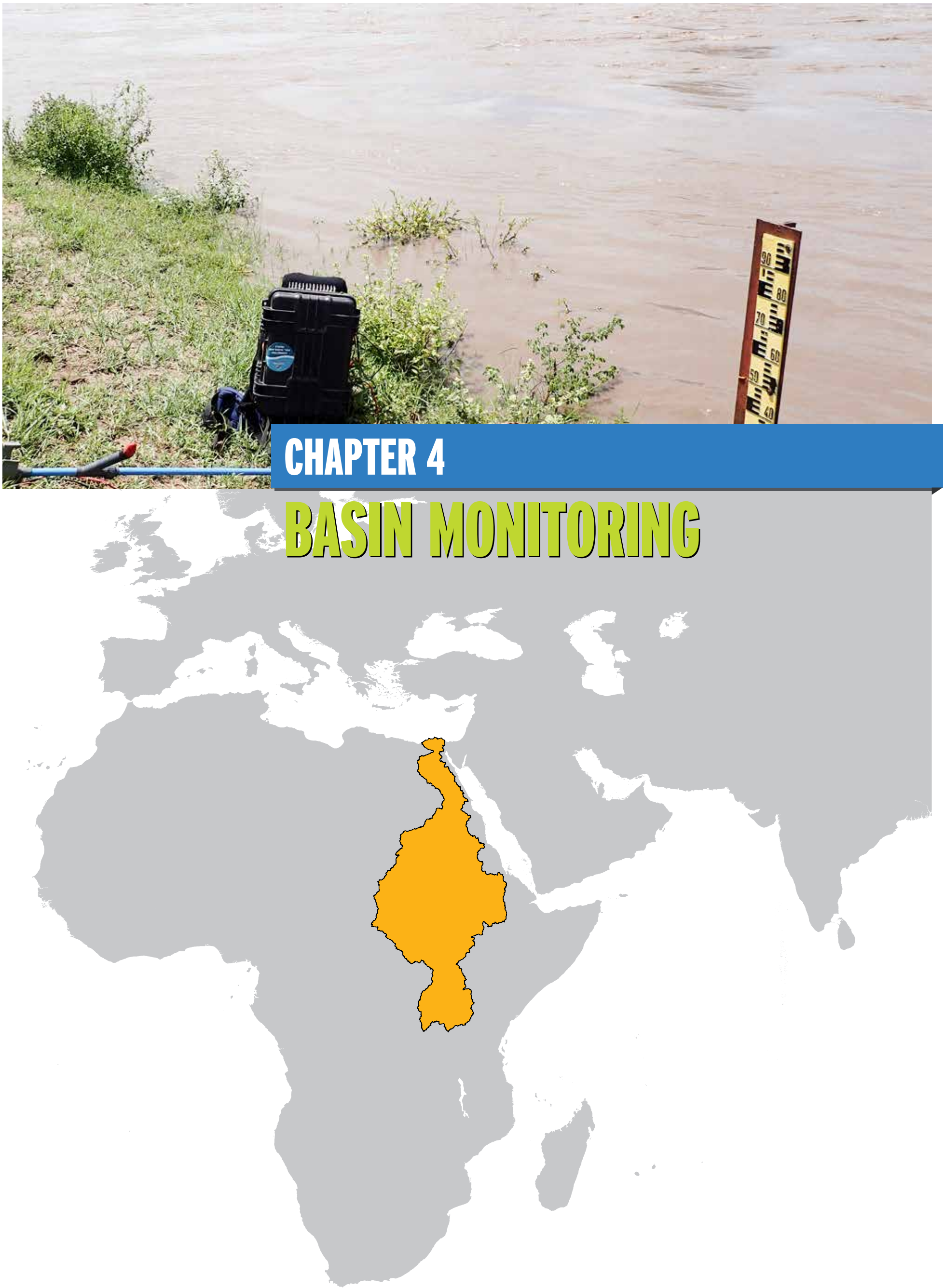



# CHAPTER 4

# BASIN MONITORING

## KEY MESSAGES

There are approximately 928 meteorological and 423 hydrometric stations in the Nile Basin. Over 70 percent of the meteorological stations measure either just daily rainfall totals or rainfall and temperature. Most hydrometric stations measure river or lake water levels. Monitoring of water quality, sediment transport in rivers, and groundwater are at their early stages in most countries. Data transmission from the stations to central data repository in most countries is manual.

The current total number of national monitoring stations in the Nile Basin countries is well below its historical maximum. Staff and financial resources to operate and maintain the complete national network of stations are limited in all countries. Automated data transmission using modern technology is being newly introduced in many countries. In all countries the potential use of data for real-time water resources management is not realized because of a lack of telemetry and data processing and management systems.

There have been national as well as regional initiatives to improve river basin monitoring in the Nile Basin. The Nile Basin Initiative has recently completed the design of a Nile Basin regional Hydromet system. This system will comprise a set of 323 meteorological and 79 hydrometric stations, groundwater and water quality laboratory strengthening and monitoring use of remote sensing for monitoring river basin processes. The system relies on existing monitoring stations to be upgraded to meet the requirements as a regional monitoring network with few new stations added where no current monitoring stations exist. The IGAD-HYCOS is another regional initiative that has supported member countries of the IGAD to upgrade their hydrological monitoring network; some of these stations are in the Nile Basin.

# INTRODUCTION

## Overview

This chapter presents the current state of water resources monitoring in the Nile Basin. The focus of the chapter is primarily on hydro-meteorological monitoring with additional information provided on monitoring of water quality and groundwater. The information in this chapter is based on data compiled by NBI from the riparian countries. No information was available for part of the Nile Basin that lies in Egypt and Eritrea. The monitoring network presented in this chapter includes only those networks that are operated by national agencies for hydrological and meteorological monitoring services. It doesn't include those monitoring stations that are established and operated by specialized agencies for specific purposes.

## Meteorological monitoring

There were 928 meteorological stations in the Nile Basin in the countries surveyed in 2014. Most (674) of these stations measure rainfall only or rainfall and temperature while the rest measure fuller set of meteorological parameters. In addition to the stations that are established and maintained by National Meteorological Services agencies, there are other networks that have been put in place for specific purposes. An example of such special purpose networks is the 19 hydro-meteorological stations that are operated by the Kenyan Flood Diagnostics and Forecasting Centre (FDFC) in the Nzoia and Tana River basins. Such networks are not included in the Atlas.

Overall, basic meteorological variables of precipitation, temperature, relative humidity and evaporation are measured in all countries. Automated weather stations have been introduced in all countries though the distribution and area coverage greatly vary between countries.

Data transmission from the stations in most countries is manual. As can be seen from the table, telemetry is introduced in only five countries, namely, DRC, Ethiopia and Kenya. The telemetry system in DR Congo is part of the SADC- HYCOS.

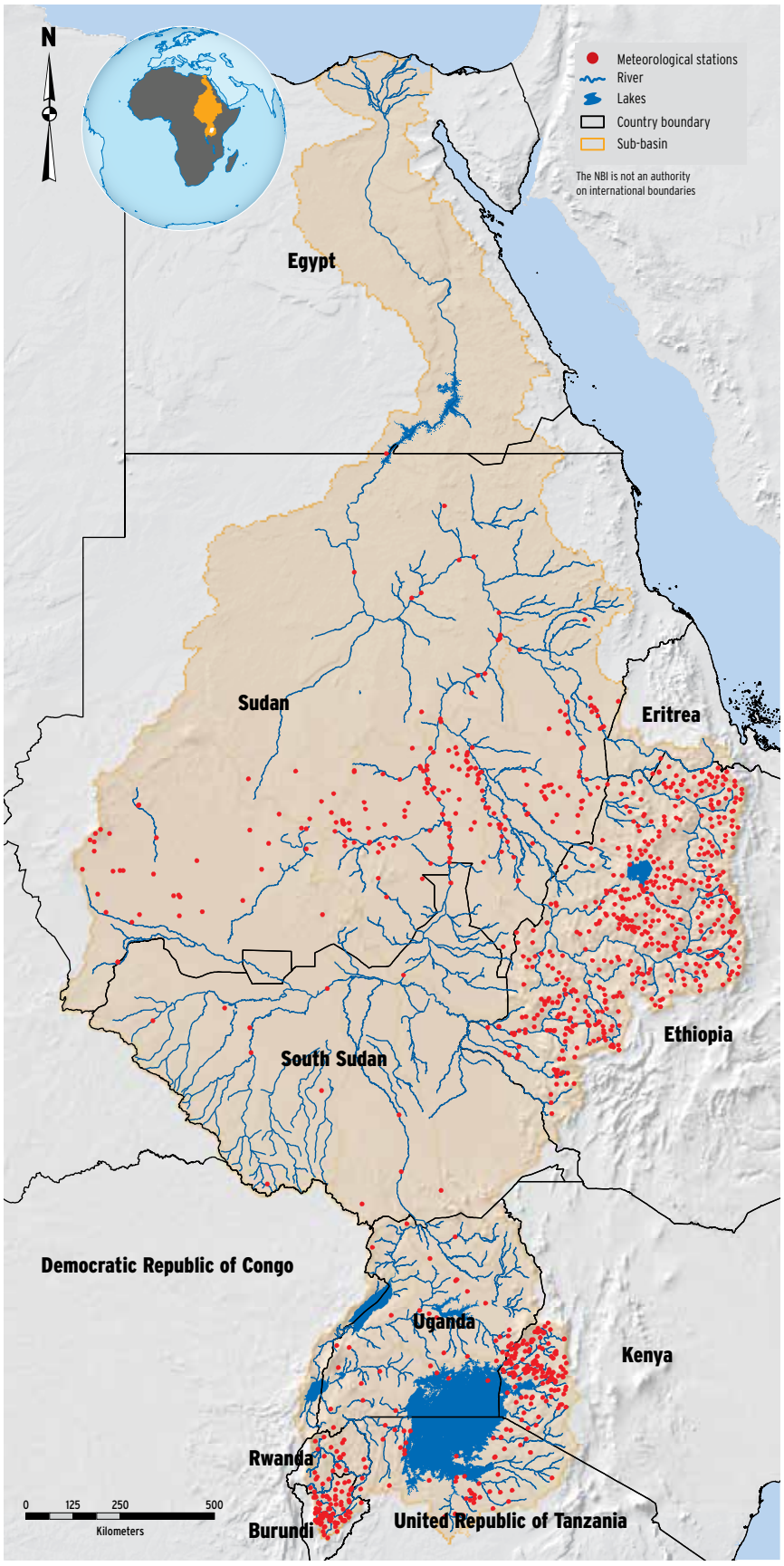



photo: Vivian Nabyonga

Meteorological station at Entebbe, Uganda

**NBI countries, met stations summary**

| Country | Full Met Stations | Rainfall or rainfall and temperature measuring stations |
|---|---|---|
| Burundi | 10 | 21 |
| DR Congo | 3 | 0 |
| Ethiopia | 99 | 397 |
| Kenya | 27 | 104 |
| Rwanda | 24 | 11 |
| South Sudan | 5 | 0 |
| Sudan | 38 | 48 |
| Tanzania | 17 | 25 |
| Uganda | 31 | 68 |
| | 254 | 674 |
| Total | 928 | |

**National institutions responsible for meteorological monitoring**

| Country | Institution | Institution full name |
|---|---|---|
| Burundi | IGEBU | Institut Géographic of Burundi |
| DR Congo | METTELSAT | Agence Nationale de Meteorologie et de Teledetection par Satellite |
| Ethiopia | MOWR | Ministry of Water, Irrigation and Electricity, National Meteorological Services Authority |
| Kenya | MEWNR | Ministry of Environment, Water and Natural Resources |
| Rwanda | MINIRENA | Ministry of Natural Resources |
| South Sudan | MEDIWR | Ministry of Electricity, Dams, Irrigation and Water Resources |
| Sudan | MWRE | Ministry of Water Resources and Electricity |
| Tanzania | TMA | Tanzania Meteorological Agency |
| Uganda | UNMA | Uganda National Meteorological Authority |

**Existing meteorological monitoring capabilities**

| Country | Burundi | DR Congo | Ethiopia | Kenya | Rwanda | South Sudan | Sudan | Tanzania | Uganda |
|---|---|---|---|---|---|---|---|---|---|
| Meteorological | | | | | | | | | |
| Automated stations | Y | N | Y* | Y | Y | Y | Y | Y | Y |
| Telemetry | N | Y | Y | Y | N | N | N | Y | N |
| Precipitation | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Temperature | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Relative humidity | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Evaporation | Y | Y | Y | Y | Y | Y | Y | Y | Y |

"* Capability recently introduced
Note: the Survey didn't include Egypt"

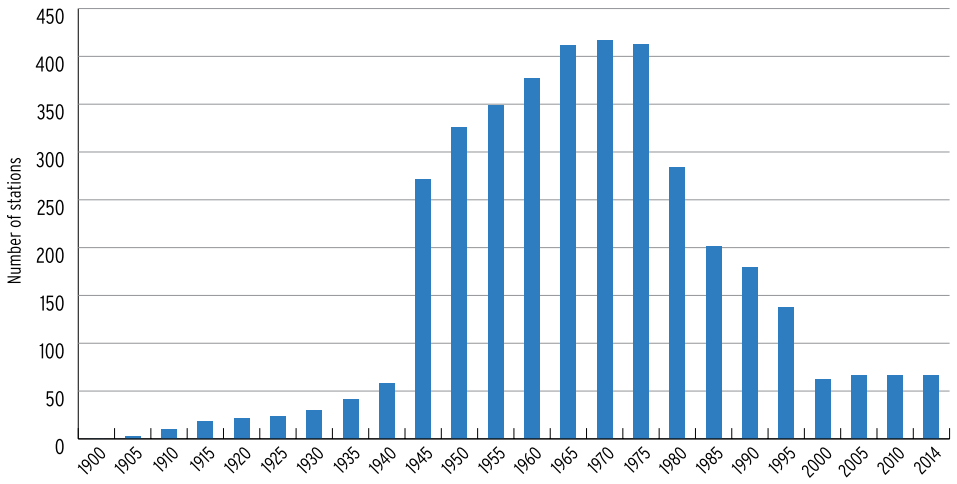
## Historical evolution of meteorological stations

In most countries, meteorological monitoring started in 1900's. The Hydromet Project (1967 – 1992) boosted river basin monitoring in the participating countries, namely, Egypt, DR Congo, Sudan, Uganda, Burundi, and Rwanda. Over the years, however, the number of monitoring stations declined in some of the countries. Charts are provided for Burundi and Uganda to indicate the historical growth and decline in number of meteorological stations for which data was available.

Evaporation pan

Wind vane

Number of meteorological stations in the Nile Basin - Uganda




Number of meteorological stations in the Nile Basin - Burundi

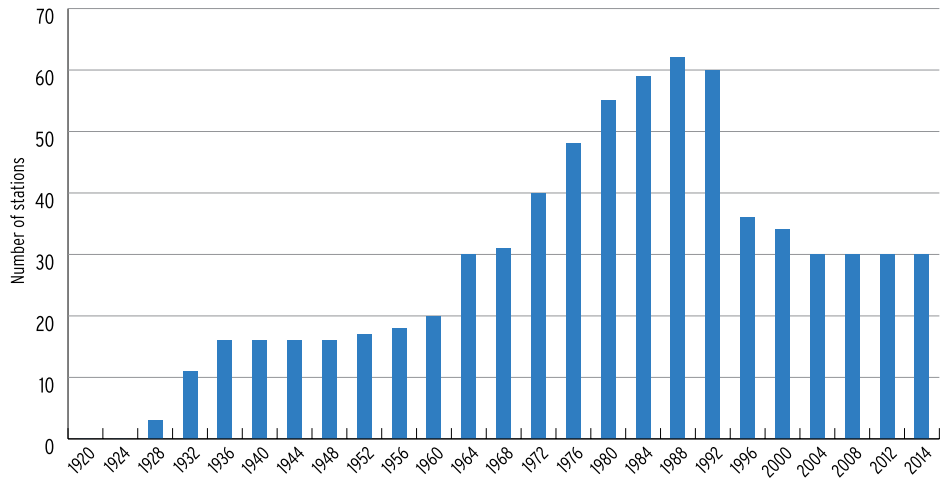



Photo: Nile-SEC

Meteoroligical station at Entebbe, Uganda

## Hydrometric monitoring

Hydrometric monitoring networks are defined as observations networks that primarily measure stream flow related parameters (primarily river/lake water levels and river discharge).

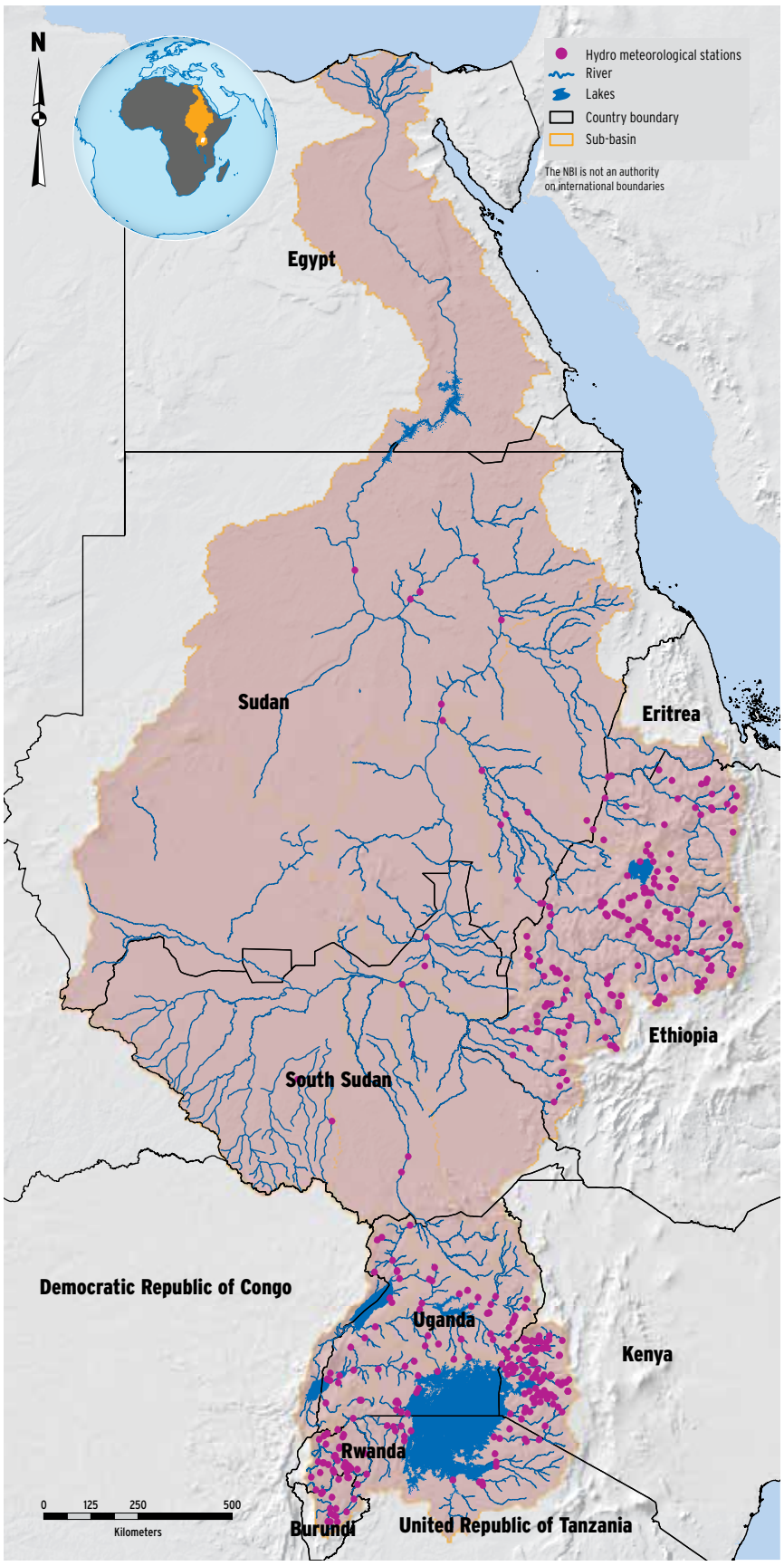
In 2014, there were 427 hydrometric stations in the countries included in the survey. These registered stations primarily measure river/lake water levels and river discharge. In very few stations, suspended sediment load at rivers are measured.

**NBI countries, hydrometric stations summary**

| Country | Hydrometric stations | Country | Hydrometric stations |
|---|---|---|---|
| Burundi | 15 | Sudan | 18 |
| Kagera | 15 | Blue Nile - Lower | 7 |
| DR Congo | 0 | Main Nile | 8 |
| Lake Albert | 0 | Tekeze-Atbara | 3 |
| Ethiopia | 176 | White Nile | 0 |
| Baro-Akobo-Sobat | 27 | Tanzania | 19 |
| Blue-Nile | 126 | Lake Victoria - Kagera | 7 |
| Tekeze-Atbara | 23 | Lake Victoria - Tanzania | 12 |
| Kenya | 93 | Uganda | 66 |
| Lake Victoria | 87 | Bahr el Jebel | 1 |
| Victoria Nile | 6 | Lake Albert | 19 |
| Rwanda | 36 | Lake Victoria -Kagera | 2 |
| Lake Victoria - Kagera | 36 | Lake Victoria -Uganda | 14 |
| South Sudan | 5 | Victoria Nile | 30 |
| Bahr el Ghazal | 1 | | |
| Bahr el Jebel | 2 | | |
| Baro-Akobo-Sobat | 1 | | |
| White Nile | 1 | Total | 428 |

photo: Kiwalbye

River Nyamugasani at Lake Victoria inlet




Most of the gauging stations employ staff gauges as the only instrument for water level measurement. The available capabilities of the countries with respect to hydrometric monitoring are shown in the adjacent table.

Telemetry for automated data transmission has been introduced in Ethiopia, Uganda and Tanzania recently.

Water quality and sediment monitoring is practiced in very few countries, which is clearly a major gap in current monitoring networks in the Nile Basin. In most countries there is not sufficient capability (laboratories, mobile calibration labs, field sampling kits).

In most countries, groundwater monitoring is virtually non-existent. Comparatively, Uganda has the largest groundwater observation network that includes 30 groundwater monitoring stations.

**Existing hydrometric capabilities**

| Hydrometric | Burundi | DR Congo | Ethiopia | Kenya | Rwanda | South Sudan | Sudan | Tanzania | Uganda |
|---|---|---|---|---|---|---|---|---|---|
| Automated stations | Y | N | Y | Y | Y | N | Y | Y | Y |
| Telemetry | N | N | Y* | N | N | N | N | Y* | Y |
| Water level | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Discharge | Y | N | Y | Y | Y | Y | Y | Y | Y |
| Reservoir/Lake level | Y | Y | Y | Y | Y | Y | Y | Y | Y |

"* Capability recently indtroduced
Note: the Survey didn't include Egypt"

**Existing water quality monitoring capabilities**

| Water quality/sediment | Burundi | DR Congo | Ethiopia | Kenya | Rwanda | South Sudan | Sudan | Tanzania | Uganda |
|---|---|---|---|---|---|---|---|---|---|
| Basic water quality | Y | N | Y* | Y | Y | N | Y | Y | Y |
| Special water quality | N | N | N | Y | N | N | Y | N | N |
| Sediment sampling | Y | N | Y | N | N | N | Y | Y | Y |

"* Capability recently indtroduced
Note: the Survey didn't include Egypt"

**Existing groundwater monitoring capabilities**

| Groundwater | Burundi | DR Congo | Ethiopia | Kenya | Rwanda | South Sudan | Sudan | Tanzania | Uganda |
|---|---|---|---|---|---|---|---|---|---|
| Water level | Y | N | Y* | Y | N | N | N | N | Y |
| Water quality | Y | N | Y* | N | Y | N | N | N | N |

"* Capability recently indtroduced
Note: the Survey didn't include Egypt"

The situation with respect to data management and data communication capabilities is shown in adjacent table. None of the countries with the exception of Kenya, Uganda and Tanzania employ systematic data storage and management tools for managing the hydro-meteorological data. Only in few countries, for example in Ethiopia, Uganda, Tanzania telemetry system has been introduced to support near-real time data transmission.

**Existing data management and communication capabilities**

| Data Management / Communication | Burundi | DR Congo | Ethiopia | Kenya | Rwanda | South Sudan | Sudan | Tanzania | Uganda |
|---|---|---|---|---|---|---|---|---|---|
| Coop-data systems | N | N | N | Y | N | N | N | N | N |
| Auto-access | N | N | N | N | N | N | N | N | N |

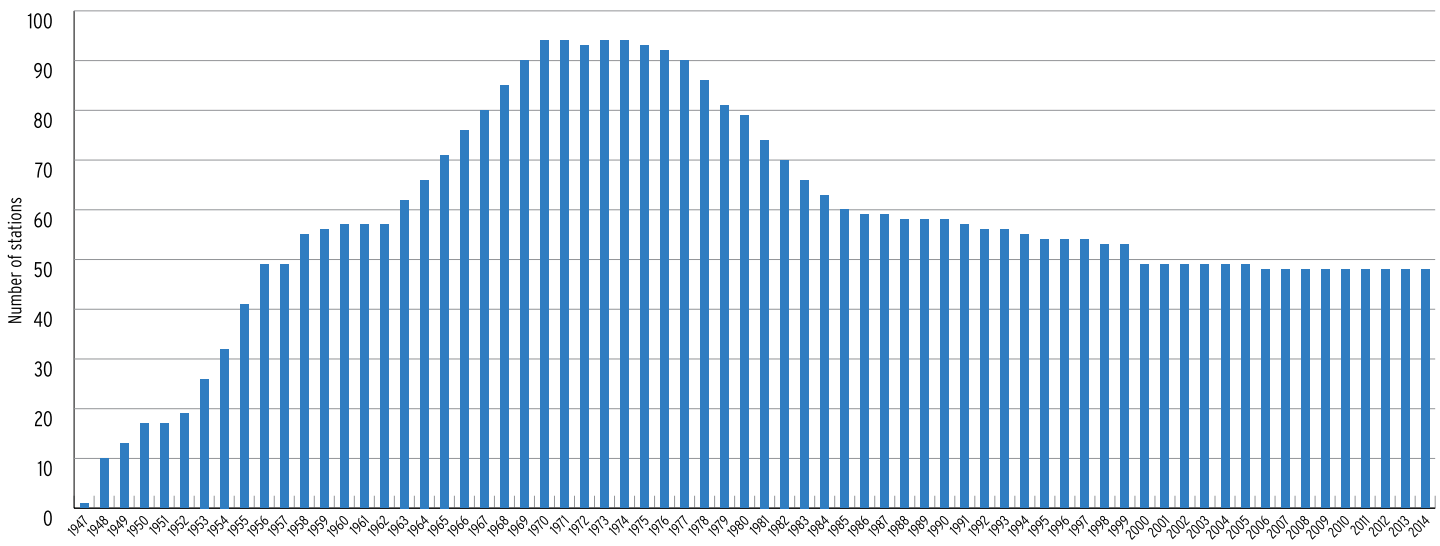
Note: the Survey didn't include Egypt"

## History of hydrometric monitoring stations

Uganda is a typical example of the development in national hydrometric monitorng stations. Expansion took place in the 1950's and lasted up to 1970's after which a decline took place. Presently the numbers seem rather stable, but this does not necessarily reflect an output in terms of a steady flow of reliable data.

The exception is Sudan, where measurement of river flow started as early as 1902. Over the years, there has been a general decline in the number of stations that are kept operational or added to the network. Graphs that show how the number of stations evolved in the last several decades are provided here for those countries for which reliable data have been obtained. It can be observed that the early 1950's and 60's exhibited expansion of the monitoring network as more and more stations were added. The late 1960's and early 1970's showed considerable increase in number of stations due to partly the implementation of the Hydromet project that was a collaboration project between countries: Egypt, DRC, Sudan, Uganda, Burundi, Rwanda.

Number of hydrometric stations - Uganda



# CURRENT MONITORING NETWORK

## The Main Nile Sub-basin

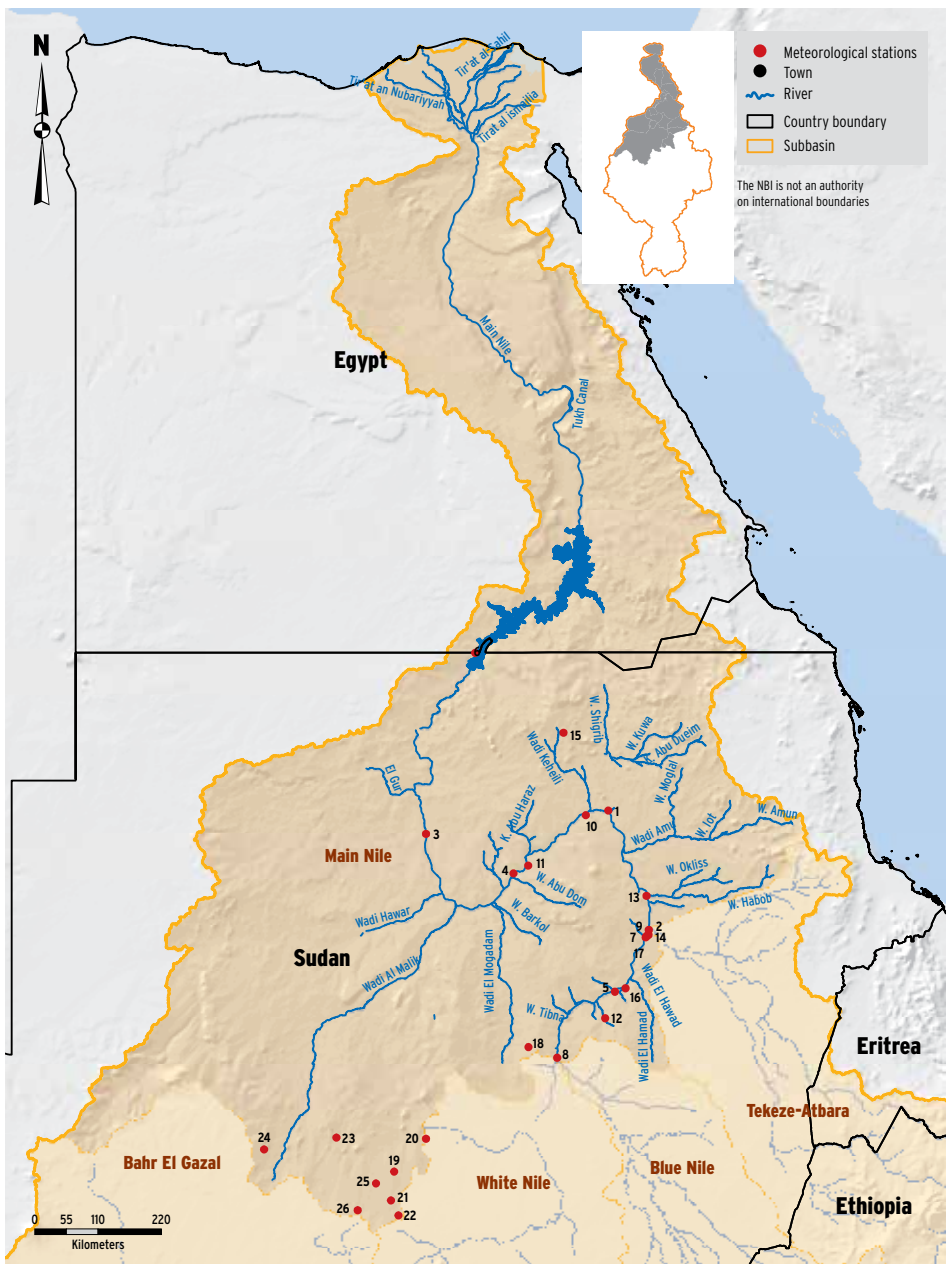
The Main Nile Sub-basin: this sub-basin includes parts of Sudan and Egypt and includes, the Nile Delta, which is one of the most intensively cultivated lands in the world since millennia. The Main Nile sub-basin is the part of the Nile Basin, which receives least amount of rainfall. However, on the other hand, this is the part of Nile Basin which exhibits most of the consumptive water use. It accounts for approximately 80 percent of the total estimated water abstraction from the Nile system for irrigation. In addition, evaporation from the High Aswan and Merowe dams account for about 13 – 14 $10^9 m^3$ of water per year that is approximately 78 percent of all the evaporation from man-made reservoirs basin-wide. With increasing water demands under increased climatic variability, it is crucial to strengthen monitoring of water use patterns and evapo-transpiration in this part of the Nile Basin.

photo: Vivian Nabyonga

Stream gauge

### Meteorological monitoring network

There are 26 meteorological stations in Sudan within the Main Nile sub-basin. The distribution of the stations is shown in the map below. 11 stations are reported to measure the full range of meteorological parameters and the rest 7 measure daily rainfall totals only.

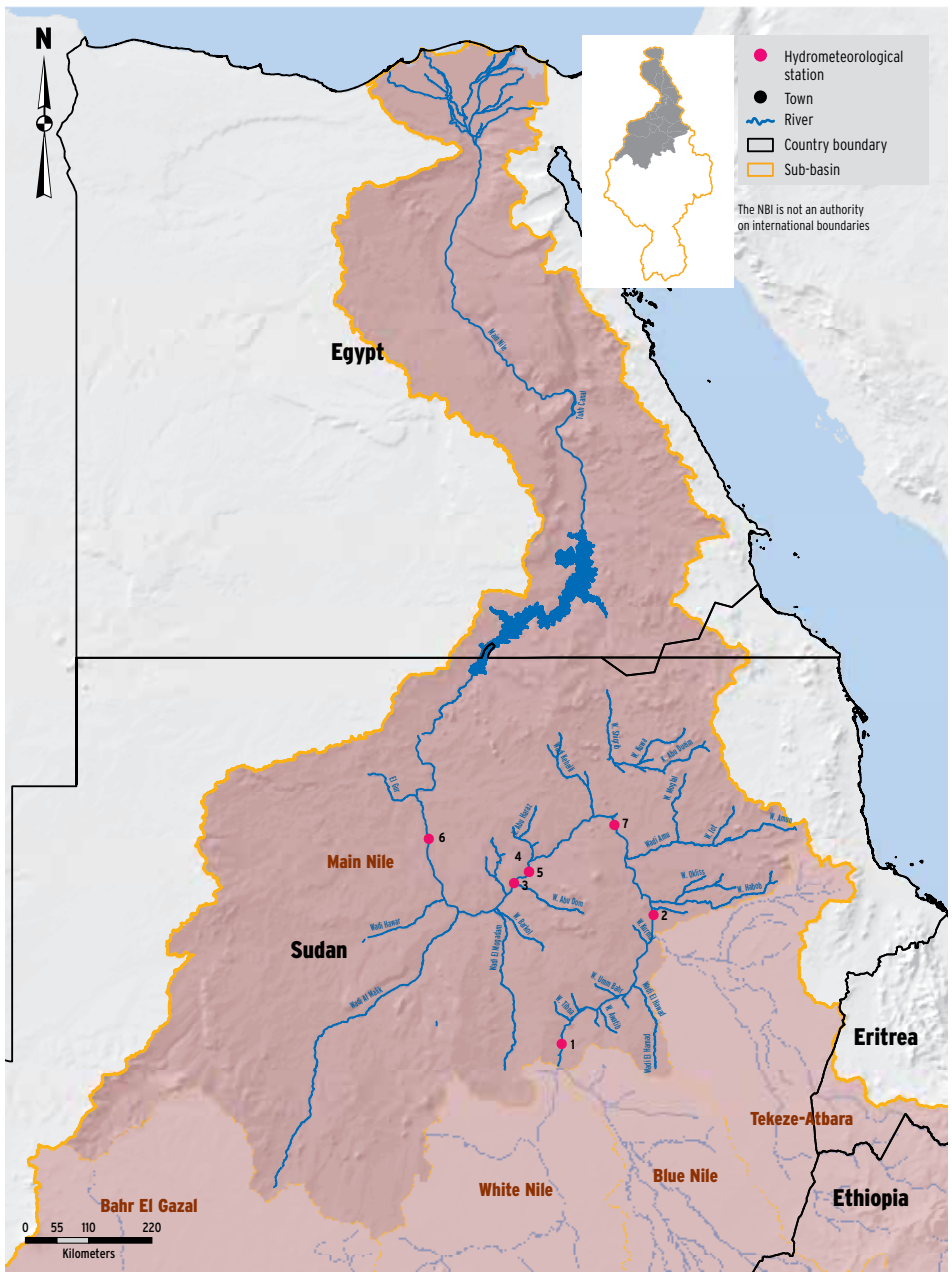



| No | Name of Station |
|---|---|
| 1 | Abu Hammad |
| 2 | El Showak |
| 3 | Dongola |
| 4 | Karima |
| 5 | Shendi |
| 6 | Wadi Halfa |
| 7 | El Hudeiba |
| 8 | Shambat |
| 9 | Eldamer |
| 10 | Gumaiza |
| 11 | Merowe Dam Axis Left Bank |
| 12 | Algoz |
| 13 | Bauga |
| 14 | Damer |
| 15 | Station no.6 |
| 16 | Turagma |
| 17 | Zeidab |
| 18 | Abu hamra |
| 19 | Hamrat Alsheikh |
| 20 | Kogmer |
| 21 | Rabwa Station |
| 22 | Shaboola |
| 23 | Sodari |
| 24 | Um bader |
| 25 | Um Karoam |
| 26 | Goz Ashger |

### Hydrometric stations

There are 8 hydrometric stations in the sub-basin in Sudan. The number of stations in Egypt, i.e. downstream of the High Aswan Dam is not included in the survey results. The oldest station, Main Nile at Thamaniat was established in 1912 and, hence, has over 100 years of records. The ultimate downstream station before the Nile enters the High Aswan Dam is at Dongola, which was established in 1923. Three stations, namely, Tamaniat, Dongola, measure sediment loads in addition to water level and discharge. A new station has been established recently at Merowe dam (commissioned in 2009).

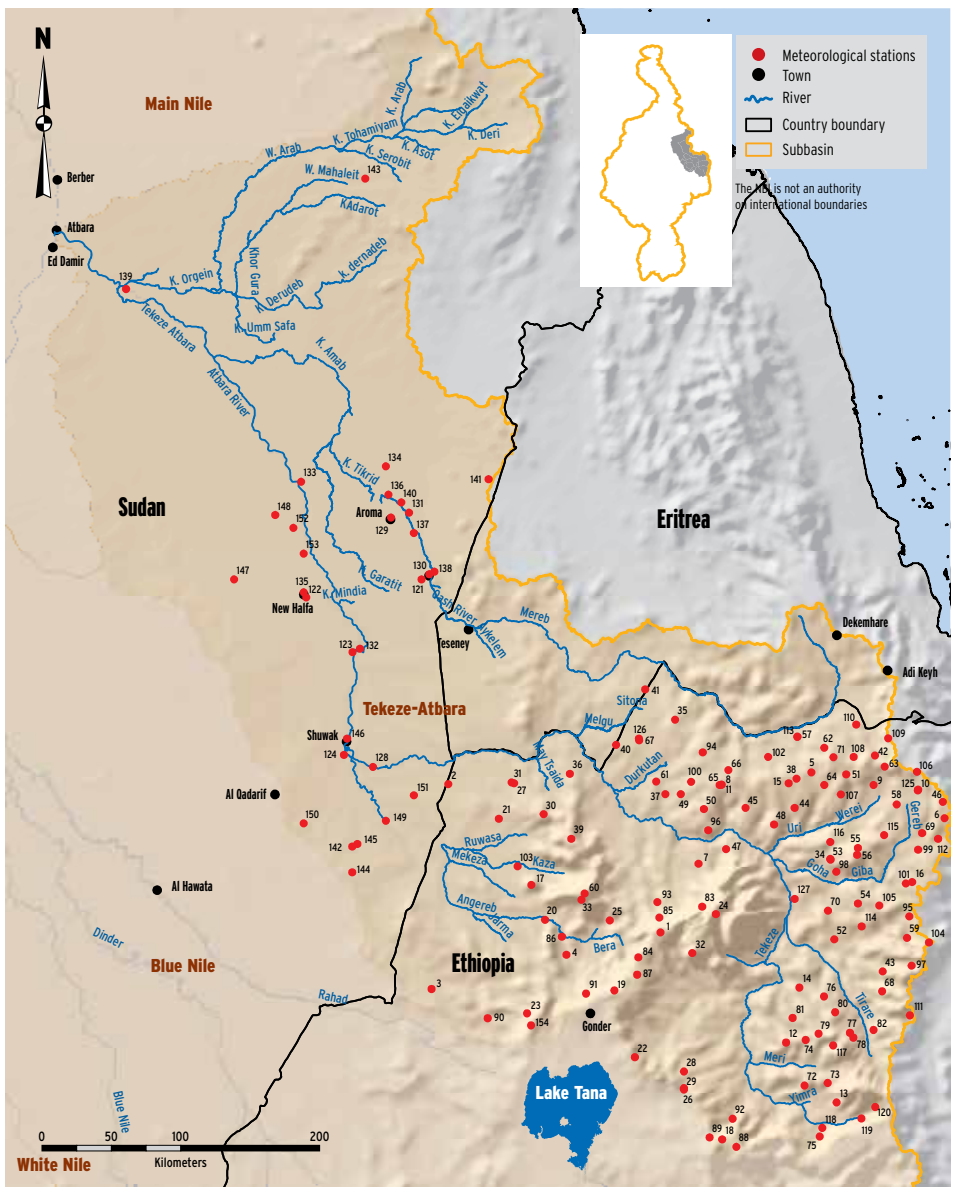
Main issues that require strengthened monitoring in this sub-basin are water quality deterioration, sediment load and sand encroachment and water loss through river bank overflows. Dongola, Tamaniat and Hassanab stations are included in the Nile Basin Regional Hydromet Network with main strengthening required in sediment and water quality monitoring.




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Tamanyat | 3 | Merowe Bridge | 5 | Merowe Dam Axis Upstream | 7 | ElKuru |
| 2 | Barbar | 4 | Merowe Dam Axis Downstream | 6 | Dongola | | |

# The Tekeze–Atbara Sub-basin

The Tekeze-Atbara Sub-basin: the Tekeze-Atbara drains the highlands of central – north Ethiopia. Its main rivers are the Tekeze (also known as Setit in its lower reaches), Gwang and Atbara, which constitutes the ultimate downstream river reaches. The long-term average annual water yield of the sub-basin is approximately 12  $10^9$ $m^3$. The rivers are highly seasonal in their flows. The rivers are used to supply water for hydropower generation and irrigation. There are three dams in the sub-basin, the TK5 in Ethiopia (commissioned in 2009), Khashm el Girba in Sudan (commissioned in 1964) and the Atbara dam complex (also known as Rumela-Burdana dam, not yet operational).

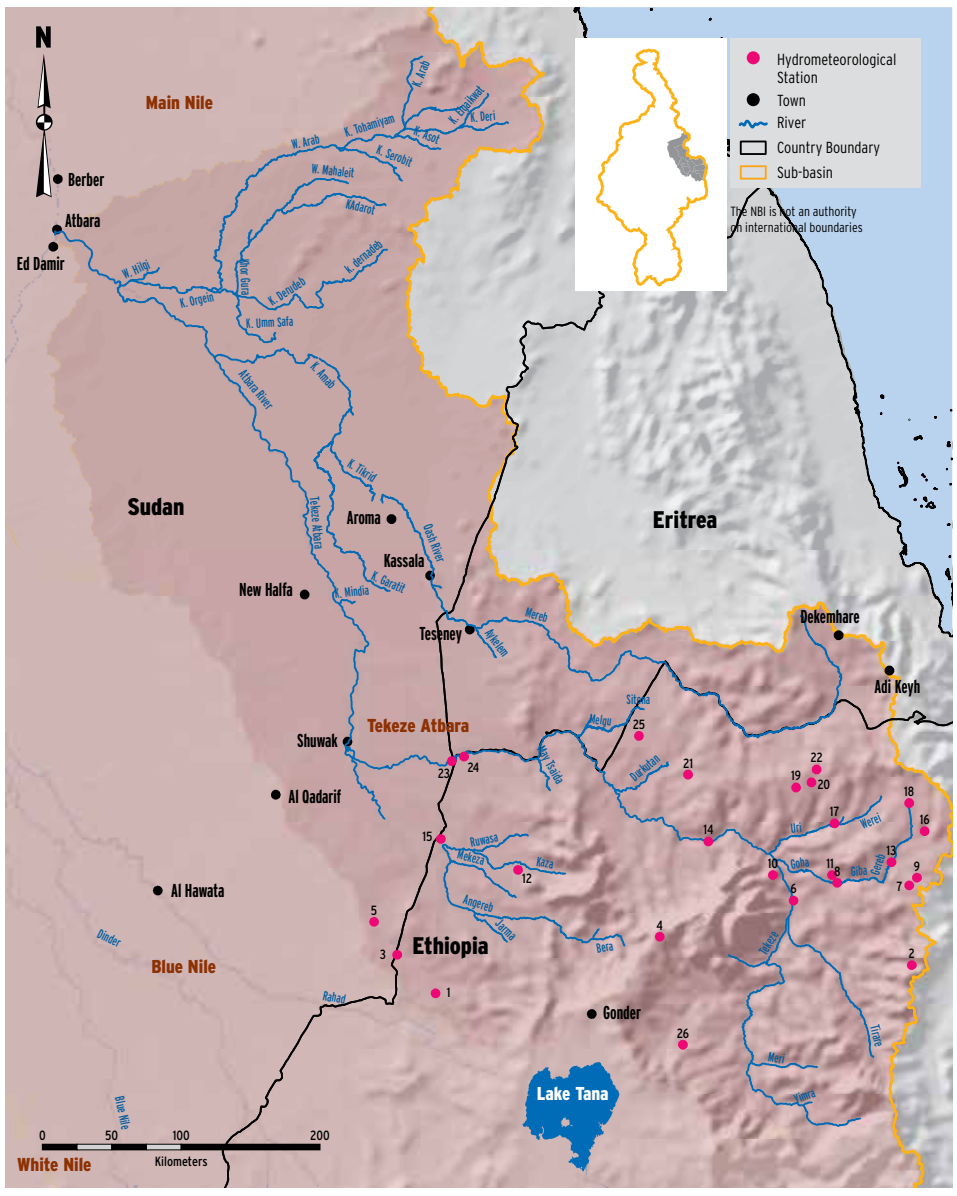



## Meteorological monitoring network

There are 136 meteorological stations in the sub-basin, with 128 of them in Ethiopia and 8 in Sudan.  The distribution of the stations is shown in the map. 30 stations (26 in Ethiopia and 4 in Sudan) are reported to measure the full range of meteorological parameters and the rest 106 measure daily rainfall totals only.

Wind vane photo: Nile-SEC

| No | Name of Station |
|---|---|
| 1 | Debark |
| 2 | Humera |
| 3 | Metema |
| 4 | Sanja |
| 5 | Adwa |
| 6 | Atsebi |
| 7 | May Tsebri |
| 8 | Maygaba |
| 9 | Nebelet |
| 10 | Senkata |
| 11 | Shire Endasilasse |
| 12 | Amde Work |
| 13 | Lalibela |
| 14 | Tsitsika |
| 15 | Axum Air Port |
| 16 | Mekele Air Port |
| 17 | Adi Arkay |
| 18 | Agere Genet |
| 19 | Ambagiorgis |
| 20 | Ashere |
| 21 | Baeker |
| 22 | Belesa (Hamusit) |
| 23 | Chanchok |
| 24 | Chenek |
| 25 | Chew Ber |
| 26 | Ebinat |
| 27 | Endris |
| 28 | Guhala |
| 29 | Ibnat |
| 30 | Kafta |
| 31 | Mykadra |
| 32 | Mekane Birhane |
| 33 | Tegdie (Kirakir) |
| 34 | Abi Adi |
| 35 | Adiawala |
| 36 | Adigoshu |
| 37 | Adikilte |
| 38 | Adimehemeday |
| 39 | Adiremets |
| 40 | Aditsetser |
| 41 | Badme |
| 42 | Biezet |
| 43 | Bora |
| 44 | Daro Hafash |
| 45 | Debrekerbe |
| 46 | Dera |
| 47 | Dimma |
| 48 | Edaga Selus |
| 49 | Edaga Hibret |
| 50 | Endabaguna |
| 51 | Feresmay |
| 52 | Finarawa |
| 53 | Gelebeda |
| 54 | Gijjet |
| 55 | Gururo |
| 56 | Hagere Selam |
| 57 | Halelo |
| 58 | Hawzen |
| 59 | Hewane |
| 60 | Ketema Negus |
| 61 | Mayhanes |
| 62 | Merhsenay |
| 63 | Muglat |
| 64 | Rahya |
| 65 | Selehelehe (IV) |
| 66 | Semema |
| 67 | Shiraro |
| 68 | Wedisemro |
| 69 | Wukuro |
| 70 | Yichila |
| 71 | Yiha |
| 72 | Ayna Bugna |
| 73 | Belebala Giyorgis |
| 74 | Chilla |
| 75 | Dibiko |
| 76 | Esrel (Libanos) |
| 77 | Gibana |
| 78 | Hamusit |
| 79 | Kewzeba |
| 80 | Sekota |
| 81 | Telajen/Hamusit |
| 82 | Zata |
| 83 | Adidaro |
| 84 | Dabat |
| 85 | Dib Bahir |
| 86 | Felwuha |
| 87 | Gedebeye |
| 88 | Gobgob |
| 89 | Kimir Dingay |
| 90 | Negadebaher |
| 91 | Tikil Dengay |
| 92 | Welela bahir |
| 93 | Zerma |
| 94 | Adidaro |
| 95 | Adigudom |
| 96 | Adigebru |
| 97 | Adishehu |
| 98 | Agibe |
| 99 | Agulai |
| 100 | Asegede |
| 101 | Aynalem |
| 102 | Chila |
| 103 | Dansha |
| 104 | Debud |
| 105 | Dengolet |
| 106 | Edaga Hamus |
| 107 | Edagaribi |
| 108 | Enticho |
| 109 | Fatsi |
| 110 | Gerehu Srnay |
| 111 | Hashenge |
| 112 | Haykmshal |
| 113 | Rama |
| 114 | Samre |
| 115 | Tsegereda |
| 116 | Workamba |
| 117 | Asketema |
| 118 | Dabo Ketema |
| 119 | Kulmesk |
| 120 | Muja |
| 121 | Kassala |
| 122 | New Halfa |
| 123 | Khashm Elgirba |
| 124 | Elshwak |
| 125 | Fireweini |
| 126 | Shiraro |
| 127 | Tekeze Hydro power |
| 128 | Wad alheleo |
| 129 | Aroma |
| 130 | Banrt |
| 131 | Degen |
| 132 | Gashm algerba |
| 133 | Goz Ragab |
| 134 | Hadalia |
| 135 | Halfa Elgadida |
| 136 | Matateb |
| 137 | Mekali |
| 138 | Mokram |
| 139 | Sidon |
| 140 | Tendalayi |
| 141 | Togan |
| 142 | Tomorgu |
| 143 | Barbar |
| 144 | Doka |
| 145 | ElGuraish |
| 146 | Showak |
| 147 | Elazaza North |
| 148 | Es salama |
| 149 | Hillat Hakuma |
| 150 | shasheina |
| 151 | Um brakeit |
| 152 | Um Grgor |
| 153 | Um Rahau |
| 154 | Aykel |




## Hydrometric stations

there are 26 hydrometric stations in the sub-basin; 23 in Ethiopia and the rest 3 in Sudan. The oldest station, Atbara near Kilo 3 was established in 1923. Most stations in Ethiopia were established after the mid 1970's. All stations measure river water level with most stations employing manual staff gauges while 8 stations in the upstream part are equipped with automatic water level recorders. Erosion and sediment transport are key processes in the sub-basin but not adequately monitored.

Strengthening sediment monitoring is one of the key areas for improving the monitoring system in the sub-basin.

The rivers in this sub-basin are highly seasonal and water resources are scarce

compared to the current and anticipated future demands. Therefore, coordinated management of storage dams in Ethiopia and Sudan would help in reducing losses, and maximizing water use efficiency. For this purpose, a real-time data collection and communication system is required to support future coordinated management of water storage dams in Ethiopia and Sudan.

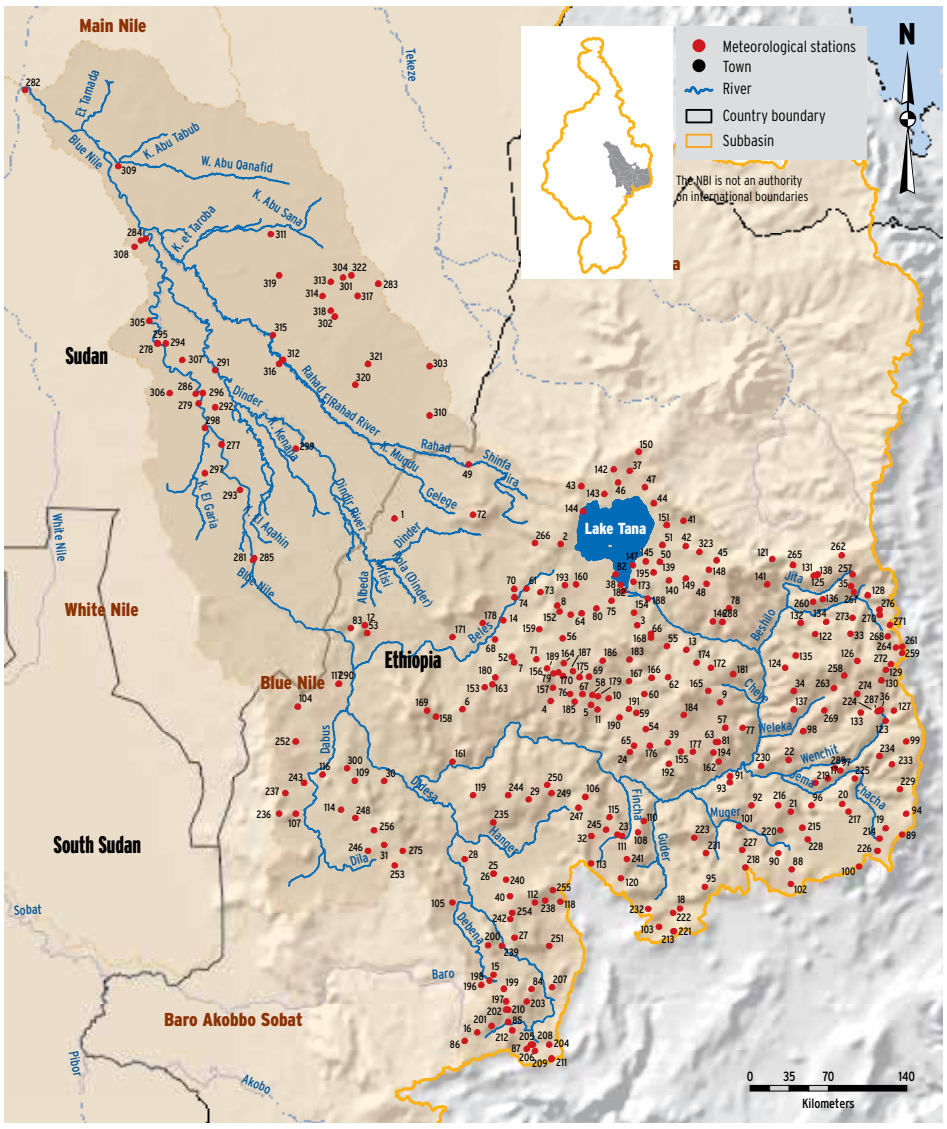
| No | Name |
|---|---|
| 1 | Gendawoha near Kokit |
| 2 | Atsela near Adishihu |
| 3 | Goang near Metema |
| 4 | Asera near Debark |
| 5 | Al Asira |
| 6 | Tekeze near Yechila |
| 7 | Metere near Ainalem |
| 8 | Gheba near Adi Kumsi |
| 9 | Dolo near Quiha |
| 10 | Buya near Maitsemri |
| 11 | Illala near Mekele |
| 12 | Mekezo near Dansha |
| 13 | Gheba near Mekele |
| 14 | Tekeze near Embamadre |
| 15 | Angareb near Abdi Rafi |
| 16 | Genfel at Wukro |
| 17 | Worie near Maikenetal |
| 18 | Sulluh near Hawsien |
| 19 | Ayehida near Axum |
| 20 | Maimidimar near Adwa |
| 21 | Sebtta near Adidahiro |
| 22 | Maidungur near Adwa |
| 23 | Hamdait |
| 24 | Tekeze at Humera |
| 25 | Molge near Shiraro |
| 26 | Zarema at Zarema |

# The Blue Nile Sub-basin

The Blue Nile river (known as Abbay in Ethiopia) drains the highlands of Ethiopia and contributes about 60 per cent of the annual flow of the Nile measured at Aswan in Egypt. The long-term average annual water yield of the sub-basin is approximately 50 BCM. The Blue Nile is highly seasonal with approximately 70 percent of its annual flow occurring in just 4 months. The Blue Nile is source of water for major irrigation schemes in the Sudan. The Blue Nile causes severe flood damages in Sudan from time to time. The Grand Ethiopian Renaissance Dam (GERD) is under construction on the Blue Nile designed to store some 74 $10^9 m^3$. With the GERD in place, the Blue Nile will be fully regulated and its downstream flow depends on releases from the dam. This is expected to reduce flood damages significantly. There are opportunities for cross border collaboration on the coordinated management of the Blue Nile in which joint monitoring of river flows is an important component.

## Meteorological monitoring network

There are 304 meteorological stations in the sub-basin, with 286 of them in Ethiopia and 18 in Sudan. The distribution of the stations is shown in the map below. 64 stations (53 in Ethiopia and 11 in Sudan) are reported to measure the full range of meteorological parameters and the rest 106 measure daily rainfall totals only.




| No | Station |
|---|---|
| 1 | Quara |
| 2 | Shahura |
| 3 | Adet |
| 4 | Ayehu |
| 5 | Birr Sheleko |
| 6 | Bullen |
| 7 | Chagni |
| 8 | Dangila |
| 9 | Debre Work |
| 10 | Finoteselam |
| 11 | Lay Birr |
| 12 | Mankush |
| 13 | Motta |
| 14 | Pawe |
| 15 | Bedele |
| 16 | Gatira |
| 17 | Alem Ketema |
| 18 | Ambo Agriculture |
| 19 | Debre Berhan |
| 20 | Eneware |
| 21 | Fiche |
| 22 | Gunde Meskel |
| 23 | Kachise |
| 24 | Mehal Meda |
| 25 | Angerguten |
| 26 | Anger |
| 27 | Arjo |
| 28 | Dedessa |
| 29 | Gidayana |
| 30 | Kamashe |
| 31 | Nedjo |
| 32 | Shambu |
| 33 | Amba Mariam |
| 34 | Mekane Selam |
| 35 | Wegel Tena |
| 36 | Wereilu |
| 37 | Gondar A.p. |
| 38 | Bahir Dar New |
| 39 | Debre Markos |
| 40 | Nekemte |
| 41 | Addis Zemen |
| 42 | Amed Ber |
| 43 | Chandiba |
| 44 | Enfranz |
| 45 | Gassay |
| 46 | Kolladiba |
| 47 | Maksegnit |
| 48 | Mekaneyesus |
| 49 | Shinfa |
| 50 | Wanzaye |
| 51 | Wereta (Add) |
| 52 | Addis Kidame |
| 53 | Almahal |
| 54 | Amanueal |
| 55 | Asteriyo |
| 56 | Bambudi |
| 57 | Bichena |
| 58 | Bure |
| 59 | Dembecha |
| 60 | Dengay Ber |
| 61 | Dengel Ber |
| 62 | Digua Tsion (Bibugn) |
| 63 | Dimma |
| 64 | Durbet |
| 65 | Elias |
| 66 | Fasiledes |
| 67 | Finoteselam |
| 68 | Gilgelbeles |
| 69 | Gundil |
| 70 | Jawi |
| 71 | Kidamaja |
| 72 | Kunzila |
| 73 | Liben |
| 74 | Mandura |
| 75 | Merawi |
| 76 | Shandi |
| 77 | Shebelberenta (Yeduha) |
| 78 | Simada |
| 79 | Wegedade |
| 80 | Wetet Abay |
| 81 | Yetemen |
| 82 | Zege |
| 83 | Zela (Yarienja) |
| 84 | Boreka |
| 85 | Dembi |
| 86 | Sigmo |
| 87 | Agaro |
| 88 | Chancho |
| 89 | Debele |
| 90 | Derba |
| 91 | Filiklik |
| 92 | Gebere Guracha |
| 93 | Gohatsion |
| 94 | Gudoberet |
| 95 | Jeldu |
| 96 | Lemi |
| 97 | Meragna |
| 98 | Rema |
| 99 | Sarmider |
| 100 | Sheno |
| 101 | Siadebr |
| 102 | Sululta |
| 103 | Tikur Enchine |
| 104 | Abadi |
| 105 | Abasina Joger |
| 106 | Alibo |
| 107 | Bambase |
| 108 | Combolcha |
| 109 | Dalaty |
| 110 | Embabo |
| 111 | Fincha |
| 112 | Gutten |
| 113 | Hareto |
| 114 | Mendi |
| 115 | Neshi |
| 116 | Odda Bildigulu |
| 117 | Sherekole |
| 118 | Sibusire |
| 119 | Uke |
| 120 | Wayu |
| 121 | Debre Zebit |
| 122 | Debre Zeit |
| 123 | Degollo |
| 124 | Densa |
| 125 | Gashena |
| 126 | Gimba |
| 127 | Gishe Rabel |
| 128 | Gishen |
| 129 | Guguftu |
| 130 | Kabie |
| 131 | Kone |
| 132 | Koreb |
| 133 | Ligwama |
| 134 | Masha |
| 135 | Saynt Adjibar |
| 136 | Shoga |
| 137 | Wegidi |
| 138 | Kon Abo |
| 139 | Ambesame |
| 140 | Arb Gebeya (Dera) |
| 141 | Arb Gebeya (Gaint) |
| 142 | Aymba |
| 143 | Chewahit |
| 144 | Delgi |
| 145 | Dera Hamusite |
| 146 | Koma Fasiledos |
| 147 | Korata |
| 148 | Lewaye |
| 149 | Licha |
| 150 | Shembekit |
| 151 | Yifag |
| 152 | Abay Sheleko |
| 153 | Addis Alem |
| 154 | Andassa |
| 155 | Aneded (Amber) |
| 156 | Askuna |
| 157 | Azana |
| 158 | Baruda |
| 159 | Chara |
| 160 | Chimba |
| 161 | Debre Zeit |
| 162 | Dejen |
| 163 | Dibate |
| 164 | Enjabara |
| 165 | Felege Berhan |
| 166 | Feres Bet |
| 167 | Genetabo |
| 168 | Geregera |
| 169 | Gesengessa |
| 170 | Gimijabet Mariam |
| 171 | Gulback |
| 172 | Gundo Woin |
| 173 | Kembaba |
| 174 | Keranio |
| 175 | Kessa |
| 176 | Kuy |
| 177 | Lumamme |
| 178 | Mambuk |
| 179 | Mankusa |
| 180 | Menta Wuha |
| 181 | Merto Lemariam |
| 182 | Meshenti |
| 183 | Quarit |
| 184 | Rob Gebeya |
| 185 | Sebader |
| 186 | Sekela |
| 187 | Tilili |
| 188 | Tis Abay |
| 189 | Urana |
| 190 | Wadeyesus |
| 191 | Yechereka |
| 192 | Yejube |
| 193 | Yesemala |
| 194 | Yetnora |
| 195 | Zenzelema |
| 196 | Abdela |
| 197 | Bido |
| 198 | Debena |
| 199 | Gechi |
| 200 | Kone |
| 201 | Setema |
| 202 | Yambero |
| 203 | Yanfa |
| 204 | Babu |
| 205 | Boto |
| 206 | Choche |
| 207 | Dame |
| 208 | Gembe |
| 209 | Semodo |
| 210 | Setema |
| 211 | Somodo |
| 212 | Toba |
| 213 | Arb Bila |
| 214 | Chacha |
| 215 | Debre Tsige |
| 216 | Degem |
| 217 | Deneba |
| 218 | Enchini |
| 219 | Fetra |
| 220 | Fital |
| 221 | Gimbi Bila |
| 222 | Gubre |
| 223 | Harodoyo |
| 224 | Jara |
| 225 | Jihur |
| 226 | Kotu |
| 227 | Muger |
| 228 | Muke Turi |
| 229 | Seladingai |
| 230 | Serkulla |
| 231 | Shekute |
| 232 | Toke Erenso |
| 233 | Wegere |
| 234 | Zemro |
| 235 | Agallo Mitti |
| 236 | Amba 10 |
| 237 | Amba 16 |
| 238 | Arbgebeya |
| 239 | Dedessa River |
| 240 | Ehud Gebeya |
| 241 | Gebete |
| 242 | Getema |
| 243 | Gizen |
| 244 | Haro |
| 245 | Homi |
| 246 | Jarso |
| 247 | Jermet |
| 248 | Kiltukara |
| 249 | Kiramu |
| 250 | Kokeffe |
| 251 | Kone |
| 252 | Menge |
| 253 | Mukelemi |
| 254 | Muletadiga |
| 255 | Sasiga |
| 256 | Werejiru |
| 257 | Ajibar (Add) |
| 258 | Akesta |
| 259 | Ancharo |
| 260 | Dawunt (Chet) |
| 261 | Dessie Zuria Met |
| 262 | Estayish |
| 263 | Genete Sch |
| 264 | Gerado |
| 265 | Geregera |
| 266 | Gobiye |
| 267 | Gosh-Meda |
| 268 | Kelem Meda |
| 269 | Kellela |
| 270 | Kundi |
| 271 | Kutaber |
| 272 | Tebasit |
| 273 | Tenta Tateke Sch |
| 274 | Wein-Amba |
| 275 | Hena |
| 276 | Teleyayen |
| 277 | Abu Naama |
| 278 | Sennar |
| 279 | Umm Benin |
| 280 | Wad Medani |
| 281 | Ed Damazine |
| 282 | Khartoum |
| 283 | El Gadaref |
| 284 | Elgezira |
| 285 | Roseires |
| 286 | Singa |
| 287 | Cheffa |
| 288 | Simada |
| 289 | Yetenora |
| 290 | Sher. Gizen (W) |
| 291 | Dendar |
| 292 | Dender |
| 293 | Karkoj |
| 294 | Kassab |
| 295 | Sennar Town |
| 296 | Singa |
| 297 | Tozi |
| 298 | Ubhugar |
| 299 | Wad Alneal |
| 300 | Abu Kshma |
| 301 | Abu Sharaba |
| 302 | Almatna |
| 303 | Kagai |
| 304 | Leiya |
| 305 | Hugerat |
| 306 | Rabak |
| 307 | Ummsigan |
| 308 | Wad En Na'em |
| 309 | Wd Alkali |
| 310 | Basunda |
| 311 | Elfaw |
| 312 | Elhawata |
| 313 | G.enahal |
| 314 | Gadamblyia |
| 315 | Mafaza |
| 316 | W.eshaair |
| 317 | Elhory |
| 318 | Elmetna |
| 319 | Gadamblyia South |
| 320 | Samsam |
| 321 | Um Blail |
| 322 | Um Leiyon |
| 323 | Debre Tabor |

## Hydrometric stations

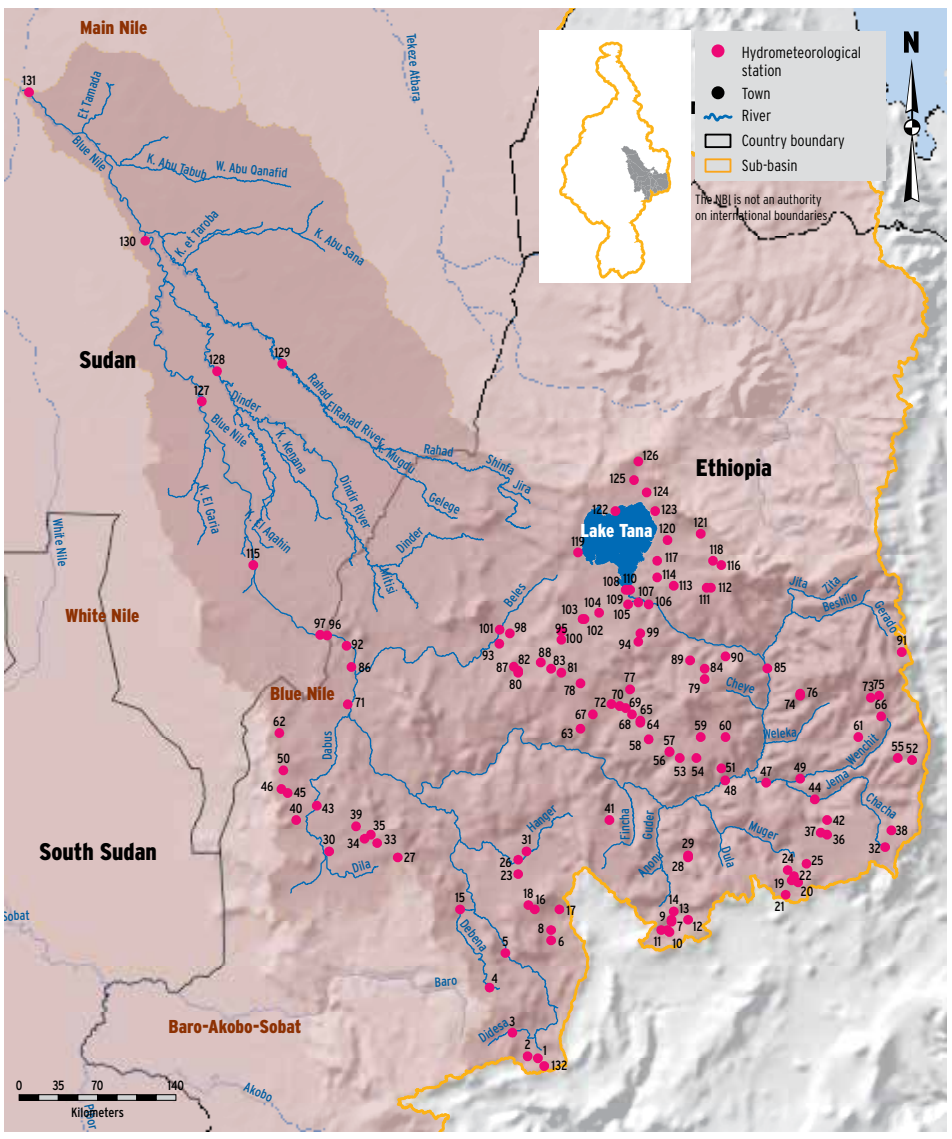
There are 133 hydrometric stations in the sub-basin; 126 in Ethiopia and the remaining seven in Sudan. The station just downstream of Ethiopia – Sudan border, the Diem station, has a record of over 100 years and, therefore, one of the most important. However, is due to the recent heightening of the Roseries Dam in Sudan, the station at times get inundated by the back-water of the dam. Most stations in Ethiopia were established in the early 1960's. Erosion and sediment transport are also key processes in the sub-basin but not adequately monitored.

The Blue Nile sub-basin offers one of the greatest opportunities for hydropower development in the Nile Basin. In addition, providing over 60 percent of the average annual flow of the Nile, the Blue Nile is the major source of water for the Nile. Key focus in strengthening of hydrometric

photo: Nile-SEC

Ground water level monitoring station

monitoring system shall be on real-time data collection and transmission system, sediment monitoring and monitoring of river morphological changes downstream as a result of anticipated flow regimes in the sub-basin.




| No | Station |
|---|---|
| 1 | Urgessa near Gembe |
| 2 | Temsa near Agaro |
| 3 | Didessa near Dembi |
| 4 | Dabana near Bunobedele |
| 5 | Didessa near Arjo |
| 6 | Wama near Nekemte |
| 7 | Melke near Guder |
| 8 | Sifa near Nekemte |
| 9 | Bello near Guder |
| 10 | Fatto near Guder |
| 11 | Indris at Guder |
| 12 | Guder at Guder |
| 13 | Huluka near Ambo |
| 14 | Debis nearGuder |
| 15 | Dabana near Abasina |
| 16 | Tato near Gutie |
| 17 | Indris near Sire |
| 18 | Adiya near Nekemte |
| 19 | Gerbi near Sululta |
| 20 | Roba near Chancho |
| 21 | Deneba near Chancho |
| 22 | Mugher near Chancho |
| 23 | Uke near Nekemte |
| 24 | Aleltu near Chancho |
| 25 | Gorfo near Gorfo |
| 26 | Angar near Nekemte |
| 27 | Dilla near Nedjo |
| 28 | Tinshu Duber near Duber |
| 29 | Tilku Duber near Duber |
| 30 | Aleltu at Nedjo |
| 31 | Little Ang at Angar Gutin |
| 32 | Chacha at Chacha |
| 33 | Komis near Gori |
| 34 | Koriche near Kiltu Kara |
| 35 | Hujur near Nedjo |
| 36 | Robi Jida near Muka Ture |
| 37 | Aleltu near Muka Ture |
| 38 | Beressa near Debre Berhan |
| 39 | Sechi nearMendi |
| 40 | Mutsa near Bambasi |
| 41 | Neshi near Shambo |
| 42 | Robigumero near Lemi |
| 43 | Dabus near Asosa |
| 44 | Jemma near Lemi |
| 45 | Haffa near Assosa |
| 46 | Gambella near Asossa |
| 47 | Jemma at Abay Confluence |
| 48 | Abay at Kessi Bridge |
| 49 | Wenchit near Alem Ketema |
| 50 | Hoha near Asossa |
| 51 | Muga near Dejen |
| 52 | Wizer near Mehal Meda |
| 53 | Yeda near Amber |
| 54 | Bogena at Lumame |
| 55 | Shy near Mehal Meda |
| 56 | Chemoga near Debremarkos |
| 57 | Abahim at Debremarcos |
| 58 | Jedeb near Ama Nuel |
| 59 | Teme near Mota |
| 60 | Suha near Bichena |
| 61 | Gebregura. near Degolo |
| 62 | Shelkole near Komosha |
| 63 | L. Fettam at Galibed |
| 64 | Temcha near Dembecha |
| 65 | Gudla at Dembecha |
| 66 | Jogola at Wereilu |
| 67 | Abbay near Bure |
| 68 | Chereka at Yechereka |
| 69 | Birr near Jiga |
| 70 | Leza near Jiga |
| 71 | Abay at Shergole Cableway RGS |
| 72 | Lah near Finote Selam |
| 73 | Mechela near Kabe |
| 74 | Boreda near Mekaneselam |
| 75 | Selgi near Kabe |
| 76 | Lege Cora near Mekaneselam |
| 77 | Talia near Jiga |
| 78 | Fettam at Tilile |
| 79 | Tigdar nearGunde Woin |
| 80 | Dondor near Metekel |
| 81 | Missini at Kossober |
| 82 | Ardy near Metekel |
| 83 | Ayo near Kossober |
| 84 | Azuari near Mota |
| 85 | Abay at Mekane Selam-Gundewein Br. |
| 86 | Abay at Yarenga Bridge |
| 87 | Dura near Metekel |
| 88 | Buchiksi near Kidamaja |
| 89 | Sedie near Mota |
| 90 | Abbay near Kessie |
| 91 | Gerado near Dessie |
| 92 | Abay at El Delm |
| 93 | Gilgel Be. near Mandura |
| 94 | Tul near Adet |
| 95 | Quashini near Addis Kidame |
| 96 | Abbay at Sudan Border |
| 97 | Eldeim |
| 98 | Main Beles at Bridge |
| 99 | Shina near Adiet |
| 100 | Amen at Dangila |
| 101 | Main Bele at Bridge DS of Bagusta |
| 102 | Gelgel Abbay near Marawi |
| 103 | Koga at Merawi |
| 104 | Bered at Merewi |
| 105 | Ezana near Bahirdar |
| 106 | Mendel near Tis Abbay |
| 107 | Andassa near Bahir Dar |
| 108 | Lake Tana at Bahir Dar |
| 109 | Abbay at Bahir Dar |
| 110 | Abbay near Pedagogi |
| 111 | Chena near Istay |
| 112 | Wenka near Istay |
| 113 | Fegoda near Arb Gebeya |
| 114 | Gelda near Ambessame |
| 115 | Roseries |
| 116 | Ribb near Gasai |
| 117 | Gumara near Bahir Dar |
| 118 | Zufil near Debre Tabor |
| 119 | Lake Tana at Kunzila |
| 120 | Ribb near Addis Zemen |
| 121 | Upper Ribb On DebreTabor Road |
| 122 | Lake Tana at Gorgora |
| 123 | Garno near Infranz |
| 124 | Gemero near Maksegnit |
| 125 | Megech near Azezo |
| 126 | Angareb near Gonder |
| 127 | Wad Eleis |
| 128 | Gewesi |
| 129 | Hawata |
| 130 | Madani |
| 131 | Khartoum |
| 132 | Yebu at Yebu |

# The White Nile Sub-basin

The White Nile contributes about 25 – 26 $10^9 m^3$ to the Main Nile measured just upstream of the White – Blue Nile confluence in Khartoum. It receives water from rivers that drain the Equatorial Lakes region of the Nile Basin and which pass through a series of natural lakes and swamps. As a result, the White Nile provides a relatively more uniform seasonal flow compared to the Blue Nile and Tekeze-Atbara rivers. The White Nile provides long navigable reaches due to its flat slope and stable flow.

## Meteorological monitoring network

There are 36 meteorological stations in the sub-basin, with 30 of them in Sudan, four in Ethiopia and two in South Sudan. The distribution of the stations is shown in the map below. 8 stations (five in Sudan and three in Ethiopia) are reported to measure the full range of meteorological parameters and the remaining 22 measure daily rainfall totals only.

photo: Nile-SEC

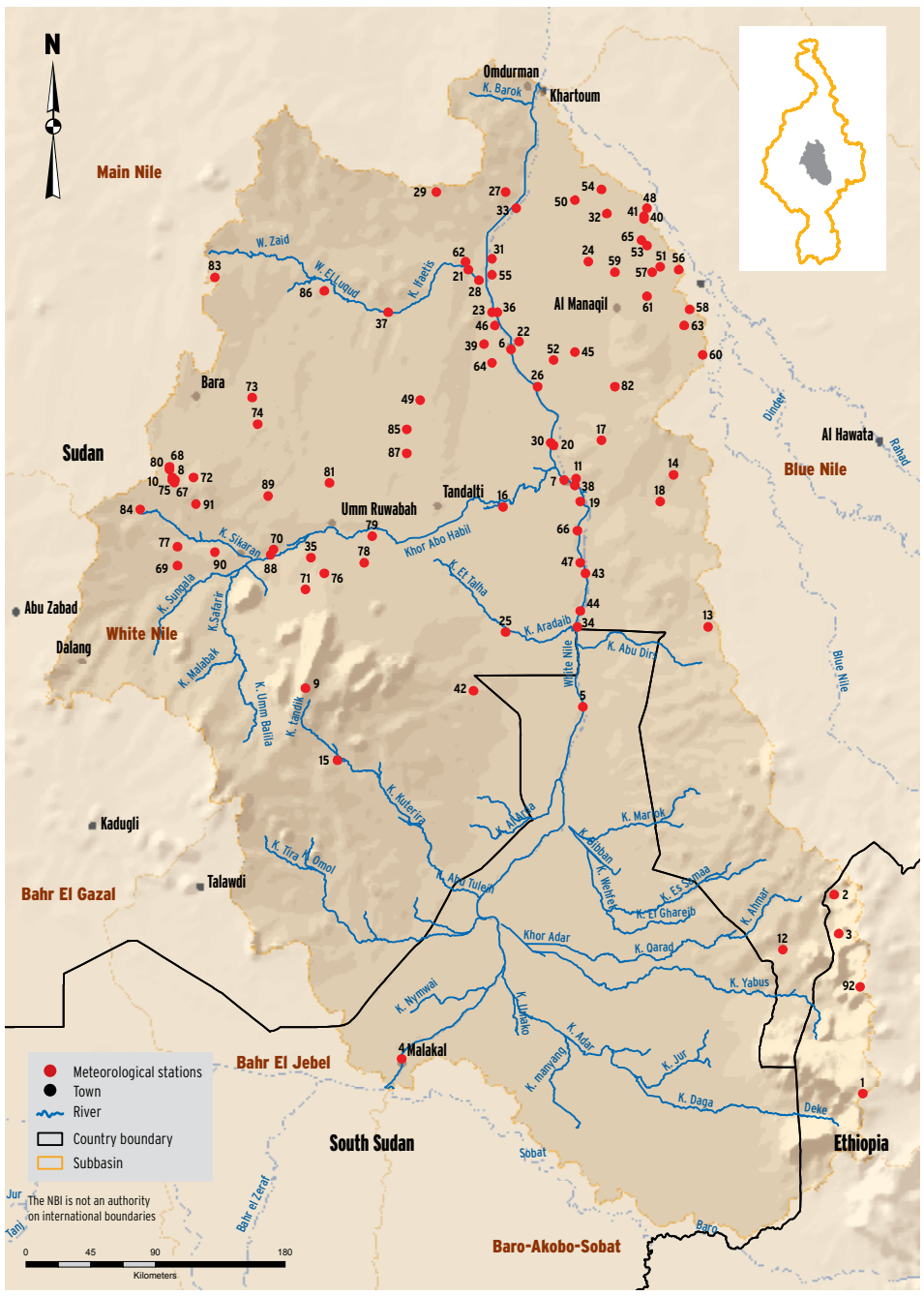
Automatic weather station

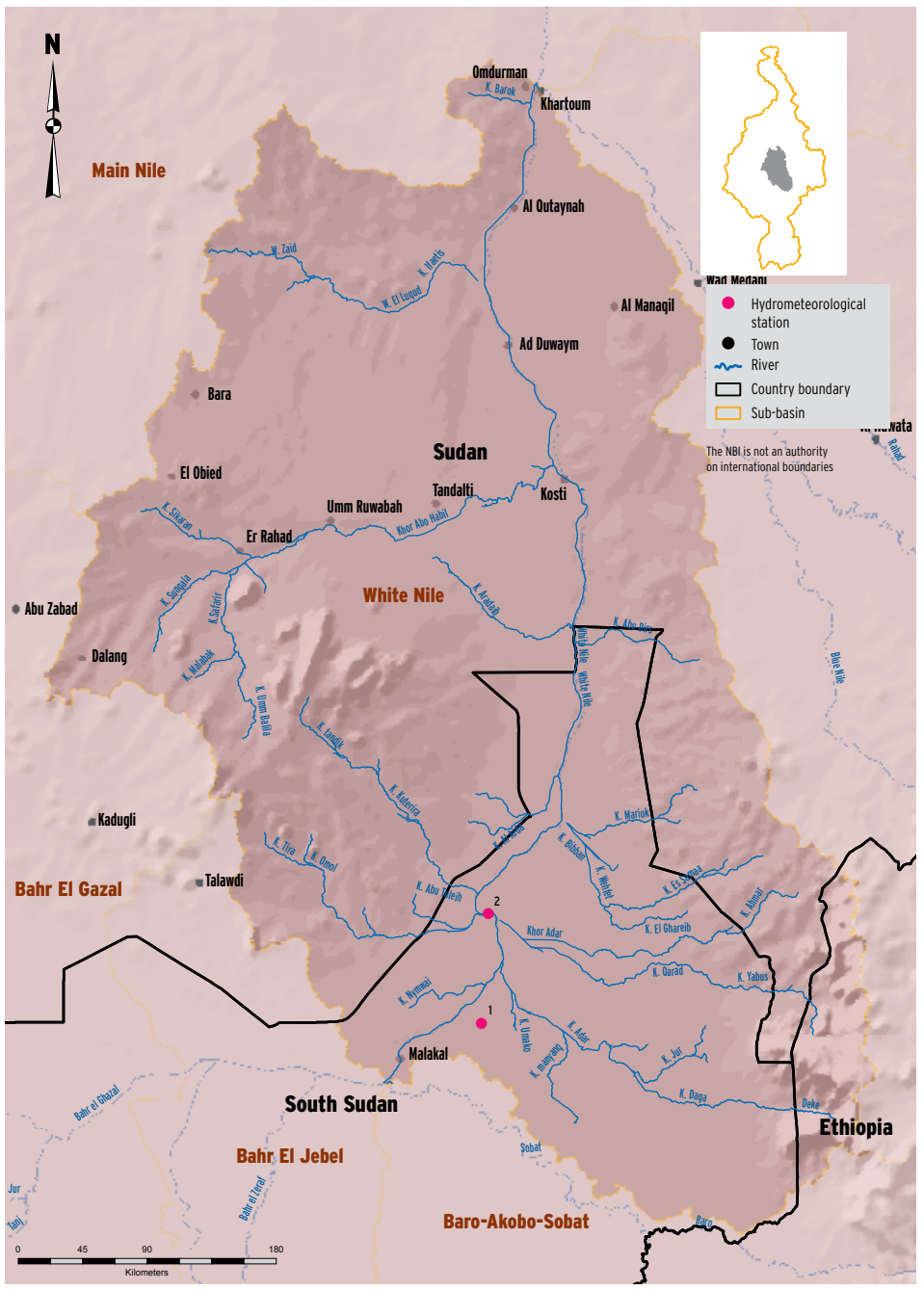
Acoustic Doppler Current Profiler (ADCP )

## Hydrometric stations

The only station that is operational is White Nile at Malakal. The station is close to of Malakal town just downstream of the Sobat – White Nile confluence. Historically, there were four additional stations but they were not operational at the time of the survey conducted in 2014.

The White Nile is an important source of water, especially during the dry season (November – May/June), when the Blue Nile and other tributaries from the Ethiopian highlands are at their lowest levels. Therefore, rehabilitating the non-functioning stations in the sub-basin is urgently required. The Nile Basin regional Hydromet system has included the station at Malakal (Renk) and the station d/s of Jebel Awlia dam as regional stations.




| No | Name Of Station |
|---|---|
| 1 | Begi |
| 2 | Kurmuk |
| 3 | Famesetre |
| 4 | Malakal |
| 5 | Renk |
| 6 | Ed Dueim |
| 7 | Kosti |
| 8 | El Obeid |
| 9 | Rashad |
| 10 | Elobeid |
| 11 | Rabak |
| 12 | Aldali |
| 13 | J.mazmoum |
| 14 | J.sagdi |
| 15 | Abu Gubeiha |
| 16 | Um Kouka |
| 17 | Jabal Biut |
| 18 | Jabal Moui |
| 19 | Um Hani |
| 20 | Aba |
| 21 | Abger |
| 22 | Abu Harira |
| 23 | Dubasi |
| 24 | El Neima |
| 25 | Elakaf |
| 26 | El-Kawa |
| 27 | Elsheikh Essaddig |
| 28 | Es Sufi |
| 29 | Esh Shageig |
| 30 | Fashashoya |
| 31 | Fatisa |
| 32 | Fawar |
| 33 | Geteina |
| 34 | Goda |
| 35 | Goz Khadra |
| 36 | Hashaba |
| 37 | Helba |
| 38 | Hellat Abbas |
| 39 | Idd El`Ud |
| 40 | Istarahna |
| 41 | Istarahna |
| 42 | J Megeneis |
| 43 | Jebelein |
| 44 | Kerikera |
| 45 | Rahama |
| 46 | Shabasha |
| 47 | Showal |
| 48 | Toba |
| 49 | Tuweimat |
| 50 | Ub Guta |
| 51 | Umm Dueina |
| 52 | Umm Suneint |
| 53 | Umm'udam |
| 54 | Ureik |
| 55 | Wad Alzaki |
| 56 | Wad Bashkar |
| 57 | Wad El Burr |
| 58 | Wad El Umarbi |
| 59 | Wad Ezzein |
| 60 | Wad Figad |
| 61 | Wad Hilal |
| 62 | Wad Nimir |
| 63 | Wad Nu'man |
| 64 | Wakara |
| 65 | Zubeir |
| 66 | Zuleit (1) |
| 67 | Algalah |
| 68 | Almashtal |
| 69 | Elban Gadid |
| 70 | Elsemaih |
| 71 | Gabrat Elshaikh |
| 72 | Khur Taget |
| 73 | Muzdalifa |
| 74 | Namlah |
| 75 | Obeid Albusta |
| 76 | Rifee Um Rawaba |
| 77 | Shekan |
| 78 | Shirkela |
| 79 | Shirkela Um Aush |
| 80 | Tareg Almashea |
| 81 | Ubo Grain |
| 82 | Um Dam Haj Ahmed |
| 83 | Um Garfa |
| 84 | Um Ramad |
| 85 | Um Saigaoon |
| 86 | Ummsiyala |
| 87 | Wd Ashana |
| 88 | Abu Habel |
| 89 | Alaen |
| 90 | Alrahed |
| 91 | Um Kadada |
| 92 | Assosa |

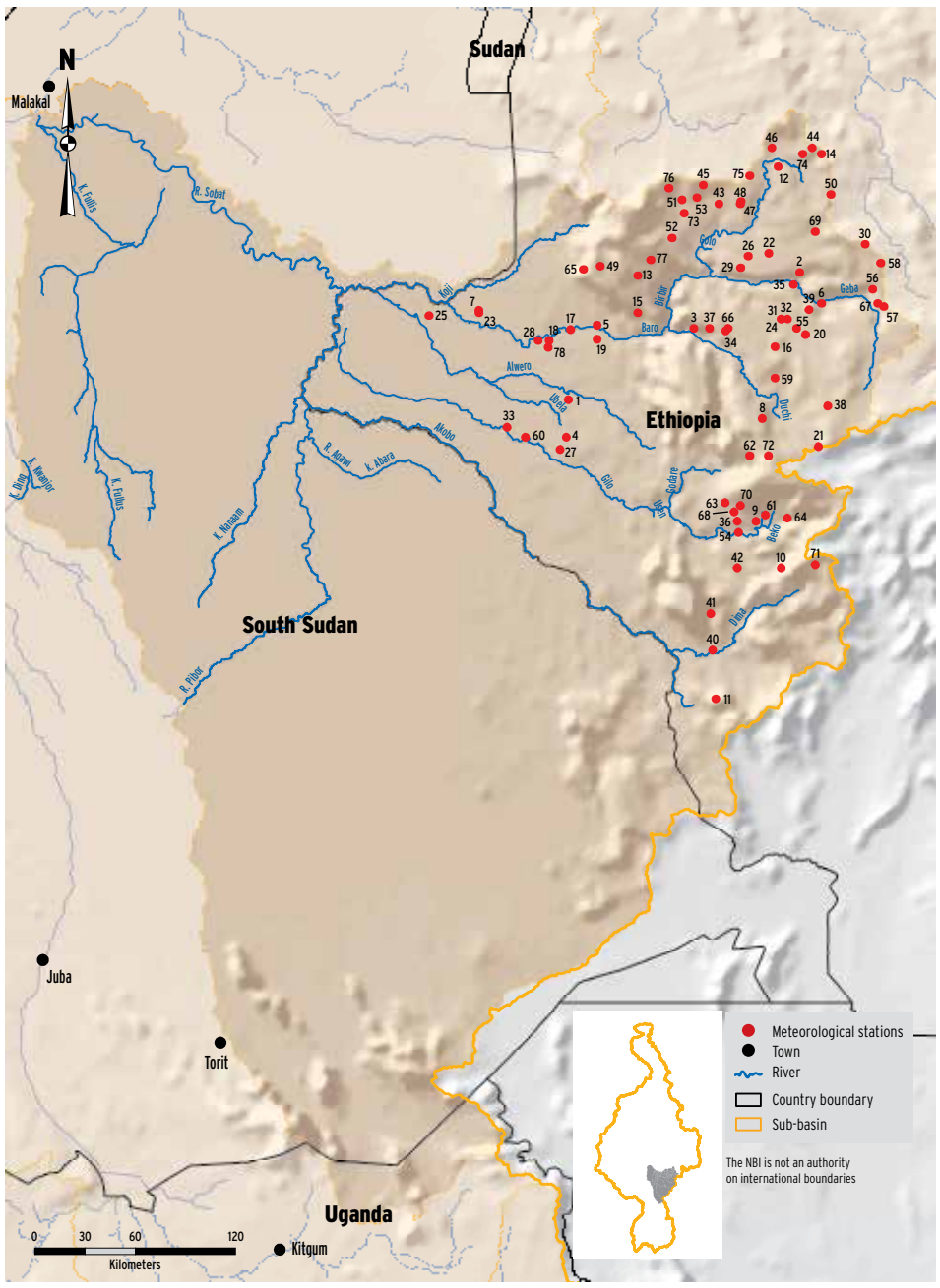
| No | Name |
|---|---|
| 1 | Khor Adar |
| 2 | Melut |

# The Baro-Akobo-Sobat Nile Sub-basin

The Baro-Akobo-Sobat sub-basin is shared by Ethiopia and South Sudan. Its major rivers are the Baro, Akobo and Pibor. The Baro, after joined by Akobo and Pibor makes the Sobat that flows to the northwest to join the Bahr el Jebel and eventually form the White Nile. The annual water yield of the Sobat is approximately 12- 13 $10^9 m^3$. The reach of the Baro and Sobat downstream of Gambella town (in Ethiopia) is navigable. A key feature of the hydrology of the sub-basin is that its rivers (especially in the lower reaches) flow over flat surface with meandering patterns creating complex interactions with surrounding floodplains. The spill from the Baro river into the Machar marshes (in the White Nile Sub-basin) is one of naturally occurring transfer of water into a neighboring catchment.

## Meteorological monitoring network

There are 78 meteorological stations in the sub-basin – all in Ethiopia. The distribution of the stations is shown in the map below. 17 stations are reported to measure the full range of meteorological parameters. Most stations are in the highlands with very few of the stations located in the lower plains of the sub-basin in Ethiopia.




| No | Name of Station |
|---|---|
| 1 | Abobo |
| 2 | Alge |
| 3 | Bure |
| 4 | Fugnido |
| 5 | Gambela |
| 6 | Hurumu |
| 7 | Jikawo (Lare) |
| 8 | Masha |
| 9 | Tepi |
| 10 | Aman |
| 11 | Jeba |
| 12 | Ayira |
| 13 | Dembidolo |
| 14 | Gimbi |
| 15 | Shebel |
| 16 | Gore |
| 17 | Abol |
| 18 | Aliyadora |
| 19 | Baro Bonga |
| 20 | Becho |
| 21 | Bitta Genet |
| 22 | Darimu (Dopa) |
| 23 | Eliadora |
| 24 | Fugo Leka |
| 25 | Gnignang |
| 26 | Gobe |
| 27 | Gog |
| 28 | Itang |
| 29 | Kidame Gebaya |
| 30 | Meko |
| 31 | Metu Hospital |
| 32 | Nopa |
| 33 | Puchala |
| 34 | Soretefasese |
| 35 | Supe |
| 36 | Tinishu Miti |
| 37 | Uka |
| 38 | Yadota |
| 39 | Yayo (Dorani) |
| 40 | Guraferda (Biftu) |
| 41 | Koy |
| 42 | Mizan Teferi |
| 43 | Alemteferi |
| 44 | Dengoro |
| 45 | Gidame |
| 46 | Guliso |
| 47 | Lalo Kelle |
| 48 | Mechara |
| 49 | Mugi |
| 50 | Nolekaba |
| 51 | Qaqi |
| 52 | Seko Humbi |
| 53 | Yubdo |
| 54 | Bechi |
| 55 | Bilambilo |
| 56 | Bontu |
| 57 | Chora |
| 58 | Dega |
| 59 | Didu Gordomo |
| 60 | Dippa |
| 61 | Fide |
| 62 | Gecha |
| 63 | Gubete |
| 64 | Kura |
| 65 | Menko Lencho |
| 66 | Sibo |
| 67 | Wetete (TP) |
| 68 | Yeki |
| 69 | Yembo |
| 70 | Ermichi |
| 71 | Shewa Gimira |
| 72 | Yina |
| 73 | Chanka |
| 74 | Enango |
| 75 | Figakobra |
| 76 | Kebe |
| 77 | Rob Gebeya (Kel) |
| 78 | Lare |

## Hydrometric stations

there are 28 stations in the sub-basin (27 in Ethiopia and 1 in South Sudan). More than half of the stations in Ethiopia were established in 1980's and, therefore, have short records. Breaks in records often pose additional challenges in using such short records.

The hydrometric network of this sub-basin is far from adequate. The sub-basin, especially in its lower reaches exhibit highly complex hydrology in which the rivers at time bifurcate and join back the main stem and floodplains and swamps interact with the river flows. The Hydrometric network in this sub-basin requires strengthening with additional data collection through remote sensing to adequately understand the hydrology of the sub-basin.


| No | Name |
|---|---|
| 1 | U. Akobo Nr. Dima |
| 2 | Berhan Nr. Bebeka Farm |
| 3 | Gacheb Nr. Mizan Tefri |
| 4 | Begwuha Nr. Tepi |
| 5 | Bitinwuha Nr. Tepi |
| 6 | Beko(Shoha Nr. Tepi |
| 7 | Gengi Nr.Gecha |
| 8 | Gilo Nr. Pignudo |
| 9 | Awero at Dam/Dumbong Village |
| 10 | Upper Baro Nr. Masha |
| 11 | Gumero Nr.Gore |
| 12 | Bonga Nr. Bonga |
| 13 | Uka @ Uka |
| 14 | Baro @ Itang |
| 15 | Baro @ Bonga |
| 16 | Baro @ Gambella |
| 17 | Sore Nr. Metu |
| 18 | Agami Nr. Ashi |
| 19 | Geba Nr. Suppi |
| 20 | Eilika Nr. Supe |
| 21 | Meti Nr. Dembidolo |
| 22 | Keto Nr. Chanka |
| 23 | Cherecha Nr. Chanka |
| 24 | Merdefa Nr. Alem Teferi |
| 25 | Kuni Nr. Chanka |
| 26 | Birbir Nr. Yubdo |
| 27 | Ouwa Nr. Guliso |
| 28 | Hillet Dolieb |

# The Bahr el Jebel Sub-basin

The Bahr el Jebel sub-basin has one of most complex hydrology in the Nile Basin. The Sudd system of wetlands, the second largest freshwater wetland in the World, is a key feature of the sub-basin. The main river, Bahr el Jebel, has river flow records since the beginning of the 20th century. However, due to conflicts in South Sudan, river gauging was interrupted for more than 20 years.

photo: Nile-SEC

Wind vane

photo: Vivian Nabyonga

Water level reader

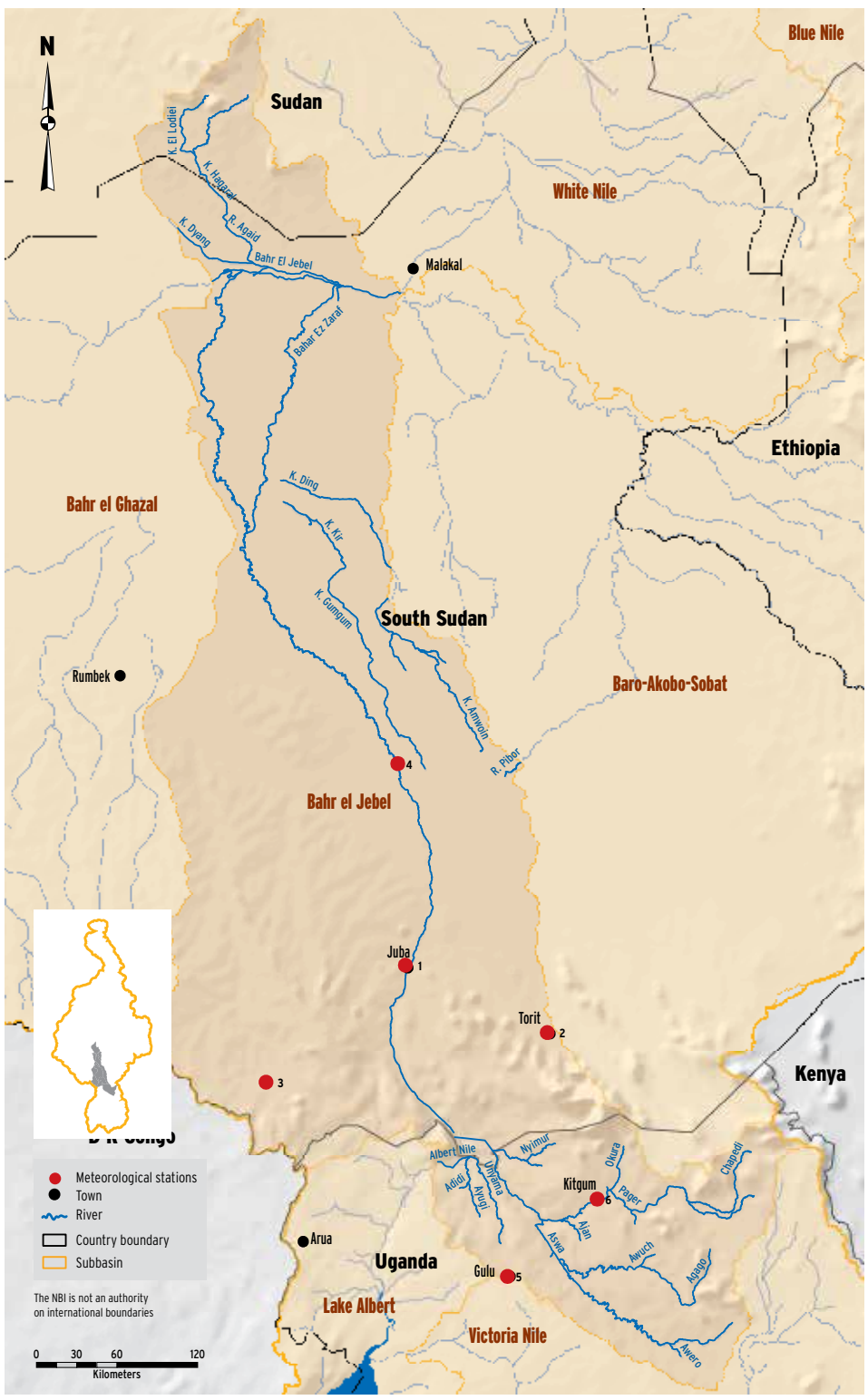
## Meteorological monitoring network

There are six meteorological stations in the sub-basin; five in Uganda and one in South Sudan. Only three full met stations are available in the entire sub-basin.

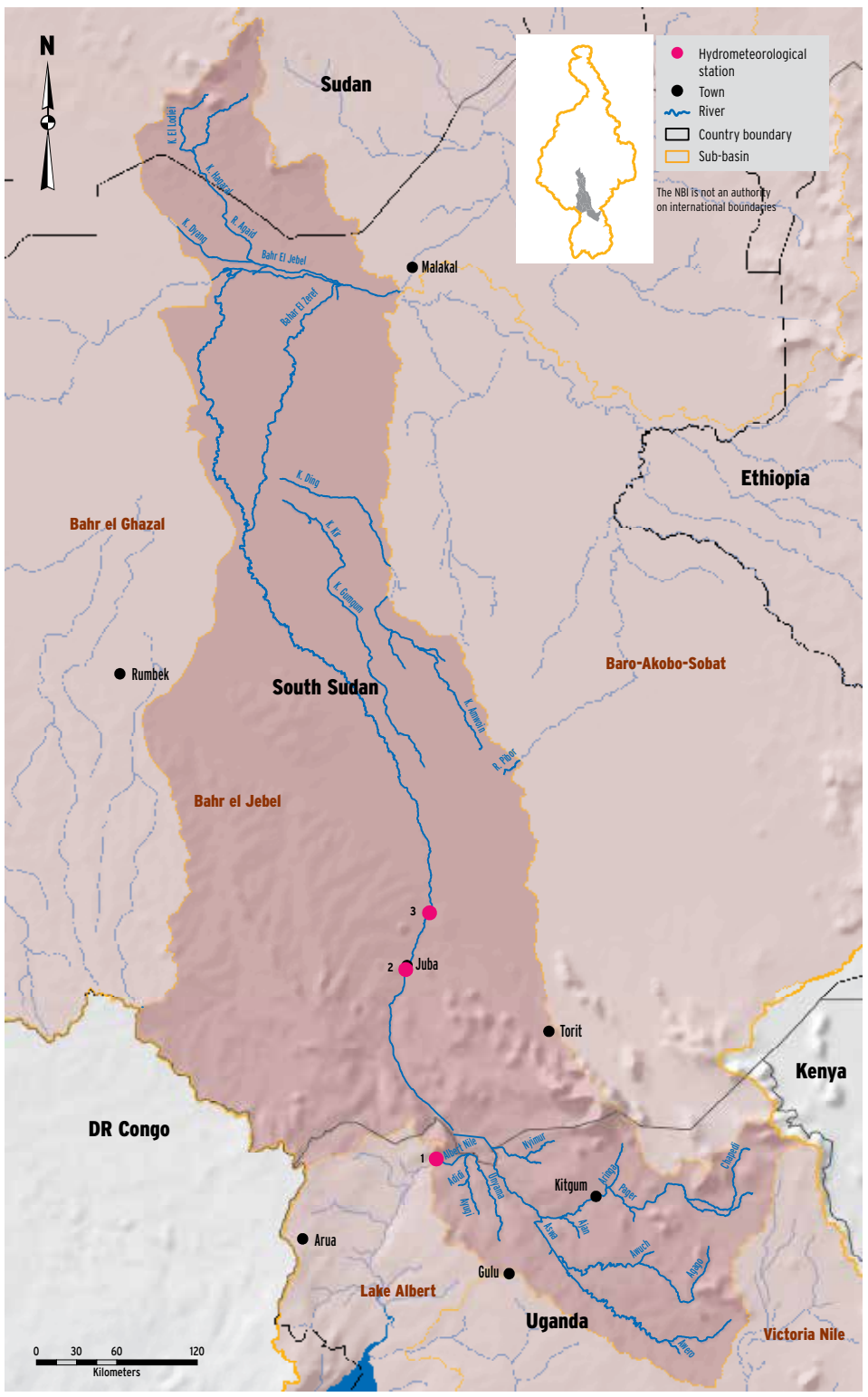
## Hydrometric stations

There are 4 stations in the sub-basin (3 in South Sudan and 1 in Uganda). The stations in South Sudan are Bahr el Jebel at Mongala and Bor while the single station in Uganda is at Laropi. Three stations are not sufficient for this sub-basin.

The hydrology of the Bahr el Jebel sub-basin has been the subject of many investigation in the past. However, there is a gap in the understanding of the interaction between the river system and the system of wetlands in the sub-basin. Severe flooding has caused huge damages in recent years but the monitoring infrastructure is nowhere near adequate. The sub-basin requires a system of monitoring that employs ground-based as well as remote sensing supported data collection and transmission.




| No | Name of Station |
|---|---|
| 1 | Juba |
| 2 | Torit |
| 3 | Yei |
| 4 | Bor |
| 5 | Gulu met station |
| 6 | Kitgum Centre Vt |




| No | Name of Staion |
|---|---|
| 1 | R. Albert Nile at Laropi |
| 2 | Juba |
| 3 | Mongalla |

# The Bahr el Ghazal Sub-basin

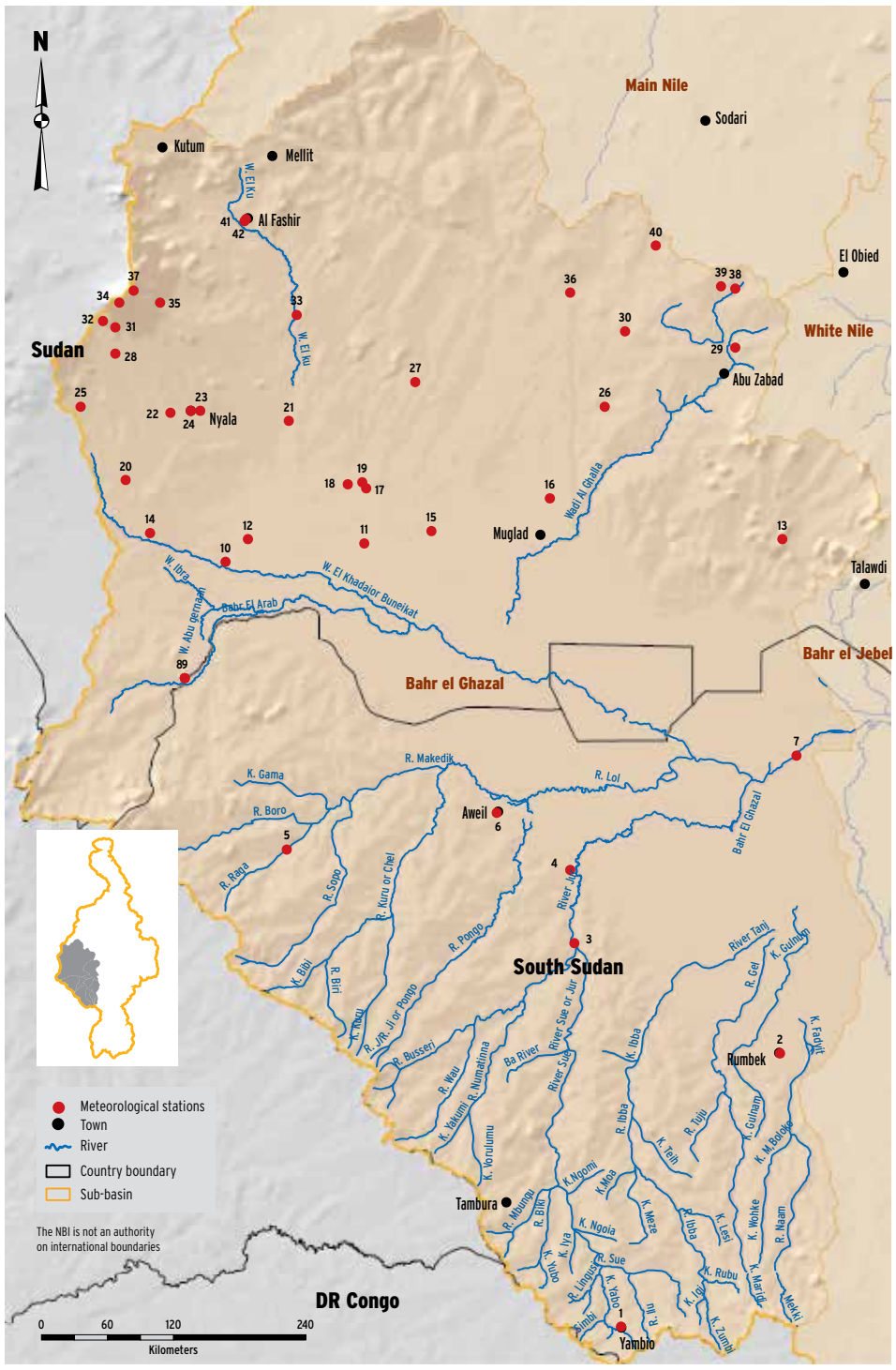
The Bahr el Ghazal Sub-basin drains is shared by South Sudan and Sudan. It has an area comparable to the Blue Nile but with very small outflow. The main river, Bahr el Ghazal, flows and joins the Bahr el Jebel downstream of Lake No.

photo: Arsenie Coseac/Flickr

Dry river bed in South Sudan

## Meteorological monitoring network

There are 14 meteorological stations in the sub-basin; two in South Sudan and 12 in Sudan. Nine stations are full met stations.

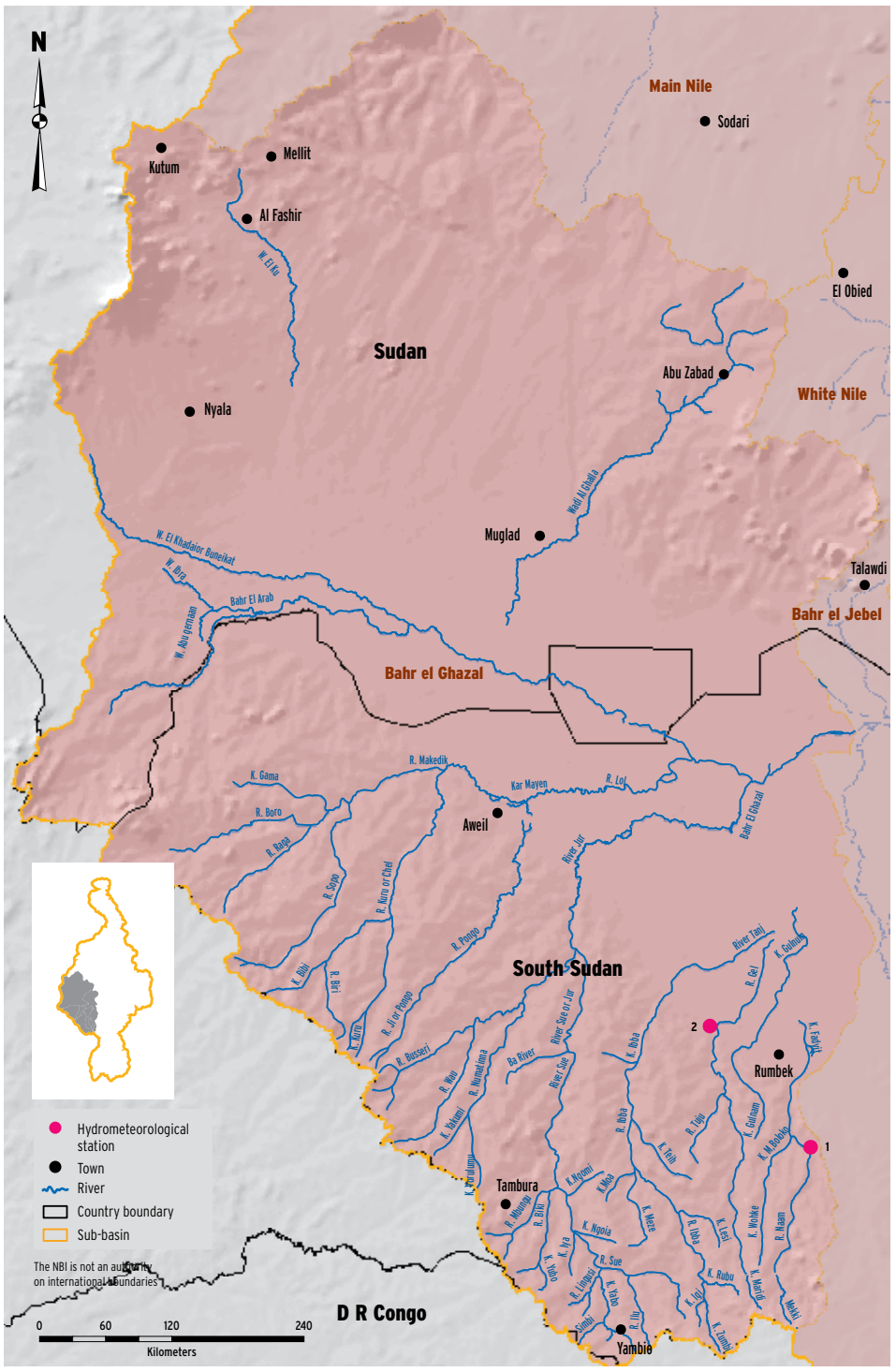



| No | Name of Station |
|---|---|
| 1 | YAMBIO |
| 2 | RUMBEK |
| 3 | Wau |
| 4 | KUAJOK |
| 5 | Raga |
| 6 | AWEIL |
| 7 | BENTIU |
| 8 | Alradoom |
| 9 | RADOM |
| 10 | BURAM |
| 11 | ABU MATARIG |
| 12 | UMM SIKEINAT |
| 13 | Kadugli |
| 14 | tulus |
| 15 | ABUGABRA |
| 16 | Babanusa |
| 17 | ABU HEMEID |
| 18 | EL-DEAIN |
| 19 | Gazala gawazat |
| 20 | EID EL-GANAM |
| 21 | MUHAGRIA |
| 22 | ET TOMAI |
| 23 | Neyala |
| 24 | Nyala |
| 25 | DANKOG |
| 26 | Elodaiah |
| 27 | EL-TEWAISHA |
| 28 | KAS |
| 29 | Giraih Elsarha |
| 30 | En Nahud |
| 31 | KALOKITING |
| 32 | KUNGAR |
| 33 | WAFA'A |
| 34 | TORA TONGA |
| 35 | MALEMM |
| 36 | Wd Bunda |
| 37 | SUNI |
| 38 | Elmazroob |
| 39 | Alkhowi |
| 40 | Eial Bakhit |
| 41 | El Fasher |
| 42 | El Fasher |

## Hydrometric stations

There is only one station in the sub-basin – on a tributary of the river at Wau in South Sudan. The map below shows the location of the station. The table adjacent to the map provides the list of hydrometric stations that were available but not operational and those newly proposed as part of strengthening the monitoring system in South Sudan.

The Bahr el Ghazal is the least monitored sub-basin in the Nile Basin. As a result, the hydrology of the sub-basin is not well understood although indications are that the sub-basin has considerable water resources potential. A combination of ground – and remote sensing based observations of hydro-meteorological parameters are needed for the long-term sustainable management of the water resources of the sub-basin.




Note: All Hydrometric stations in Bahr el Ghazal are not operational

| | |
|---|---|
| 1 | Rumbek |
| 2 | Gel |

# The Lake Albert Sub-basin

The Lake Albert Sub-basin is shared by DR Congo and Uganda. The sub-basin has three main lakes, Edward, Albert and George. Victoria Nile is regulated in part by the outflow from the lake. The sub-basin is an area of oil exploration and, hence, water quality and quantity monitoring is very important for sustainable management of the water resources.

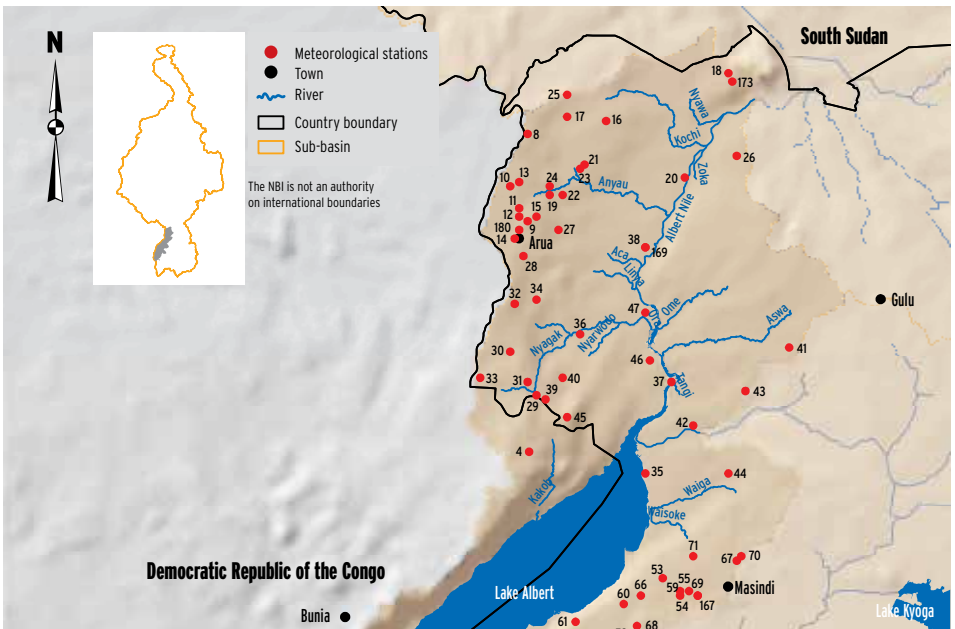
ADCP being lowered into the the stream

photo: Vivian Nabyonga

Taking ADCP readings

## Meteorological monitoring network

There are 29 meteorological stations in the sub-basin; all in Uganda.11 stations are full met stations. The distribution of the stations is shown in the map below.



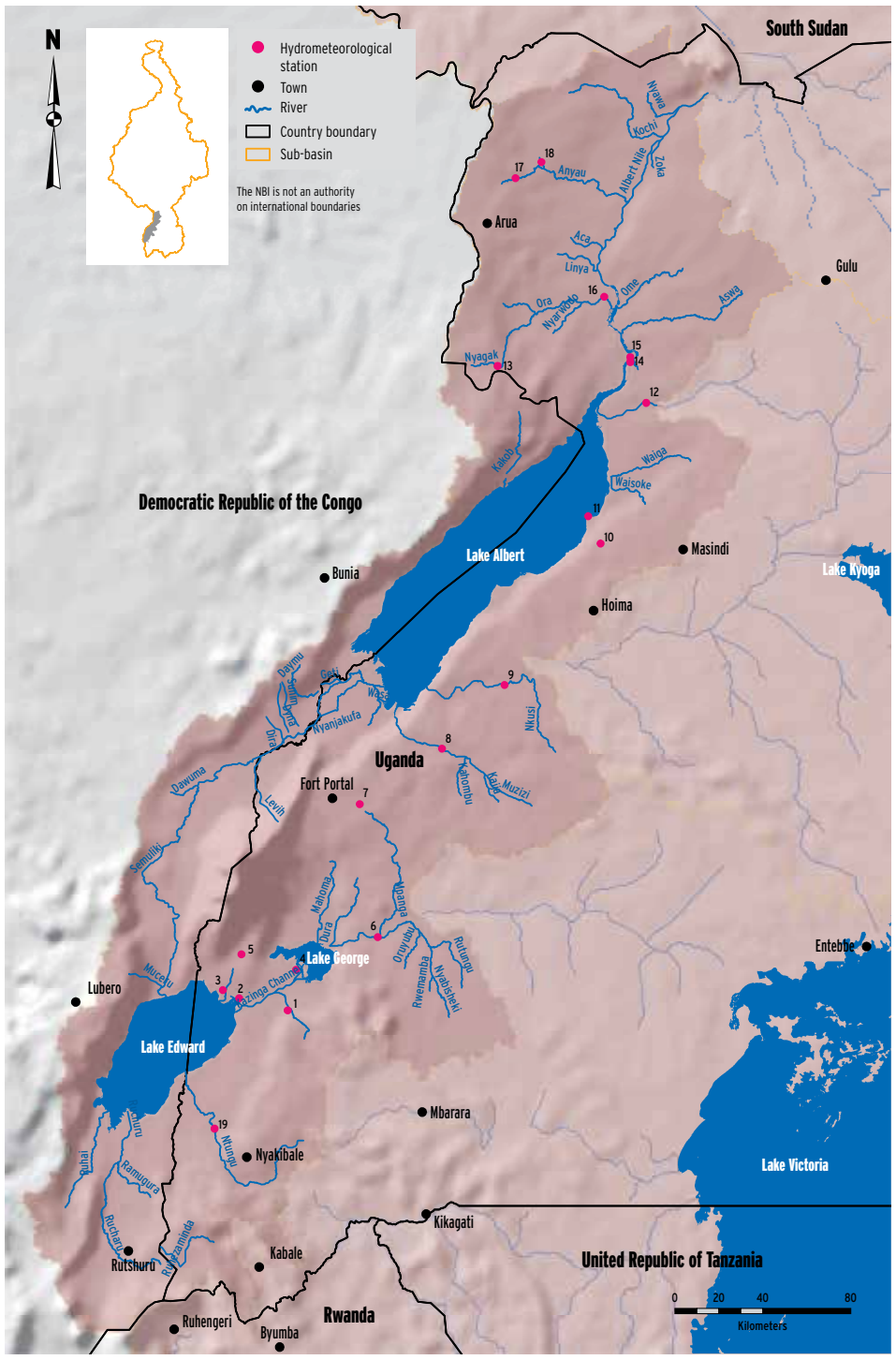

| No | Name |
|---|---|
| 1 | Bukombo |
| 2 | Isale Vuhovi |
| 3 | Rumangabo |
| 4 | Ugongo |
| 5 | BUNGWE-PNILP |
| 6 | SHINGIRO |
| 7 | Fort Portal |
| 8 | Koboko St. Charles L |
| 9 | Abi Estate |
| 10 | Olovu |
| 11 | Lokiragodo |
| 12 | Manibe Omuazire |
| 13 | Ovujo |
| 14 | Arua Central Govt Prison |
| 15 | Wandi BAT Uganda Ltd |
| 16 | Yumbe Hospital (Aringa) |
| 17 | Ladonga VFM |
| 18 | Moyo Boma |
| 19 | Terego Dispensary |
| 20 | Obongi Dispensary |
| 21 | Upupe Dispensary - Arua |
| 22 | Otrevu |
| 23 | Utumbari - Arua |
| 24 | Ivu |
| 25 | Mount Kei Forest Station |
| 26 | Adjumani Prisons Farm |
| 27 | Bileafe Tobacco Station |
| 28 | Kuluva |
| 29 | Payidha |
| 30 | Warr Dispensary |
| 31 | Nyapea St.Aloysius |
| 32 | Usi Forest Station - Nebbi |
| 33 | Lendu Forest Station |
| 34 | Nyara TWGCS |
| 35 | Buliisa Gomborora Hqs |
| 36 | Okollo Dispensary |
| 37 | Pakwach Dispensary |
| 38 | Rhino Camp Dispensary |
| 39 | Goli African.Inland. |
| 40 | Nebbi UTC |
| 41 | Anaka |
| 42 | Kabalega Falls |
| 43 | Wangkwar Camp |
| 44 | Wairingo River Camp |
| 45 | Erusi Forest Station |
| 46 | Pokwero Group Farm |
| 47 | Wadelai WDD |
| 48 | Rwebisengo |
| 49 | Kyangwali |
| 50 | Mugalike WFM |
| 51 | Kasonga HM |
| 52 | Dwoli Estate |
| 53 | Busingiro Forest |
| 54 | Nyamageta Estate |
| 55 | Kinyala Estate |
| 56 | Kizirafumbi |
| 57 | Kabwoya |
| 58 | Kiryanga Gombolola |
| 59 | Nyabyeya |
| 60 | Kigorobya |
| 61 | Biseruka |
| 62 | Bugoma CFR |
| 63 | Bugambe Tea Estate |
| 64 | Rwabikondo Estate |
| 65 | Nyamolobyo Estate |
| 66 | Siba |
| 67 | Kihonda Estate |
| 68 | Wampanga Forest Station |
| 69 | Kinyala Sugar Scheme B |
| 70 | Kisindi Group Farm |
| 71 | Kigumba Farm |
| 72 | Muntme Fatima Parish |
| 73 | Mpondwe Customs Post |
| 74 | Nyabirongo |
| 75 | Nyamugasani |
| 76 | Bwera |
| 77 | Bundibujo |
| 78 | Butiti |
| 79 | Kahangi Estate |
| 80 | Kilchooney Estate |
| 81 | Nyakasura School |
| 82 | Bugoye |
| 83 | Kagadi Gombololo |
| 84 | Kisomoro |
| 85 | Nkoma |
| 86 | Bigodi |
| 87 | Matiri |
| 88 | Nyaruru |
| 89 | Kyembogo Farm |
| 90 | Virika School |
| 91 | Kyenjojo |
| 92 | Kijura Tea Factory |
| 93 | Yeriya Estate |
| 94 | Mugusu Estate |
| 95 | Chakatimba Estate |
| 96 | Muhokya Toro Limeco Ltd |
| 97 | Isunga Estate |
| 98 | Kilembe Mines |
| 99 | Sebutole |
| 100 | Kyehara II |
| 101 | Bulemba |
| 102 | Kikumiro V |
| 103 | Mobuku HEP |
| 104 | Itwara C.F.R. |
| 105 | Ruimi Prison Farm |
| 106 | Kiburara |
| 107 | Mubuku\Sebwe Irr Scheme |
| 108 | Kahangi Estate |
| 109 | Bihanga prison Farm |
| 110 | Rwebitaba Tea Res Station |
| 111 | Kanyawara |
| 112 | Bundibugyo Cocoa Devt |
| 113 | Kyenjojo 1st Order Station |
| 114 | Mubuku Giant prison Farm |
| 115 | Kinyamasika TTC |
| 116 | Kakumiro Variety TC |
| 117 | Buyanja (Buyaga) |
| 118 | Kyegegwa |
| 119 | Nyakibale |
| 120 | Katwe |
| 121 | Kanungu |
| 122 | Rukungiri Dispensary |
| 123 | Bugangari Dispensary |
| 124 | Myeya |
| 125 | Burema |
| 126 | Rulind Swamp Inlet |
| 127 | Kihihi Tractor Hire |
| 128 | Kitahulira Forest Station |
| 129 | Uganda Institute of Ecology - Kasese |
| 130 | Kaniabizo |
| 131 | Ishasha River Camp |
| 132 | Rwashamaire |
| 133 | Bunyaruguru WFM |
| 134 | Bushenyi |
| 135 | Kitabi Seminary |
| 136 | Nyabusozi Saza Hqs |
| 137 | Kicheche |
| 138 | Kalinzu Forest |
| 139 | Kanoni Gombolola Hqs |
| 140 | Mitoma |
| 141 | Ibanda |
| 142 | Tufmac Kasenyi |
| 143 | Ankole Tea Company |
| 144 | Kazo Sub County |
| 145 | Bushenyi Agromet Station |
| 146 | Rubirizi Saza Hqs |
| 147 | Kisoro Police Station |
| 148 | Mutolere Sen Sec School |
| 149 | Karengere Pyrethrum Plant |
| 150 | Kisizi Health Centre |
| 151 | Bufundi Dispensary |
| 152 | Bwama Island |
| 153 | Bukimbiri |
| 154 | Rubaya Dispensary |
| 155 | Chananke |
| 156 | Kashambya |
| 157 | Nyarushanje Agric Centre |
| 158 | Rushanga Forest Station |
| 159 | Ruhiza Forest Station |
| 160 | Sabinio Forest Station |
| 161 | Echuya Forest Station |
| 162 | Muko Forest Station |
| 163 | Kitanga |
| 164 | Mparo Dispensary |
| 165 | Rwomuhororo - Mbarara |
| 166 | Pachwa Hydromet Station |
| 167 | Kinyara Sugar - Masindi |
| 168 | Kashwa Primary School - Mbararara |
| 169 | Rhino Camp Ginnery - Arua |
| 170 | Nyamugasani - Kabarole |
| 171 | Kamuli High School - Kamuli |
| 172 | Bogoro |

## Hydrometric stations

There are 18 hydrometric stations in the sub-basin. The map below shows the location of the stations. The table adjacent to the map provides the list of hydrometric stations that were active at the time of the survey in 2014.

Improved monitoring of Lake Albert and Edward outflows would enhance understanding of the interaction between Victoria Nile and the Lake outflow.

Water quality monitoring in upper parts of the sub-basin requires emphasis in order to monitor and potentially avert pollution risks from oil exploration efforts there.




| No | Name |
|---|---|
| 1 | R. Mitano at Kanungu - Rwensama |
| 2 | R. Chambura at Kichwamba |
| 3 | L. Edward at Katwe |
| 4 | R. Nyamugasani at Katwe - Zaire |
| 5 | L. George at Kasenyi |
| 6 | Nyamugasani |
| 7 | R. Mpanga at Fort Portal - Ibanda Road |
| 8 | R. Mpanga at Kampala - Fort Portal Road |
| 9 | Muzizi |
| 10 | R. Nkussi at Kyenjojo - Hoima R |
| 11 | R. Waki II at Biiso - Hoima Road |
| 12 | L. Albert at Butiaba |
| 13 | R. Kyoga Nile at Paraa |
| 14 | R. Nyagak at Nyapea |
| 15 | Albert Nile at Pakwach |
| 16 | R. Albert Nile at Panyango. |
| 17 | R. Ora at Inde - Pakwach Road |
| 18 | R. Anyau at Arua - Moyo Road |
| 19 | R. Oru at Arua - Yumbe Road |

# The Victoria Nile Sub-basin

The largest part of the Victoria Nile sub-basin lies in Uganda with a small part in Kenya and is the drained by the Victoria Nile once it leaves the Lake Victoria. The sub-basin has substantial hydropower potential. The average annual flow of Victoria Nile at Jinja station in Uganda is approximately 32 $10^9 m^3$. This is a sub-basin with relatively good monitoring infrastructure in the Nile Basin.

photo: Vivian Nabyonga

Station at River Kafu

## Meteorological monitoring network

There are 48 meteorological stations in the sub-basin; distributed in Kenya (6) and Uganda (42).11 stations are full met stations. The distribution of the stations is shown in the map below.

photo: Vivian Nabyonga

Lake Kyoga at Bugondo during dry season

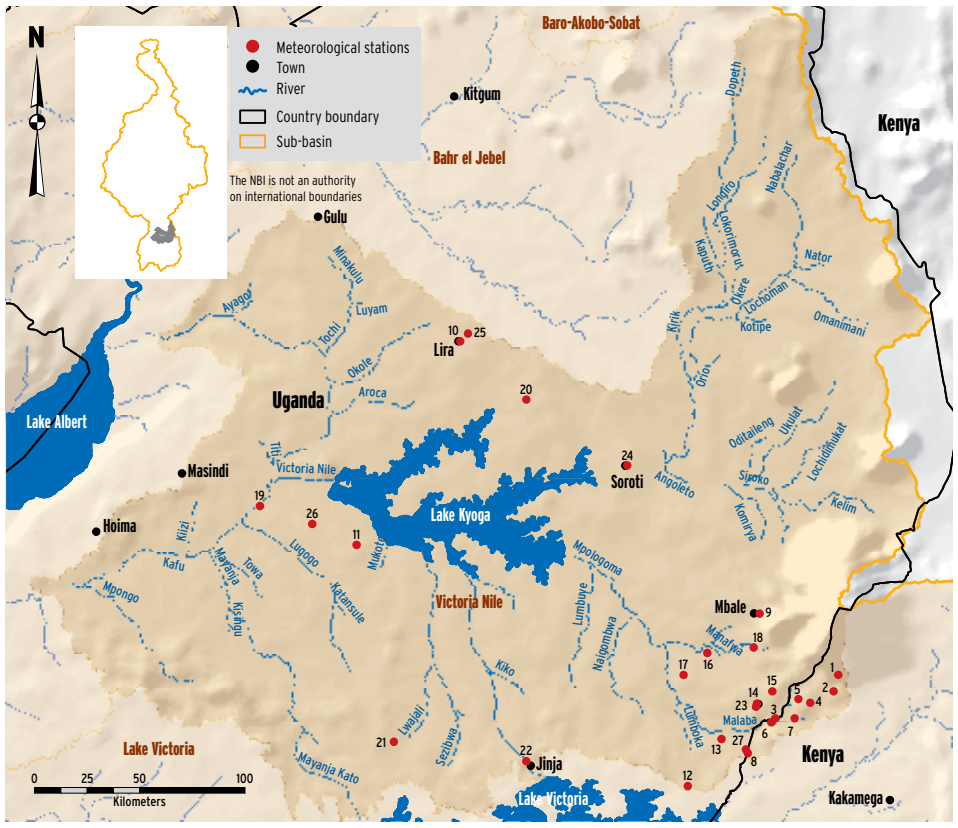
photo: Vivian Nabyonga

Lake Kyoga at Bugondo during wet season

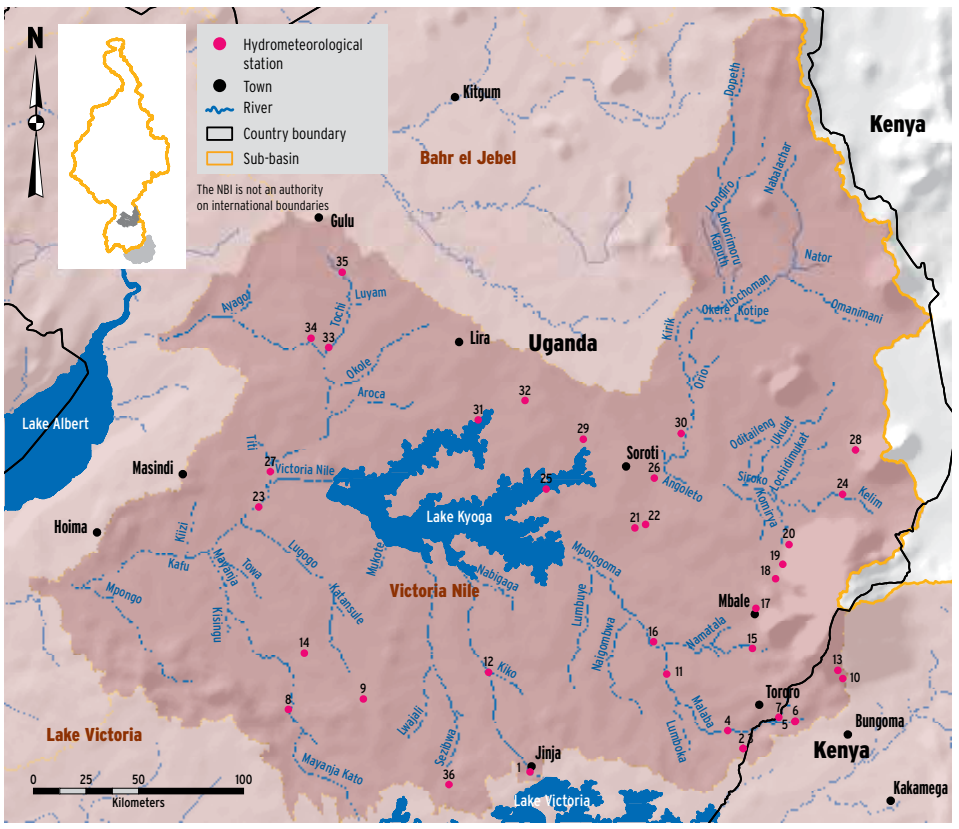
## Hydrometric stations

there are 53 hydrometric stations in the sub-basin; 6 in Kenya and 47 in Uganda. The map below shows the location of the station. The table adjacent to the map provides the list of hydrometric stations that were active at the time of the survey in 2014.

Enhancing reservoir operation of a cascade of hydropower dams (existing and planned ones) is one of the priority areas in the sub-basin. This requires enhanced real-time data collection and transmission system linked with appropriately built reservoir management system.




| No | Name |
|---|---|
| 1 | Kimama Primary |
| 2 | Sirisia Chief's Camp |
| 3 | Lukolis Dispensary,Kakamega |
| 4 | Kolonya Boy's Sec. School |
| 5 | Angorai Chief's Centre |
| 6 | Machakusi Nursery |
| 7 | Amagoro D.o's Office |
| 8 | Alupe Cotton Research Station |
| 9 | Mbale |
| 10 | Lira |
| 11 | Nakasongola |
| 12 | Namayingo Health Centre |
| 13 | Busitema University |
| 14 | Tororo Met |
| 15 | Kwapa Sub County H/Q |
| 16 | Butaleja District H/Q |
| 17 | Budumba Health Centre |
| 18 | Manafwa Water Works |
| 19 | Kafu (Masindi) |
| 20 | Enget (Lira) |
| 21 | Namulonge Res Station |
| 22 | Jinja Met. Station |
| 23 | Tororo Met.station |
| 24 | Soroti Met Station |
| 25 | Lira Ngetta Agromet Station. |
| 26 | Nabiswera |
| 27 | Alupe Kari |




| | | | | | |
|---|---|---|---|---|---|
| 1 | L. Victoria at Jinja Pier | 14 | Wamboli at Nabiswera - Gulu Rd | 27 | R. Kyoga Nile at Masindi Port |
| 2 | Alupe | 15 | R. Manafwa at Mbale - Tororo Ro | 28 | R. Namalu at Mbale - Moroto Rd |
| 3 | Alupe | 16 | R. Mpologoma at Tirinyi-Mbale road | 29 | R. Omunyal Upper at Tiriri ri - |
| 4 | R. Malaba at Jinja - Tororo Road | 17 | R. Namatala at Mbale - Soroti R | 30 | R. Akokorio at Soroti - Katakwi |
| 5 | Malakisi | 18 | R. Sironko at Mbale - Moroto Road | 31 | L. Kwania at Kachung |
| 6 | Malakisi | 19 | R. Simu at Mbale - Moroto Road | 32 | R. Enget at Bata - Dokolo Road |
| 7 | Malaba | 20 | R. Sipi at Mbale - Moroto Road | 33 | R. Tochi II at Gulu - Atura Roa |
| 8 | R. Mayanja at Kapeeka - Kakunga | 21 | R. Abuket at Kumi - Serere Road | 34 | R. Kyoga Nile at Kamdini |
| 9 | R. Kigwe at Semuto - Wobulenzi | 22 | R. Agu at Kumi - Serere Road | 35 | Tochi1 |
| 10 | Yala | 23 | R. Kafu at Kampala - Gulu Road | 36 | R. Sezibwa at Falls |
| 11 | R. Mpologoma at Budumba | 24 | R. Kelim (Greek) at Mbale - Moroto Road | | |
| 12 | R. Victoria Nile at Mbulamuti | 25 | L. Kyoga at Bugondo Pier | | |
| 13 | Malakisi | 26 | R. Kapiri at Kumi - Soroti Road | | |

# The Lake Victoria Sub-basin

The Lake Victoria sub-basin makes the headwater of the White Nile. The Lake, with an area of about 68,000 km² offers a major regulation to the flow of Victoria Nile. Major tributaries of the Lake include the Kagera (draining parts of Burundi, Rwanda and Tanzania), Mara (originating in Kenya), Nzoiya (Kenya) and Yala (Kenya). The lake, which is a source of water for users in three countries is also used widely for navigation.

## Meteorological monitoring network

There are 254 meteorological stations in the sub-basin; distributed in Burundi (31), Kenya (124), Rwanda (34), Tanzania (42) and Uganda (23). The distribution of the stations is shown in the map below.

photo: Vivian Nabyonga

Station on River Kagera at Masangano

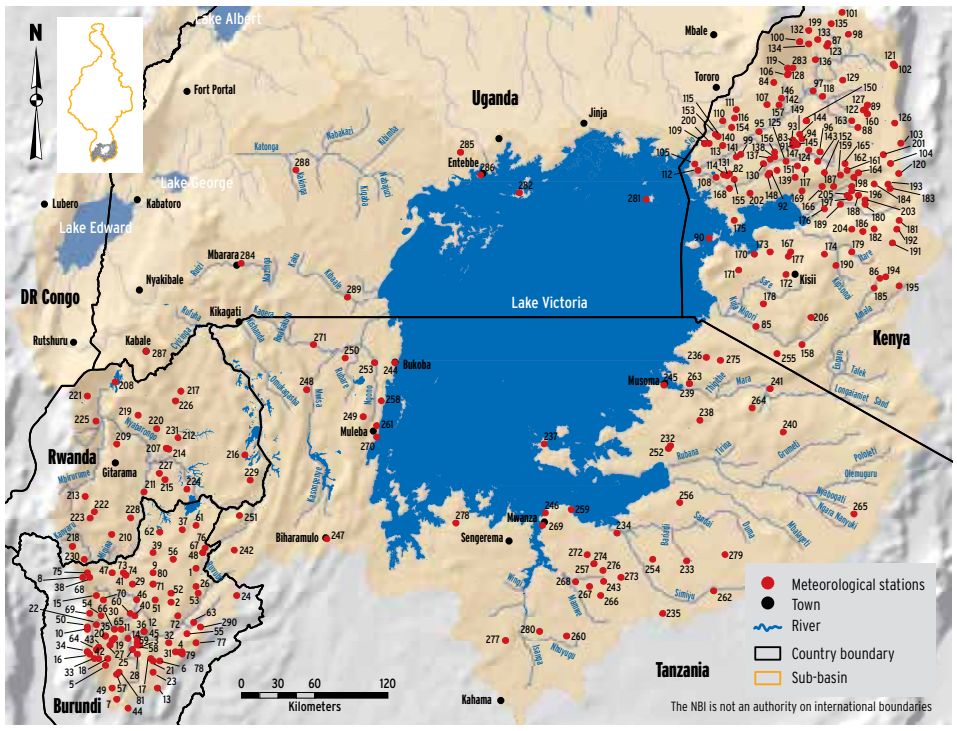

photo: Nile-SEC

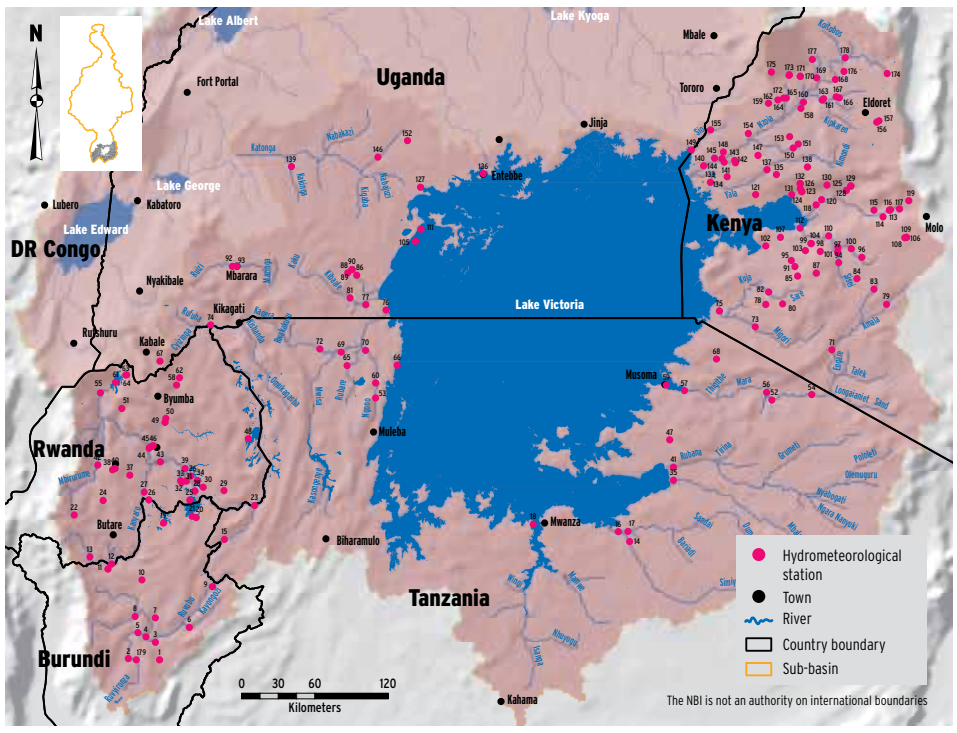
Entebbe station

## Hydrometric stations

There are 158 hydrometric stations in the sub-basin; 14 in Burundi (in Kagera catchment), 87 in Kenya, 36 in Rwanda (Kagera catchment), seven in Tanzania and four in Uganda. The map below shows the location of the stations. The table adjacent to the map provides the list of hydrometric stations that were active at the time of the survey in 2014.

Monitoring of water quality and lake water levels are two priority areas for strengthening the hydrometric monitoring system in the Lake Victoria Sub-basin. In the Kagera, sediment monitoring is a priority.




| No | Name |
|---|---|
| 1 | Muyinga |
| 2 | Karuzi |
| 3 | Gitega (Aero) |
| 4 | Ruyigi |
| 5 | Gisozi |
| 6 | Muriza |
| 7 | Ruvyironza |
| 8 | Rwegura |
| 9 | Nyamuswaga |
| 10 | Bugarama (B.aeronaut) |
| 11 | Giheta |
| 12 | Mugera (Paroisse) |
| 13 | Musongati |
| 14 | Gitega (Zege) |
| 15 | Teza (Nyabigondo) |
| 16 | Bukwavu |
| 17 | Burenza |
| 18 | Butora |
| 19 | Buziracanda |
| 20 | Fota |
| 21 | Gikwiye |
| 22 | Kiganda (Paroisse) |
| 23 | Mugege |
| 24 | Mugera (Cankuzo) |
| 25 | Mungwa |
| 26 | Muramba |
| 27 | Mwaro |
| 28 | Mweya |
| 29 | Ngozi (Kagoma) |
| 30 | Rutegama |
| 31 | Rutonganik |
| 32 | Butezi |
| 33 | Ijenda (Mission) |
| 34 | Ijenda (The Villag) |
| 35 | Kibumbu |
| 36 | Mugera (Lycee) |
| 37 | Mulehe |
| 38 | Munanira |
| 39 | Murehe (Mission) |
| 40 | Murongwe |
| 41 | Ngozi (Ocibu) |
| 42 | Nyakararo |
| 43 | Rusaka |
| 44 | Rutovu |
| 45 | Mashitsi |
| 46 | Burasira (Seminaire) |
| 47 | Busiga |
| 48 | Rugari (E.F.I.) |
| 49 | Bitezi (Gasibe) |
| 50 | Bugarama (Commune) |
| 51 | Bugenyuzi (Paroisse) |
| 52 | Buhiga |
| 53 | Buhinyuza |
| 54 | Bukeye (E.F.I.) |
| 55 | Bwagiriza |
| 56 | Gisanze |
| 57 | Gishubi |
| 58 | Gitega (Agri) |
| 59 | Gitega (Ndebe) |
| 60 | Gitongo |
| 61 | Kabuyenge |
| 62 | Kanyinya (E.F.I.) |
| 63 | Kayongozi |
| 64 | Kaziba |
| 65 | Kibimba |
| 66 | Kiganda (E.F.I.) |
| 67 | Kinazi |
| 68 | Matongo(Com) |
| 69 | Muramvya |
| 70 | Musema |
| 71 | Musenyi (E.F.I.) |
| 72 | Mutumba (Nyabikere) |
| 73 | Ngozi (Caprin) |
| 74 | Ngozi (College) |
| 75 | Remera |
| 76 | Rugari (Paroisse) |
| 77 | Rusengo (E.F.I.) |
| 78 | Ruyigi (Agri) |
| 79 | Ruyigi (Mission) |
| 80 | Musenyi (Paroisse) |
| 81 | Rweza (Nyangwa) |
| 82 | Siaya Atc |
| 83 | Masinde Muliro University |
| 84 | Chwele |
| 85 | Migori |
| 86 | Bomet |
| 87 | Kitale Met |
| 88 | Eldoret Airport |
| 89 | Eldoret Kapsoya Met |
| 90 | Suba Met, Rusinga Island Kaswanga Hdr. Stn |
| 91 | Kakamega Met |
| 92 | Nganyi Community Ranet |
| 93 | Kakamega Met New Site |
| 94 | Kakamega Airport |
| 95 | Mumias Sugar Factory |
| 96 | Kaimosi Farmers Training Centre |
| 97 | Lugari Forest Station |
| 98 | Kapsara Tea Factory |
| 99 | Uholo Chief's Office |
| 100 | Chorlim Adc |
| 101 | Kapenguria Wrma Office |
| 102 | Cheptongei Chief's Office |
| 103 | Kipkabus Forest Station |
| 104 | Nabkoi Forest Station |
| 105 | Bunyala Ranet Fm |
| 106 | Mukuyuni Dc's Office |
| 107 | Bungoma Water Yard |
| 108 | Kadenge Yala Swamp |
| 109 | Nangina Girls H. School |
| 110 | Nambale Agric. Office |
| 111 | Kwangamor Primary School |
| 112 | Bunyala Irrigation Scheme. |
| 113 | Wakhungu Nursery-Samia |
| 114 | Kaliwa Primary |
| 115 | Matayos Youth Polytechnic |
| 116 | Madende Secondary |
| 117 | Erusui Secondary |
| 118 | Lugari Water Yard |
| 119 | Kapsokwony Water Yard |
| 120 | Timboroa Forest |
| 121 | Chebara Dam |
| 122 | Eldoret Water Yard |
| 123 | Kitale Water Yard |
| 124 | Kakamega Forest Station |
| 125 | Ebusiratsi Health Centre. |
| 126 | Kaptagat Forest Station |
| 127 | Eldoret,Institute Of Agriculture |
| 128 | Kimilili Agric. Department. |
| 129 | Chief's Centre Kongoni |
| 130 | Yala Tn |
| 131 | Bondo Water Supply |
| 132 | Chorlim A.d.c. |
| 133 | A.d.c. Namandala Farm |
| 134 | Nakami Farm No.1 |
| 135 | Leissa Farm,Kitale |
| 136 | Kitale Gloucester Vale Estate |
| 137 | Khwisero Met Station |
| 138 | Mwihila Secondary School,Yala |
| 139 | Kigama Primary School |
| 140 | Sega Primary School |
| 141 | Oholo Chief's Camp. |
| 142 | Malava Agiric. Station. |
| 143 | Kaimosi Tea Estate Ltd. |
| 144 | Shikusa Borstal Institution. |
| 145 | Kakamega Agromet Station |
| 146 | Bukembe |
| 147 | Eregi, St. Augustine's T.t.c. |
| 148 | Esalwa Secondary School |
| 149 | Mundoli |
| 150 | Malava Forest Guard Post. |
| 151 | Sabatia Chief's Office |
| 152 | Kabujoi Forest Station |
| 153 | Namuichula Nursery |
| 154 | Lugulu Primary School |
| 155 | Barding Harambee Secondary Sch. |
| 156 | Bukura Institute Of Agriculture |
| 157 | Nzoia Sugar Factory Bungoma |
| 158 | Shiakungu Sec. School |
| 159 | Nandi Hills, Savani Estate |
| 160 | Eldoret Kenya Coop. Creameries |
| 161 | Siret Tea Co. Ltd.,Nandi |
| 162 | Nandi Hills,Kibweri Tea Estate |
| 163 | Kapsaret Forest Station ,Eldoret |
| 164 | Kimwani A.d.c. Farm |
| 165 | Kapkeben Chemoni Estate |
| 166 | Miwani Sugar Section III |
| 167 | Oyugis Agricultural Station |
| 168 | Bondo Water Supply |
| 169 | Kibos Cotton Experimental Sta. |
| 170 | Homabay Farmers Training Centre |
| 171 | Lambwe Forest Station |
| 172 | Wanjare Chief's Camp |
| 173 | Ndiru Chief's Camp |
| 174 | Kebabe Primary School |
| 175 | Madiany Chief's Office |
| 176 | Masaka Apundo's Farm |
| 177 | Nyabola Girl's Secondary School |
| 178 | South Nyanza Sugar Factory |
| 179 | Kaminjeiwet Secondary School |
| 180 | Koru Homa Lime Co' Ltd |
| 181 | Londian, Keresoi Forest Station |
| 182 | Kericho Tea Research Foundation |
| 183 | Maragat Forest Station |
| 184 | Tenderet Tea Estate |
| 185 | Bomet Water Supply |
| 186 | Hail Research Station Kericho |
| 187 | Chemase Cane Grow |
| 188 | Mombwo Sugar Belt Co. |
| 189 | Awasi School |
| 190 | Aroket Tea Estate Sotik |
| 191 | Ndoinet Forest Station |
| 192 | Saino Forest Station |
| 193 | Tendeno Forest Station |
| 194 | Nyangores Forest Station |
| 195 | Narotia Forest Station |
| 196 | Achego Primary School |
| 197 | God Abuoro Primary School |
| 198 | Ogen Primary School |
| 199 | Naluwa Farm Endebess |
| 200 | Nangina Catholic Mission |
| 201 | Burnt Forest Agric. Station |
| 202 | Akala Dispensary |
| 203 | Koru, Coffee Board Sub-Station |
| 204 | Cheptenye Secondary School |
| 205 | Makindu Pri. School, Muhoroni |
| 206 | Kilgoris Divissional Agr.office |
| 207 | Kigali Aero |
| 208 | Ntaruka |
| 209 | Bakokwe |
| 210 | Butare Aero |
| 211 | Gihinga |
| 212 | Gikomero |
| 213 | Kaduha |
| 214 | Kanombe |
| 215 | Mayange |
| 216 | Ndego |
| 217 | Ngarama |
| 218 | Nyabimata |
| 219 | Rulindo |
| 220 | Rutongo |
| 221 | Busogo-Isae |
| 222 | Cyanika |
| 223 | Gikongoro Met |
| 224 | Karama Kilimbi |
| 225 | Muramba Paroisse |
| 226 | Nyagahanga Efa |
| 227 | Nyamata |
| 228 | Nyamiyaga |
| 229 | Nyarubuye |
| 230 | Runyombyi |
| 231 | Kigali Aero |
| 232 | Bunda/ Bitaraguru Met. Station |
| 233 | Kidinda Met. Station |
| 234 | Magu Met. Station |
| 235 | Maswa Met. Station |
| 236 | Randa Met. Station |
| 237 | Ukerewe Met. Station |
| 238 | Buhemba Met. Station |
| 239 | Kuruya Met. Station |
| 240 | Mugumu Met. Station |
| 241 | Nyabusara Met. Station |
| 242 | Rulenge Met. Station |
| 243 | Ngudu Met. Station |
| 244 | Bukoba |
| 245 | Musoma |
| 246 | Mwanza |
| 247 | Biharamulo |
| 248 | Kayanga Met. Station |
| 249 | Kishanda Met. Station |
| 250 | Kyakakera Met. Station |
| 251 | Ngara |
| 252 | Bitaraguru P/School |
| 253 | Bukoba Maji (Yard) |
| 254 | Busulwangili P/School |
| 255 | Busweta P/School |
| 256 | Bwai P/School |
| 257 | Chanongu P/School |
| 258 | Izigo |
| 259 | Kayenze P/School |
| 260 | Kikubiji P/School |
| 261 | Kikuku |
| 262 | Kisesa P/School |
| 263 | Kuruya P/School |
| 264 | Lukuba Island |
| 265 | Mugumu P/School |
| 266 | Mwabagole P/School |
| 267 | Mwadubi P/School |
| 268 | Mwanangwa P/School |
| 269 | Mwanza Maji (Yard) |
| 270 | Nshambya |
| 271 | Nyakanyasi |
| 272 | Sumve High School |
| 273 | Tallaga P/School |
| 274 | Tallo Secondary School |
| 275 | Utegi P/School |
| 276 | Walla P/School |
| 277 | Kharumwa P/School |
| 278 | Nyehunge P/School |
| 279 | Sagata P/School |
| 280 | Zunzuli P/School |
| 281 | Lolui |
| 282 | Kome |
| 283 | Molo Sub County H/Q |
| 284 | Mbarara Met Station |
| 285 | Mpanga Forest Statio |
| 286 | Entebbe Intl Airport |
| 287 | Kabake Met Station |
| 288 | Lwemiyaga |
| 289 | Kakuto |
| 290 | Cankuzo (Projet) |

| No | Name |
|---|---|
| 1 | Nyakijanda (Buhoro K10) |
| 2 | Ruvyironza (Muyange) |
| 3 | Nyabaha (Mubuga) |
| 4 | Ruvubu (Gitega) |
| 5 | Ruvyironza (Kibaya) |
| 6 | Kayongozi (Nyankanda) |
| 7 | Ndurumu (Shombo) |
| 8 | Mubarazi (Murongwe) |
| 9 | Ruvubu (Muyinga) |
| 10 | Nyamuswaga (Gisha) |
| 11 | Kayave (Mparamirundi |
| 12 | Rte Butare/Ngozi (Akanyaru) |
| 13 | Kibeho (Akanyaru) |
| 14 | Simiyu River at Lumeji |
| 15 | Ruvuvu/Mumwendo Ferry |
| 16 | Simiyu River at M/Bridge |
| 17 | Duma River at Sayaka |
| 18 | Mwanza South Port |
| 19 | Cohoha (Kigozi) |
| 20 | Kazingiri (Nyagatare) |
| 21 | Rweru (Nyagisozi) |
| 22 | Mudasomwa (Rukarara) |
| 23 | Rusumo (Akagera) |
| 24 | Nyabisindu (Mwogo) |
| 25 | Gakindo (Lac Rweru) |
| 26 | Shell (Lac Cyohoha S) |
| 27 | Gihinga (Akanyaru) |
| 28 | Mbuye (Akagera) |
| 29 | Nduruma (Cyunuzi) |
| 30 | Rubago (Lac Sake) |
| 31 | Gashora (Lac Mirayi) |
| 32 | Mfune (Nyabarongo) |
| 33 | Gashora (Lac Rumira) |
| 34 | Rukoma (Lac Sake) |
| 35 | Mbalageti |
| 36 | Shyembe (Lac Bilira) |
| 37 | Ururumanza (Ururumanza) |
| 38 | Gihuma (Gihuma) |
| 39 | Rwinzoka (Akagera) |
| 40 | Kavumu (Rugeramigozi) |
| 41 | Grumet River at M/Bridge |
| 42 | Mwaka (Nyabarongo) |
| 43 | Kanzenze (Nyabarongo) |
| 44 | Ruliba (Nyabarongo) |
| 45 | Nemba (Nyabugogo) |
| 46 | Yanze (Yanze) |
| 47 | Suguti |
| 48 | Ihema (Ihema Lake) |
| 49 | Gaseke (Nyamabuye) |
| 50 | Rusumo (Mwange) |
| 51 | Kinoni (Base) |
| 52 | Mara River at Nyansurura |
| 53 | Ngono/Muhutwe |
| 54 | Kogatende Ranger Post |
| 55 | Nyakinama (Mukungwa) |
| 56 | Mara River at Mara Mine |
| 57 | Mara River at Kirumi Ferry |
| 58 | Nyagahanga (Warufu) |
| 59 | Musoma Port |
| 60 | Ngono/Kalebe Bridge |
| 61 | Ntaruka (Lac Bulera) |
| 62 | Ngoma (Ngoma) |
| 63 | Kamiranzovu (Kamiranzovu) |
| 64 | Rusumo (Rugezi) |
| 65 | West Ngono at Kyakakera |
| 66 | Bukoba Port |
| 67 | R. Nyakizumba at Maziba |
| 68 | Mori River at Utegi |
| 69 | Kagera/Kyaka Ferry |
| 70 | Ngono/Kyaka Rd Bridge |
| 71 | Mara |
| 72 | Kagera/Nyakanyasi |
| 73 | Migori |
| 74 | Kagitumba (Muvumba) |
| 75 | Gucha Migori |
| 76 | R. Kagera at Masangano |
| 77 | R. Bukora at Katera |
| 78 | Sare |
| 79 | Amala |
| 80 | Nyangweta |
| 81 | R. Bukora at Mutukula - Kyotera |
| 82 | Gucha |
| 83 | Nyangores |
| 84 | Kipsonoi |
| 85 | Nyakobisara |
| 86 | R. Kisoma at Mutukula - Kyotera |
| 87 | Kenyamware |
| 88 | R. Lwanda at Kyotera - Rakai Ro |
| 89 | R. Kisoma Upper Stream at Kyote |
| 90 | R. Kisoma Upper at Kyotera - Ra |
| 91 | Mogusii |
| 92 | R. Ruizi at New Waterworks |
| 93 | R. Ruizi at Mbarara Water Works |
| 94 | Kipsonoi Kapsimbiri |
| 95 | Isanda |
| 96 | Kiptiget |
| 97 | Kipsonoi |
| 98 | Eaka Kioge |
| 99 | Awach Ober |
| 100 | New Itare |
| 101 | Yurith |
| 102 | Awach Tende |
| 103 | Awach |
| 104 | Awach Kabondo |
| 105 | Mapamujugu |
| 106 | Songon |
| 107 | Awach Kabuon |
| 108 | Lower Songon |
| 109 | Ainapkoi |
| 110 | Sondu |
| 111 | Katonga at Kampala Katonga Road |
| 112 | Miriu Sondu |
| 113 | Tugenon |
| 114 | Nyando |
| 115 | Namuting |
| 116 | Nyando |
| 117 | Masaita |
| 118 | Nyando (Ahero Bridge) |
| 119 | Masaita Dam |
| 120 | Nyando |
| 121 | Awach Seme |
| 122 | Lake Victoria at Kisumu |
| 123 | Kibos |
| 124 | Kibos |
| 125 | Mbogo |
| 126 | Awach |
| 127 | R. Katonga at Kampala - Masaka |
| 128 | Ainamatua |
| 129 | Ainopsiwa |
| 130 | Great Oruba |
| 131 | Tributary of Kibos |
| 132 | Kibos |
| 133 | Yala Kadenge |
| 134 | Yala |
| 135 | Zaaba |
| 136 | L. Victoria at Entebbe Pier |
| 137 | Edzawa |
| 138 | Garagoli |
| 139 | R. Kakinga Index Catchment |
| 140 | Nzoia Ruambwa |
| 141 | Uludhi |
| 142 | Wuroya |
| 143 | Wuroya |
| 144 | Nzoia |
| 145 | Gaula |
| 146 | R. Kibimba at Kinoni - Mubende |
| 147 | Firatsi |
| 148 | Placemark |
| 149 | R. Sio at Luhalali Near Bunadet |
| 150 | Isiukhu |
| 151 | Ikhamala |
| 152 | L. Wamala at Lubajja |
| 153 | Áisasala |
| 154 | Lairi |
| 155 | Sio River |
| 156 | Endoroto |
| 157 | Ellegirini |
| 158 | Chevaywa |
| 159 | Khalaba |
| 160 | Luandeti |
| 161 | Kipkarren |
| 162 | Chwele |
| 163 | Murqusi |
| 164 | Bokoli |
| 165 | Kuywa |
| 166 | Sosiani |
| 167 | Segoit |
| 168 | Large Nzoia |
| 169 | Rongai |
| 170 | Kamakoiwa |
| 171 | Kamukoywa |
| 172 | Kimilili Springs |
| 173 | Kimilili |
| 174 | Moiben |
| 175 | Kuywa |
| 176 | Little Nzoia |
| 177 | Tongaren |
| 178 | Nzoia |
| 179 | Ruvyironza (Nyabiraba) |

# NILE BASIN REGIONAL HYDROMET

## Challenges and Opportunities

River basin monitoring is essential for knowledge-based water resources planning, efficient water resources management, socio-economic development, and environmental sustainability. The current system of Nile Basin monitoring is inadequate where many significant hydrologic portions of the Nile Basin are either un-gauged or very sparselyt gauged even with respect to basic hydrological parameters. To address these critical gaps and improve transboundary water resource collaboration, the NBI worked with the NBI riparian countries to develop design specifications and an implementation plan for the Nile Basin Regional Hydro-meteorological Monitoring System.

Based on the individual country inclusive assessments, it was clear that each of the riparian countries had the requisite institutions established for monitoring, but that the level of professional depth and breadth of training and staffing varied, as did the hardware and software available for collecting and managing the data and actual parameters being measured. The most important gaps identified and addressed in the development of the Nile Basin Regional Monitoring Network are: significant number of stations that are outdated and out of service, inadequate equipment calibration, limited or non-existent telemetry systems, lack of adequate or modern data acquisition and management systems, and weak national water quality, groundwater and sediment monitoring programs.

## Recent developments

Recognizing the importance of a functional Nile River Basin Monitoring System, NBI developed the design of a regional hydromet system that addresses the severe gaps, responds to the strategic water resource management issues that had direct bearing on the socio-economic developments within the basin, builds on existing networks – including those of IGAD-HYCOS Program – is based on international guidelines and best practices, and considers national needs and limitations.

## Meteorological Network Design

The meteorological network design was driven by the spatial distribution necessary to capture the meteorological variability within the basin. A total of 322 meteorological stations are proposed for the regional network of the Nile Basin. This includes 227 stations to measure a full suite of meteorological parameters and 95 to monitor rainfall only. The full meteorological (Full Met) stations include instruments to measure precipitation, wind, air temperature, humidity, barometric pressure and solar radiation which allows for the calculation of evaporation.

### Proposed meteorological network for the Nile Basin

## Meteorological stations per sub-basin

| Sub-basin | Area (KM²) | Regional design |
|---|---|---|
| Lake Victoria - Kagera | 197,181 | 30 |
| Lake Victoria - Kenya/Mara | 49,737 | 31 |
| Lake Victoria - Tanzania/Mara | 71,305 | 22 |
| Lake Victoria - Uganda | 27,660 | 13 |
| Victoria Nile | 85,521 | 28 |
| Lake Albert | 74,819 | 28 |
| Bahr el Jebel | 185,364 | 14 |
| Bahr el Ghazal | 604,746 | 23 |
| Baro-Akobo-Sobat | 204,288 | 17 |
| White Nile | 258,803 | 17 |
| Blue Nile - Upper | 175,374 | 41 |
| Blue Nile - Lower | 132,344 | 13 |
| Tekeze-Atbara | 232,374 | 35 |
| Main Nile | 592,637 | 10 |
| | Total | 322 |

## Summary of proposed meteorological network by country

| Country | Active | Inactive* | New | Total | # of Stations w/ | |
|---|---|---|---|---|---|---|
| | | | | | Full Met | Rain Only |
| Burundi | 9 | 1 | 1 | 11 | 10 | 1 |
| DR Congo | 3 | 2 | 4 | 9 | 7 | 2 |
| Ethiopia | 82 | 1 | 0 | 83 | 74 | 9 |
| Kenya | 28 | 5 | 0 | 33 | 21 | 12 |
| Rwanda | 10 | 1 | 0 | 11 | 11 | 0 |
| South Sudan | 5 | 22 | 5 | 32 | 18 | 14 |
| Sudan | 33 | 18 | 0 | 51 | 29 | 22 |
| Tanzania | 21 | 6 | 0 | 27 | 22 | 5 |
| Uganda | 48 | 17 | 0 | 65 | 35 | 30 |
| Total | 239 | 73 | 10 | 322 | 227 | 95 |
| % of Total | 74% | 23% | 3% | 100% | 70% | 30% |

*Inactive Stations also include unknown or "blank" status entries originally received

## Hydrological Network Design

The primary purpose of the existing hydrometric stations for the regional design would be for measuring stream-flow at rivers and water level at lakes. In addition, the hydrometric design also includes locations by water quality and sediment monitoring, which typically aligns with streamflow gauging locations. The regional design proposes monitoring of both basic and advanced water quality parameters. The Nile Basin hydrometric design focuses on achieving the monitoring of transboundary water management issues. A total of 79 hydrometric stations are proposed for the regional network of the Nile Basin.

## Summary of Proposed Regional Hydrometric Network by Country

| Country | Active | Inactive* | New | Total | # of Stations w/ | |
|---|---|---|---|---|---|---|
| | | | | | WQ | Sediment |
| Burundi | 2 | 0 | 0 | 2 | 1 | 2 |
| DR Congo | 0 | 0 | 1 | 1 | 1 | 0 |
| Ethiopia | 15 | 0 | 0 | 15 | 4 | 14 |
| Kenya | 6 | 0 | 0 | 6 | 6 | 1 |
| Rwanda | 6 | 0 | 1 | 7 | 6 | 5 |
| South Sudan | 4 | 6 | 2 | 12 | 5 | 2 |
| Sudan | 12 | 1 | 0 | 13 | 9 | 12 |
| Tanzania | 8 | 0 | 0 | 8 | 8 | 6 |
| Uganda | 14 | 1 | 0 | 15 | 12 | 1 |
| Total | 67 | 8 | 4 | 79 | 52 | 43 |
| % of Total | 85% | 10% | 5% | 100% | 66% | 55% |

*Inactive Stations also include unknown or "blank" status entries originally received

## Proposed hydrometric network map

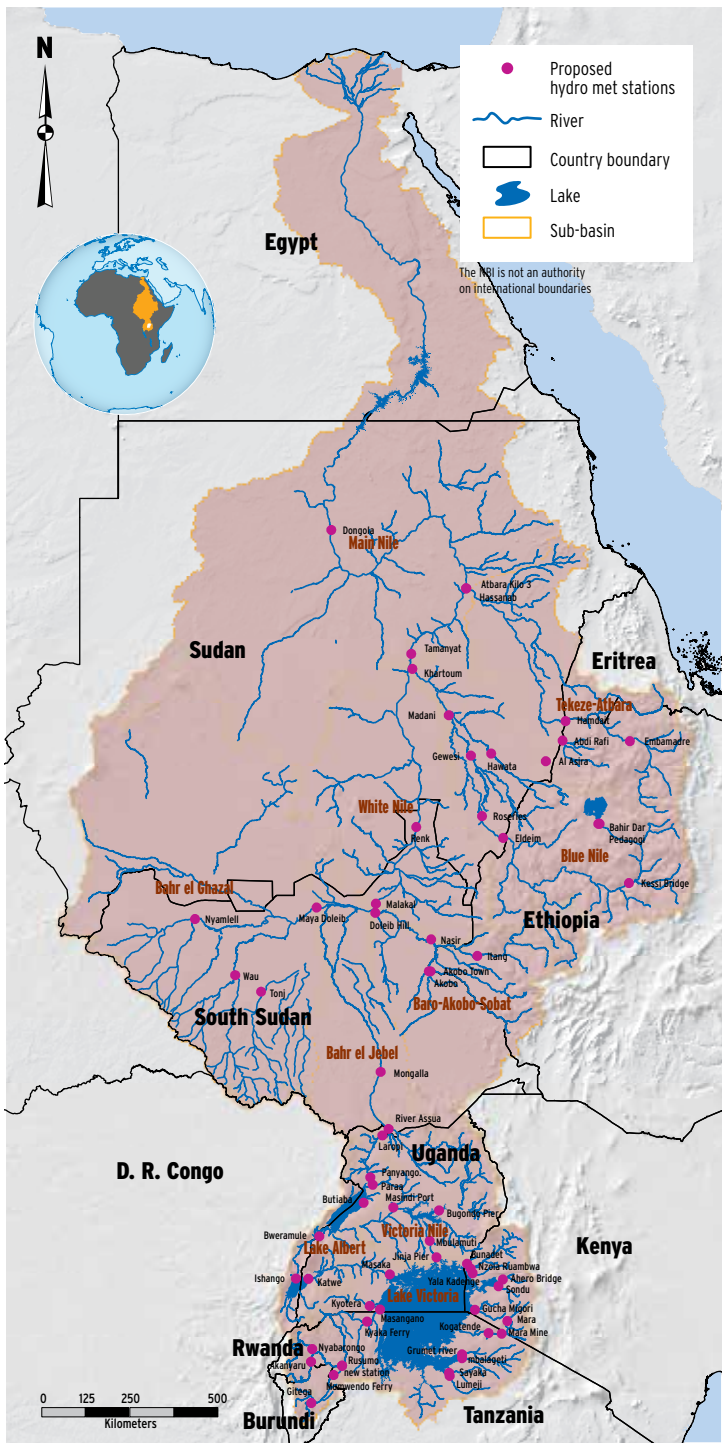



photo: Amy the Nurse/flickr.com

Meandering river in South Sudan

photo: Amy the Nurse/flickr.com

Meandering river in South Sudan

# CONCLUSION

Photo istock

The critical gap in data in the Nile Basin has been recognized early during the preparation of the first set of cooperative projects under NBI. As a result, NBI developed the Nile River Basin Monitoring Strategy to guide its activities for enhancing the monitoring system in the Nile Basin. The strategy was endorsed by the NBI governance and remains the guiding document for the design of the regional monitoring network.

Gaps in spatial coverage and time series in key catchments result in an incomplete understanding and knowledge of bio-physical conditions, setbacks in strategic assessment and water resources planning, suboptimal water management decisions, and delays in planning and execution of investment projects.

Some 14 issues were first identified by NBI Member States; these included: improved water resource planning and management; flood management; rain-fed agricultural management, irrigated agricultural management; drought management; soil erosion and sediment transport; surface water quality; groundwater management; hydropower; navigation; fisheries; watershed management; wetlands management; and climate change. These regional issues played a key role in the methodology of station selection for the regional network.

Information collected by the system will be accessible to all NBI Member States through the NBI Regional Data Management system; guided by the effective data sharing protocol among the NBI countries. NBI will compile all the data collected within the riparian countries and provide synthesized information, trends, patterns, and facts that will inform both national and regional water resources planning and management.