by an on-site visit as well as various remote consultations. Following the CHD structures, this report is presented along the ten most critical elements of the hydromet value cycles with an indication of their respective maturity level and some high-level recommendations to help lifting up that maturity level, and as mentioned above, with a special emphasize on monitoring, forecasting, climate projection and warning systems for climate-related hazards, across timescales.

2. Country Hydromet Diagnostics

Element 1: Governance and institutional setting

1.1 Existence of Act or Policy describing the NMHS legal mandate and its scope

The SSMS is a directorate of the Civil Aviation Authority of South Sudan (SSCAA), which is under the Ministry of Transport. The organizational positioning of SSMS inside the SSCAA explains the focus of the services into the aeronautical meteorology. However, regardless its activities, there is no specific official act or policy that is related to the role, mandate or scope of the SSMS.

The Minister of Transport has expressed a strong interest to advance a proposal to formulate a legal framework for transforming SSMS into an independent entity with the mandate to provide climate, weather and early warning services to the country. High-level discussions are held currently in the council of ministers and together with ministry of the President of South Sudan.

1.2 Existence of Strategic, Operational and Risk Management plans and their reporting as part of oversight and management.

Two strategic plans (one for 2013-2018 and another for 2018-2023) have been developed, but due to the political turmoil the country had to cope with, their subsequent implementation has never been possible. Unfortunately, the strategic plan 2018-2023 is only valid until the end of this year (2023) and no further strategic plan for the upcoming years has been developed yet. There has been no effort yet to establish what parts of the strategy remain valid 2024+ and what parts need to be redesigned.

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.

The current budget of the SSMS consists of 1,550,000 SSP a year (last updated in 2021). The budget is limited to cover the salaries of the employees (which consist 90% of the total budget) as well as the basic maintenance of its premises (the rest of the budget), e.g. the office of the Director General, the operational office in Juba and the observation station sites at 5 localities: It is to be highlighted, that almost no budget is allocated to meet the other national or international needs of the SSMS. Thus, the budget does not cover IT issues, maintenance of the existing instruments, purchase of new instruments, training and so on. Despite the SSMS being the entity providing meteorological data for civil aviation, there is no cost recovery mechanism from these services.

Hence, there is no budget for staff training and continuous development, which currently depends entirely on external international support. The current staffing is sufficient to cover the core functions in terms of quantity, however:

1. Staff members do not hold the needed competencies to conduct their working duties.
2. The core activity of SSMS is the provision of meteorological services to civil aviation; however, the overall quality of these services needs a substantial improvement, which in turn implies an increase in staff members.

1.4 Proportion of staff (availability of in-house, seconded, contracted- out) with adequate training in relevant disciplines, including scientific, technical, and . Institutional and policy arrangements in country to support training needs of NMHS.

The SSMS is severely understaffed in all fields, including its core service domain, with a limited number of competent and trained forecasters (7) and observers (12, out of which seven are in Juba, so the other stations are either lacking any observers or having too little). There is no staff for IT, research, climate services or station maintenance. The hydrological service is separate entity, so the SSMS does not have hydrologists or hydrological technicians.

In addition to that, there is no staff allocated for administrative support, agrometeorology (for a country, which economy is based on agriculture, for a large extent), IT personnel, research, climate service or station maintenance.

Currently, the vast majority of the employees are male (25male to 3female), there is also a volunteers working for SMSS where the gender balance is better.

1.5 Experience and track record in implementing internationally funded hydromet projects as well as research and development projects in general.

Through the years, the SSMS has been benefiting from some development and cooperation projects; however, frequent political instability and civil unrest have discouraged international partners from financing interventions in the country, and even in some cases, causing the discontinuation of ongoing projects. For these reasons, several internationally funded projects have included capacity-building activities of SSMS staff conducted outside the country. Some UN agencies operating in South Sudan, like WFP, FAO and UNDP, have been running projects which involve SSMS. These projects, finished during the last five years or still active, include: FISU II (2016-2019), WISER 2 (with ICPAC and Met Office), GEF for South Sudan (2013 -), BRETON (2023), Ecosystem-based Adaptation (With UNEP and UNDP). While past projects generally had a good aim and a valid scope, their results and outcomes were rather limited so far due to the poor capacity of the SSMS.

The experience and track record of SSMS in implementing internationally funded projects is therefore poor and limited to a smaller portion of staff members.

Summary score and recommendations for Element 1

The CHD Element 1 score for the "Governance and Institutional Setting" assessed as Maturity Level 1 on the CHD scale, reflecting "Weakly defined mandate; serious funding challenges; essential skills lacking; little formalized governance and future planning".

This low score leads to a set of recommendations that should be both realistic and aligned with the current situation of the country. Namely:

a. To formalize the role and the scope of activities of the SSMS through a proper legal act.

b. To support South Sudan towards developing a meteorology policy and converting the SSMS into an autonomous national entity.

c. To develop a cost-recovery process for the aeronautical services provided by SSMS to the civil aviation.

d. To develop a strategic plan for SSMS, leveraging on the former ones, with an emphasis on improving governance and institutional setting.

e. To strengthen the collaboration between the Meteorological Department of the Juba University and SSMS, geared towards developing an in-country capacity for training and continuous development of SSMS staff.

f. To establish a standing committee, headed by the Director General of SSMS and with representatives of all the relevant international and governmental agencies, to coordinate development and cooperation projects.

Element 2: Effective partnerships to improve service delivery

2.1. Effective partnerships for service delivery in place with other government institutions.

The SSMS has a robust relationship with the SSCAA (Civil Aviation Authority), which is their parent organization. In addition, the SSMS has also a relationship with , the Disaster Management Authorities, ministries of Agriculture, Health, Water resources, Transport and Livestock, which consist mainly in providing consultation about the seasonal weather forecasts produced by the IGAD Climate Centre (ICPAC). Whenever a new seasonal weather forecast is issued by ICPAC, SSMS is forwarding it by WhatsApp to the relevant authorities and a discussion is evolved. There is a special committee (multi-agency platform) comprising of related line ministries, disaster management authority (inc. NMS and NHS) and organizing its meetings with support of FAO and WFP, periodically every 10 days (for major hazardous events), bringing key international partners (UN agencies) and NGOs. This committee should coordinate all the governmental activities during these events, but sadly, there is, however, no legal framework behind this collaboration and the committee, de facto, meets only on an ad-hoc mode.

2.2. Effective partnerships in place at the national and international level with the private sector, research centers and academia, including joint research and innovation projects.

SSMS has no relationship with any actors of the private sector. There is only a minimal informal partnership with the University of Juba, limited also by the low capacities of the university. Nevertheless, there is much potential in enhancing the collaboration between the two entities as recommended above, which could certainly create a win-win situation.

At the international level, the SSMS is in partnership with ICPAC, as provider of forecasting products. WMO supports South Sudan through sponsoring the participation of SSMS staff in international meetings and capacity building interventions outside the country.

2.3. Effective partnerships in place with international climate and development finance partners.

There are several initiatives related to meteorology co-sponsored by FAO, UNDP and WFP, but their effectiveness is rather limited as the poor governance and institutional settings of the SSMS affect its capacity to absorb knowledge transfer and benefit from the support and assistance provided. FAO and UNDP are intending to procure and install new AWSs as well as manual stations, as parts of 1-3 years projects they are involved in; the Director General of the SSMS is a member of the steering committees of these initiatives. However, due to the abovementioned settings of the SSMS, the SSMS is currently not in a position to participate very actively in these meetings.

2.4. New or enhanced products, services or dissemination techniques or new uses or applications of existing products and services that culminated from these relationships.

SSMS is issuing a forecast of weekly average weather parameters, based on the products obtained by the limited area NWP runs by ICPAC computational facilities and distributing it to various stakeholders. The SSMS was supposed to downscale these products for South Sudan, but due to staff and other technical issues, the SSMS only further distributes the products provided by ICPAC.

FAO and WFP have developed early warning systems, partially based on a cooperation with the SSMS. Representatives from the SSMS are participating, on a partial base, in the different meetings related to these systems. However, due to the local capacities of the SSMS, its contribution is predominantly limited to advisory. These systems are mostly based on remote sensing (Satellite imagery). Though the SSMS has access to the products

derived from these systems, again, due to their low capacities, they are currently unable to benefit from them.

Summary score, recommendations, and comments for Element 2

The CHD Element 2 score for the "Effective partnerships to improve service delivery" assessed as Maturity Level 2 on the CHD scale, reflecting " Limited partnerships and mostly excluded from relevant finance opportunities".

Recommendations:

i. To expand the legal scope of the activities conducted by SSMS, as well as strengthen its capacities, so the SSMS would be able to cover the range of issues any modern NMHS is expected to deal with. The SSMS therefore should:

   a. improve the collaboration and establish long term partnerships with other ministries and their departments, e.g., the ministry of agriculture, the ministry of water, ministry of mining, etc.

   b. establish sustainable relationship with the private sector, e.g., the electricity company, the telecommunication companies, the oil industry, etc. in order to find new users for potential products, but also to support the maintenance of its future observations systems.

   c. Improve the collaboration with international partners (e.g., WMO, NCAR, well-established NMHSs) and with other UN Agencies and liaise collaboration with new potential partners like UNDRR, UNICEF, WHO, etc.

   d. As already mentioned in element 1, to strengthen the collaboration with the Juba University. Such a stronger collaboration and partnership would both benefit SSMS and the University by on one side providing a pool of experts and training and update studying materials while at the same time opening potential career pathways for the students.

Element 3: Observational infrastructure

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.

There are five weather observation stations in the country, and only two are operational (Figure 3). Country is not GBON compliant, as it requires 16 operational stations to comply with 200 km resolution.

The one in Juba is a non-standard AWS, whereas the manual station in Wau, is providing only three-hourly observations and only during daytime (for security reasons). One of the other three other stations was destroyed during the last civil war, another one is having only one observer left and the letter and the fifth stations lack instruments. Due to the fact, that the SSMS' budget does not include maintenance or investments, no spare parts could have been purchased. An additional issue is that the observations were provided by phone, but the SSMS does not have the means to pay for the telecommunication costs.

This demonstrates the very limited observational capacity of the country, since actually, according to the low-level resolution GBON requirement for South Sudan; it should have operated at least 16 international surface stations. Furthermore, there are no regular upper air observations.

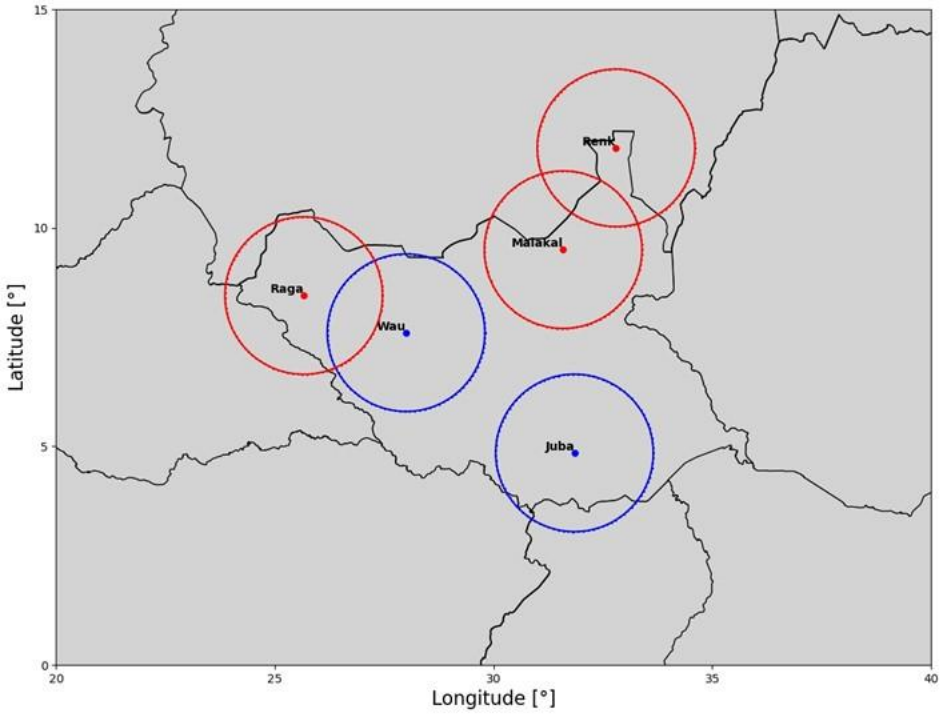


Figure 3. Map of the current surface weather station network of South Sudan, consisting of five sites, of which two host currently operational weather stations (within the blue circles), e.g. Juba and Wau. The remaining three sites, e.g. Malakal, Renk and Raga are partially or completely non-functional at the moment

3.2. Additional observations used for nowcasting and specialized purposes.

None existing.

3.3. Standard Operating Practices in place for the deployment, maintenance, calibrations and quality assurance of the observational network.

The already very limited observational capacity comes together with a lack of procedures (SOPs) to perform operations, calibration, or maintenance. It needs to be stressed that there is a significant lack of equipment, infrastructure, or relevant technical staff (Technicians and IT). Furthermore, the SSMS currently does not have adequate storage facilities for eventual spare equipment.

3.4 Implementation of sustainable newer approaches to observations.

None.

3.5. Percentage of the surface observations that depend on automatic techniques.

Currently, there is only one AWS in the country, which is not compliant with WMO standards.

Summary score, recommendations, and comments for Element 3

The CHD Element 3 score for the "Observational Infrastructure" assessed as Maturity Level 1 on the CHD scale, reflecting "No or limited basic surface observations and no-upper air observations".

Recommendations:

a. Through a gradual and multi-phase process and by leveraging on the synergies of different international initiatives (such as SOFF, CREWS, etc.) to upscale the observational network of South Sudan to a GBON-compliant network. In such multi-phase approach, the manual stations should be revived and retained in the current five observation sites (see Figure 1) and later by addition of new stations in other chosen sites. This phased approach is recommended to include specific milestones to ensure a following phase is not started without completion of the initial one. In particular, all that that relates to sustainability of activities and sites deployment is to be considered a critical aspect and the backbone of any plan to enhance the capacity of the country. It is evident that this recommendation includes all the components of an observational network as well such as IT, backup systems, etc. that are required in addition to the meteorological stations.

b. Build capacity at the University of Juba to train staff and to build up the required professional competencies of the weather observers and technicians, who serve in the observation stations. As it is clear, this linkage to the University of Juba cutting across the elements of the CHD and it is a preliminary action in many of the strategic recommendations provided.

c. To provide the SSMS with sufficient and adequate storage space for equipment.

Element 4: Data and product sharing and policies

4.1. Percentage of GBON compliance – for how many prescribed surface and upper-air stations are observations exchanged internationally. Usage of regional WIGOS centers.

The observational data from two operational observation stations is sent to the RTH Nairobi by email, from where they are supposed to be routed to the GTS. However, due to errors in coding, the observation messages are not accepted by the system at RTH and therefore not distributed internationally via the GTS. The percentage is therefore unfortunately zero.

4.2. A formal policy and practice for the free and open sharing of observational data.

None.

4.3. Main data and products received from external sources in a national, regional and global context, such as model and satellite data.

The forecasters have access to ECMWF, EUMETSAT, and NWP from IGPAC etc. only through their respective websites; hence they have an access only to very basic products. Currently, the operational room has only two unstable and low bandwidth internet connections, with an unstable electricity supply. This last fact hinders any further progress with providing the forecasters better tools.

Summary score, recommendations, and comments for Element 4

The CHD Element 4 score for the "Data and Product Sharing and Policies" assessed as Maturity Level 1 on the CHD scale, reflecting "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".

Recommendations:

a. To build the capacity of observers in Juba on observational data communication protocols, through an external training of experts from the Nairobi RTC and GISC,

for a basic international dissemination of the observations. Due to the abovementioned IT limitations, any progress towards WIS2 could be planned only further on in time, but for the time being, to get any observations into the GTS, the basic ability to share them should be established with high priority.

b. As part of the abovementioned new legal framework for the SSMS, also include a formal policy for a free and open sharing of observational data, as derived from the WMO recommendation of an open data policy.

c. To provide, through different international projects, adequate workstations, with an adequate internet connection. Otherwise, the forecasters at SSMS would never be able to benefit from more advanced products delivered by the international centers, nor having a comfortable and unified access to their own observations.

Element 5: Numerical model and forecasting tool application

5.1. Model and remote sensed products form the primary source for products across the different forecasting timescales.

As mentioned in the previous element, the forecasters can access products from ECMWF (only charts), EUMETSAT, etc. only through their respective websites. They therefore have access to the basic products only. The forecasters also get directly the products of the limited-area NWP run by ICPAC (short-term forecast), but without a further downscaling for South Sudan, they do not provide too much of an additional information.

5.2. a) Models run internally (and sustainably), b) Data assimilation and verification performed, c) appropriateness of horizontal and vertical resolution.

There is no internal numerical modelling capability. No data assimilation or verification is performed. ICPAC has provided SSMS with a cluster for WRF NWP model operations and a capacity building; however, the computer is not in use due to poor internet connection. Without a proper internet connection, there is no possibility to obtain boundary or initial conditions from ICPAC. Moreover, one of the personnel should be fully dedicated to this mission. Hence, there are no operational runs of the WRF model for South Sudan (or even experimental ones).

Having analyzed the country conditions through WMO Guidelines on High-resolution Numerical Weather Prediction (WMO-No.1311) country falls under the 2nd category where "Enhanced use of NWP products from RSMCs through post-processing" should be adapted as sustainable solution rather than further investment in-situ high performance computational capacities.

5.3. Probabilistic forecasts produced and, if so, based on ensemble predictions.

SSMS is not producing any probabilistic forecasts; nevertheless, forecasters do use ensemble products from global NWP models retrieved through the internet, to create forecasting products for aviation, including TAFORs (which include a probabilistic part).

Summary score, recommendations, and comments for Element 5

The CHD Element 5 score for the "Numerical Weather Prediction Model and Forecasting Tool Application" assessed as Maturity Level 1 on the CHD scale, reflecting, "Forecasts are based on classical forecasting techniques without model guidance and only cover a limited forecast time range".

Recommendations:

a. Operationalize the WRF software installed on the cluster donated by ICPAC for national capacity on NWP.

b. Procure adequate forecaster workstations, together with an adequate internet connection to access the required data to perform runs, meteorological assessments and other duty activities.

c. The current space of the operational duties is not sufficient and adequate to accommodate personnel and equipment. A new space should be arranged as working environment for the operations of SSMS. In addition, a stable electricity supply is a mandatory prerequisite for the operation of a modern NMHS.

d. To provide a training for the relevant staff of SSMS on postprocessing of NWP and EPS products, based on regional and international experience, using ICPAC as well as the regional training Centre in Nairobi.

e. Further engage with global and regional partners, preferably within the Severe Weather Forecasting Programme, to continue to improve the applicability of global and regional models for South Sudan.

Element 6: Warning and advisory services

6.1. Warning and alert service cover 24/7.

SSMS receives the early warnings created by the Regional Specialized Meteorological Centre (RSMC) Nairobi, which include guidance for potential 3 days severe weather over the EAC (East Africa Community) region. Once the institution obtains this information via email, it is forwarded to relevant governmental and international entities dealing with emergency events through a dedicated WhatsApp group. Added to the RSMC information, the forecaster on duty may provide some additional information and advisory through the same WhatsApp group. The forecasters also distribute these warnings to the media (national Radio stations and newspapers), but their outreach in the country is rather limited. The forecasters are on duty solely during daytime. So, the required 24/7 capacity for warning and alert services is currently missing.

6.2. Hydrometeorological hazards for which forecasting and warning capacity is available and whether feedback and lessons learned are included to improve warnings.

The weather parameters addressed by the abovementioned early warnings are precipitation, wind and temperature. The SSMS receives some feedback through the WhatsApp group, personal interaction and periodical meetings, but there is no systematic mechanism to collect feedback and moreover, the SSMS is currently unable to take corresponding actions in order to improve the warnings based on eventual feedback.

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.

None.

Summary score, recommendations, and comments for Element 6

The CHD Element 6 score for the “Warning and Advisory Services” assessed as Maturity Level 1 on the CHD scale, reflecting "Warning service not operational for public preparedness and response”.

Recommendations:

a. SSMS will not be able to produce even basic warnings without adequate infrastructure (observations, physical space, IT facilities, access to global and regional models, satellite imagery, etc.). The recommendations in former elements covering these aspects are essential for starting the journey towards warnings.

b. In case the previous condition to be fulfilled, dedicated training should be arranged for the forecasters.

c. Currently, the forecasters are working only daytime shifts. Without expanding the working time to 24/7, no continuous 24/7 warning services can be arranged. With a 24/7 operational schedule the warnings could be disseminated and acquired at the right times for proper response and citizen awareness.

d. To provide a training for the staff of the SSMS on the implementation of the CAP format.

Element 7: Contribution to Climate Services

7.1. Where relevant, contribution to climate services according to the established capacity for the provision of climate services.

As a whole, as abovementioned, the SSMS is currently considered only to be provider of meteorological information for aviation and therefore, not responsible officially for anything related to climate services.

As for the available services, climate services might be divided, roughly, into services based on past climate (observations) and those are based on future climate (model forecasts and predictions).

As for past climate, the SSMS has a very limited-scale historical data archive, which is mostly in hard copy and not in a systematic way. No systems for digitalization of historical data nor for management and manipulation is available at SSMS. The electronic average datasets from the observations conducted in the five observations sites of South Sudan before the independence have been availed by the Sudanese Meteorological Administration (SMA) to SSMS; however, it is not clear where these datasets are saved.

Based upon the existing limited data archive, the SSMS is hardly providing any basic climatology services. From time to time, there are some requests for climatic data by the university, governmental entities or international aid agencies, but due to the limited existing data archive, as well as for lack of allocated staff, the SSMS is hardly providing any basic climatology services.

As for future climate, the SSMS is receiving seasonal forecasts over the IGAD region from the ICAPC regional climate center. ICPAC has built capacity for downscaling the seasonal forecast, but technical challenges are preventing SSMS from conducting this operation and therefore the SSMS is simply forwarding the forecasts to its users and providing also additional insights if requested and if possible.

There is no monitoring or evaluation of the socioeconomic benefits of climate services.

Summary score, recommendations, and comments for Element 7

The CHD Element 7 score for the “Contribution to Climate Services” assessed as Maturity Level 1 on the CHD scale, reflecting "Less than basic Capacity to provide Climate Services”.

Recommendations:

1. To contact SMA and get the raw historical observational data from efore the independence.
2. To digitize the observations conducted before and after the independence and saved in hard copy and arrange a backup.
3. To provide the SSMS with an adequate storage space for the paper observations.
4. To train climatologists inside SSMS, provide them with adequate software and hardware and relevant training in collaboration with the Juba University, through a support of the WMO Nairobi Regional Training Centre on Meteorology.
5. To provide the SSMS with the IT equipment required for a statistical downscaling the ICPAC seasonal forecasts.

Element 8: Contribution to hydrology

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.

The Hydrological service of South Sudan (which is a separate entity), hosted by the ministry for Water Resources and Irrigation (NHS) lacks functioning hydrological stations or any other observational or technological infrastructure.

Capacities to operate the ancillary data (both NMS and NHS), digitize and use for operational tasks and build further forecasting efforts on it is very low. SSMS has a very limited number of rain gauges (in the two functioning surface stations) and remote sensing products (e.g., QPE) are not in operationally use (e.g. QPE is not used for hydrological forecasting).

8.2. SOPs in place to formalize the relation between Met Service and Hydrology Agency, showing evidence that the whole value chain is addressed.

None

8.3. Data sharing agreements (between local and national agencies and across international borders as required) on hydrological data in place or under development.

Such agreements do not exist.

8.4 Joint projects/initiatives with hydrological community designed to build hydrometeorological cooperation.

None.

Summary score, recommendations, and comments for Element 8

The CHD Element 8 score for the "Contribution to Hydrology" assessed as Maturity Level 1 on the CHD scale, reflecting "No or very little meteorological input in hydrology and water resource management".

Recommendations:

a. Establish a dialogue between SSMS and the hydrology department to understand the needs and capacities, therefore moving the first steps. The dialogue could be supported by the peer advisors or other external entity that would guide the evolution of this process.

b. Extend the rain gauge network of the SSMS, train climatologists and provide appropriate systems for precipitation forecasting. As for today, the SSMS lacks completely any people specializing on climatology and a lack of observers as well.

Element 9: Product dissemination and outreach

9.1. Channels used for user-centered 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?).

Forecasters disseminate weather forecasts on the national radio. However, due to relatively low geographical coverage, large parts of the population are not able to receive these broadcasts. The forecasters also use dedicated WhatsApp groups to connect with other government agencies and local offices, and multi-agency platforms organized regularly with the support and coordination of FAO and WFP with the government of South Sudan; every ten days or during major natural hazardous situations, where they coordinate their own activities in the country, collaborating with the South Sudanese government. However, mostly the SSMS is represented only by the Director General or his deputy, which is not always possible, due to their own availability. FAO and WFP are also distributing information through radio stations about the approaching major events, but even their outreach is quite limited, due to the generally limited Radio network and the large number of different languages, existing in South Sudan.

SSMS was provided with equipment and training for producing weather forecasts for TV broadcast, which however could not be operationalised due to poor internet connection which prevented from sharing the forecast packages with the broadcasting company.

In addition, one should recall the SSMS does not have the legal mandate to provide information to the wide public, as well as the fact that the SSMS is currently focusing most of its resources on meteorological services for aviation, rather than services for the public.

9.2. Education and awareness initiatives in place.

None. The only initiatives taking place are performed through some of the international organizations, without the participation of the SSMS or with a very minor role for it.

9.3. Special measures in place to reach marginalized communities and indigenous people.

None. It should be added also that the population of South Sudan speaks around 64 languages, whereas the official languages are English and local dialect of Arabic, which are not spoken by the entire population. There are some initiatives of international organizations addressing the language complexity, but with a very limited or no participation of the SSMS.

Summary score, recommendations, and comments for Element 9

The CHD Element 9 score for the “Product Dissemination and Outreach” assessed as Maturity Level 1 on the CHD scale, reflecting " Dissemination using only limited traditional channels such as daily newspapers and the national broadcaster and with little control over messaging and/or format”.

Recommendations:

a. To formalize the legal status of the SSMS as the national provider of meteorological forecasts, warnings and advisory for the public.

b. In a collaboration with international organizations, e.g South Sudan Red Cross or any other organization approaching the Last Mile, to try and foster a closer communication with the different communities, mostly using "information agents", such as local governmental officials, leaders of communities as well as priests and imams (who are mostly more educated than most of the population and enjoy a well-accepted authority). These agents should be trained in understanding and translating meteorological information for their communities.

Element 10: Use and national value of products and services

10.1. Formalized platform to engage with users in order to co-design improved services.

The only existing formalized multi-sector platforms include a dialogue with national and UN agencies operating in the country such as WFP, FAO and UNDP. However, the participation of SSMS in these platforms is affected by the limited availability of staff to join these events actively and regularly; another constraint is the fact that internal communication inside SSMS is rather poor, therefore de-briefing back to internal SSMS staff is not efficient.

10.2. Independent user satisfaction surveys are conducted, and the results used to inform service improvement.

None

10.3. Quality management processes that satisfy key user needs and support continuous improvement.

None. The country does not have the capacity to support the implementation of a QMS at SSMS.

Summary score, recommendations, and comments for Element 10

The CHD Element 10 score for the "Use and National Value of Products and Services" assessed as Maturity Level 1 on the CHD scale, reflecting, "Service development lacks any routine stakeholder feedback practice".

Recommendations:

a. To schedule weekly meetings of the management of the SSMS, together with relevant technical staff, to coordinate regarding the participation in different external meetings.

b. To schedule monthly meetings with the director General, the relevant staff of the SSMS and representatives from other ministries and international organizations to discuss and foster mutual issues and plans.

c. To create a yearly survey to be sent to the aviation companies using the airports of South Sudan, as the current main user groups of the SSMS.

Annex 1 Consultations (including experts and stakeholder consultations)

SSMS:

Name	Unit	Role
Mojwok Ogawi Modo	Management	Director General
Abdelgadir Juma Musa	Management	Deputy
Juma Ali Mohammed	Management	Assistant to DG
Emmanuel Wani Rajab	Forecasting	Forecaster
Badrel Din Yousif Fartak	Forecasting	Forecaster
Philip Nyagirch Korok	Forecasting	Senior Observer
Aceik Thukbull Ayom	Forecasting	Forecaster

Government of South Sudan:

Name	Organization	Unit	Role
Madut Biar Yel	Ministry of Transport	Ministry of Transport	Minister
Captain Subek David Dada	Ministry of Transport	Aviation Authority	CEO
Joseph Africano Bartel	Ministry of environment and Forestry	Ministry of environment and Forestry	First undersecretary

Academy:

Name	Organization	Unit	Role
Dr. Christopher Tombe Lewis Gore	University of Juba	School of Applied and Industrial Sciences	Dean
Dr. John Tombe Jada Marcellino	University of Juba	Department of Physics	Head
Silvio Laku Micheal	University of Juba	Department of Physics	Lecturer
James Ayuong Abednego Akol	University of Juba	Department of Physics	Teaching Assistant
Mabuong Majok Mabuong	University of Juba	Department of Physics	Teaching Assistant
Marko Pitya	University of Juba	Department of Physics	Technician
Alice Augustino Wani Ladu	University of Juba	Department of Physics	Technician

International Organizations:

Name	Organization	Unit	Role
Md. Badrul Alam Talukder	FAO	Natural Resources Management	Head
Wilson Makuwaza	FAO	Natural Resources Management	Project Manager
Mark Nyeko	FAO	Natural Resources Management	State Coordinator
Patrick Ochaya	FAO	Natural Resources Management	GIS Specialist
Suzan Lupai	FAO	Natural Resources Management	Nutrition Analysis Officer
Kiganzi Nyakoto	WFP	Emergencies Unit	Head
Maurine Ambani	WFP	Emergencies Unit	Regional AA Expert
Lia Pozzi	WFP	Vulnerabilities and Analysis Mapping	Head
Nyele Mabe	WFP	Emergencies Unit	National Coordinator for Capacity support to Min Humanitarian Affairs and Disaster Management
Maria Raquena	WFP	Emergencies Unit	Climate Adaptation Expert
Dominic Nyirongo	WFP	Emergencies Unit	Program Policy Office - resilience
Kuach Pech	UNDP	Stabilization, Resilience and Recovery	Project Manager – Climate, Energy & Environment
Johan Gely	Federal Department of Foreign Affairs FDFA (Switzerland)	Swiss Cooperation Office and Consular Agency in South Sudan	Expert
Vuciri Taban Kenyi	Federal Department of Foreign Affairs FDFA (Switzerland)	Swiss Cooperation Office and Consular Agency in South Sudan	Expert

Annex 2 Urgent needs reported

As mentioned in the executive summary:

a. A lack of a formalized governmental mandate of SSMS.
b. A lack of adequate physical facilities to host SSMD staff and equipment.
c. A very poor observation network.
d. A lack of an adequate technical infrastructure, e.g. IT equipment, observational equipment, enabling system like Wi-Fi and fixed, internet cables.
e. A limited number of skilled and specialized staff.

Annex 3 Information supplied through WMO

1. WMO Monitoring System Data
2. WMO EW4All Rapid Assessment for Pillar-2
3. WMO Hydrology Survey

4. Data from Checklist for Climate Services Implementation

Annex 4 List of materials used

(This may include WMO Guidance Materials, Data and Information, Review Reports, Database etc.)

1. Country Hydromet Diagnostics, published by WMO, 2023
2. CHD Operational Guidance for SOFF, 2023
3. Strategic Plan for the Development of South Sudan Meteorological Department, 2015 – 2019. Revised October 2014.
4. Letter "Implementation of the Global Basic Observing Network (GBON) – Initial Composition of the Network". Sent on the 15th August, 2022.
5. Early Warning in South Sudan, as 7 March 2023 (GEF Project)
6. Final SSMS Communication Strategy for South Sudan Meteorological Department (SSMS), UNEP, Dec 2019
7. Project proposal "Strengthening the capacity of government and communities in South Sudan to adapt to climate change", UNEP, 2018
8. SSMS Strategic Plan 2018 – 2023, (a draft), 2017
9. SSMS Risk Assessment, 2017
10. FISU II ICI project document (development and cooperation project between Finland, Sudan and South Sudan funded by the Finnish Government)

Annex 5 List of Abbreviations

Abbreviation	Full Name
ASL	Above Sea Level
AWS	Automatic Weather Stations
AfDB	African Development Bank
CHD	Country Hydromet Diagnostics
CREWS	Climate Risk and Early Warning Systems
EAC	East African Community
ECMWF	European Centre for Medium-range Weather Forecasts
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EW4all	Early Warnings for all
FAO	Food and Agriculture Organization
GBON	Global Basic Observing Network
GDPFS	Global Data processing and Forecasting System
GISC	Global Information System Centre
ICT	information and communication technologies
ICPAC	IGAD Climate Centre
IGAD	The Intergovernmental Authority on Development
NCAR	National Center for Atmospheric Research
NMHS	National Meteorological and Hydrological Service
NWP	Numerical Weather Prediction
OECD	Organization for Economic Co-operation and Development
RTC	Regional Training Centre
RTH	Regional Telecommunication Hub
SMA	Sudan Meteorological Administration
SOFF	Systematic Observation Funding Facilities
SSCAA	Civil Aviation Authority of South Sudan
SSMS	South Sudan Meteorological Department
TAFOR	Terminal Aerodrome Forecasts
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNICEF	United Nations Children's Fund
WFP	World Food Programme
WMO	World Meteorological Organization