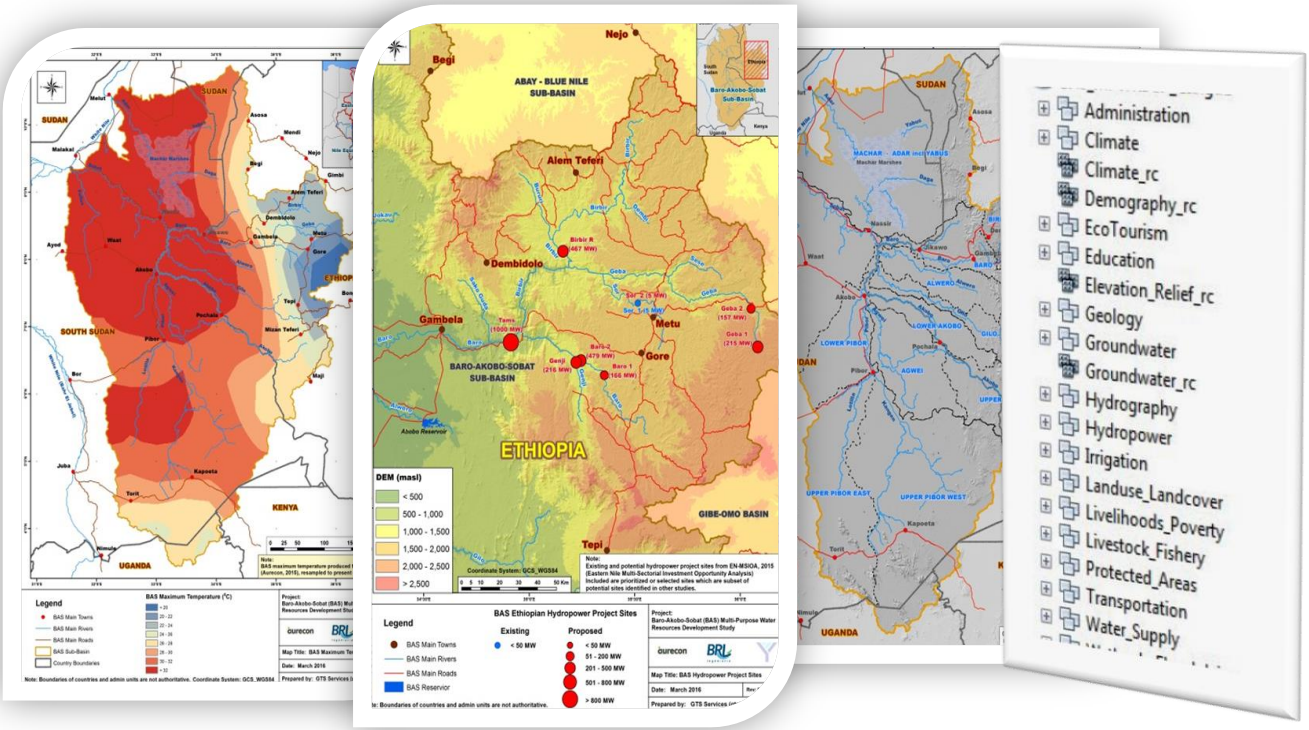
Baro-Akobo-Sobat Multi-Purpose Water Resources Development Study Project

BAS Atlas of Maps



May 2017

Prepared by:
GTS Services Plc.
(gtshsig@gmail.com)

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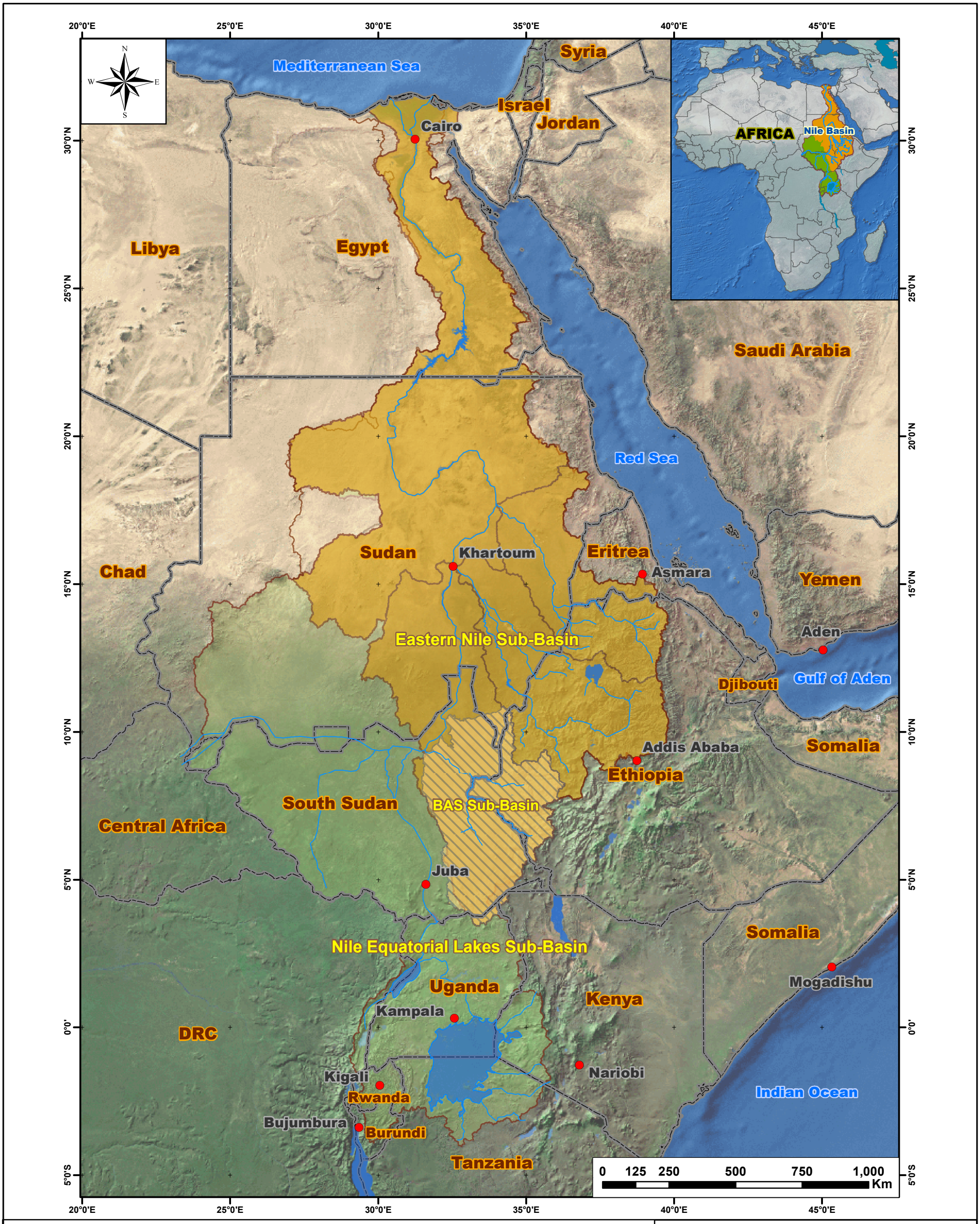
1. GENERAL OVERVIEW

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: LOCATION MAP



Legend

- Capital Cities
- Nile Basin Main Rivers
- Lakes & Reservoirs
- Baro-Akobo-Sobat Sub-Basin
- Eastern Nile Sub-Basin
- Nile Equatorial Lakes Sub-Basin
- Country Boundaries

Basin/Sub-Basin Boundaries:
Eastern Nile Technical Regional Office (ENTRO)
Nile Basin Initiative (NBI)

Background Map:
World Color Shaded Relief Imagery
(ESRI/Environmental Systems Research Institute)

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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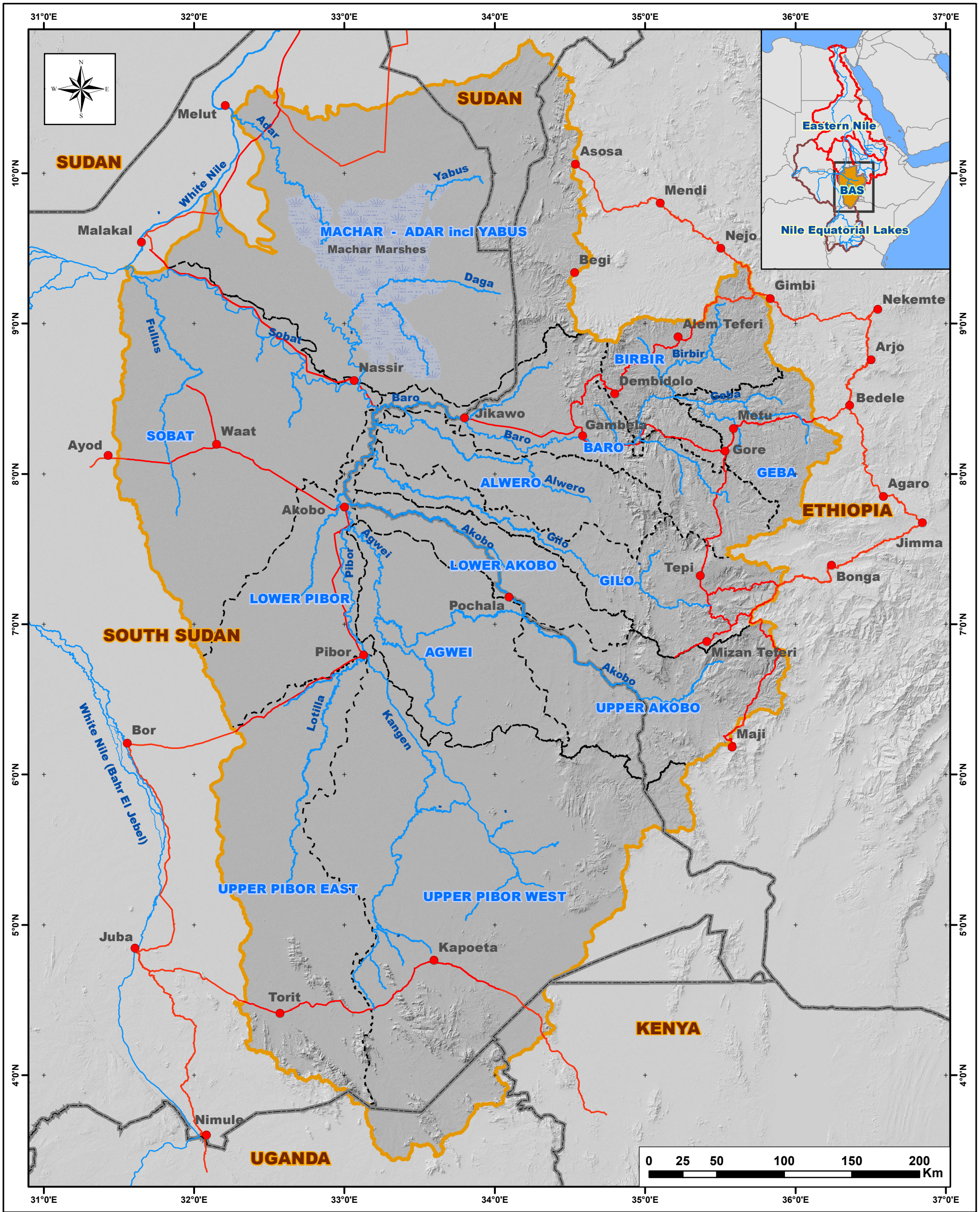
Title: BAS Sub-Basin Location Map

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: BACKGROUND MAP



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

Background Map:
Hillshade of BAS DEM (Digital Elevation Model, SRTM)
Spatial Resolution: 30m

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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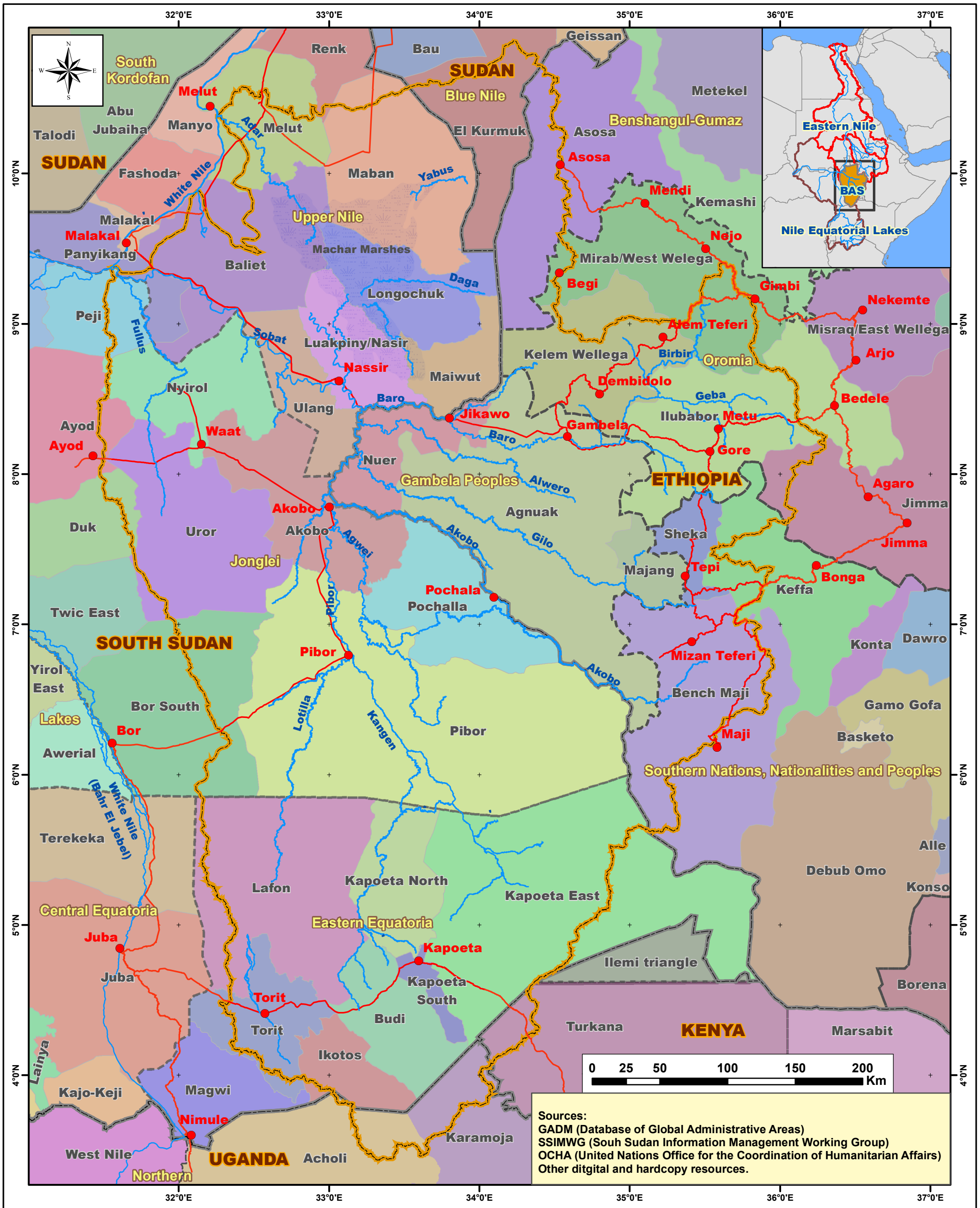
Map Title: BAS Background Map

Date: March 2016 | **Rev:** Final Draft

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: ADMINISTRATIVE MAP



Sources:
GADM (Database of Global Administrative Areas)
SSIMWG (Souh Sudan Information Management Working Group)
OCHA (United Nations Office for the Coordination of Humanitarian Affairs)
Other ditgital and hardcopy resources.

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- ETH Regions/SSD States/SDN States
  UGA Sub-Regions/KEN Counties
- BAS Sub-Basin
- Country Boundaries

BAS Admin Mapping Units:

Ethiopia (ETH):	Zones
South Sudan (SSD):	Counties
Sudan (SDN):	Localities
Uganda (UGA):	Sub-Regions
Kenya (KEN):	Counties

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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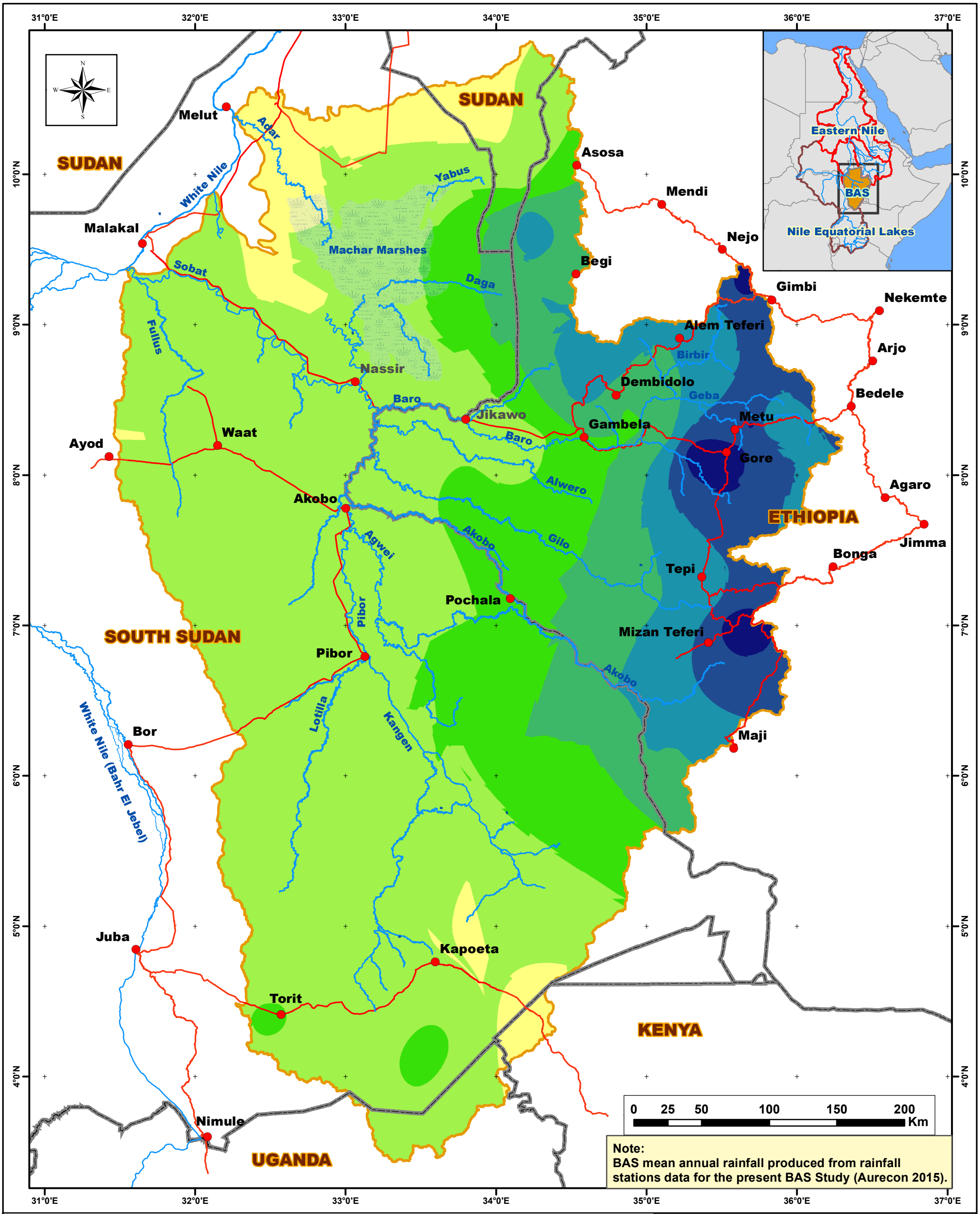
Map Title: BAS Administrative Map

Date: March 2016 | Rev: Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

2. BIO-PHYSICAL ENVIRONMENT

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: MEAN ANNUAL RAINFALL



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Mean Annual Rainfall (mm)

- < 750
- 750 - 1,000
- 1,000 - 1,250
- 1,250 - 1,500
- 1,500 - 1,750
- 1,750 - 2,000
- > 2,000

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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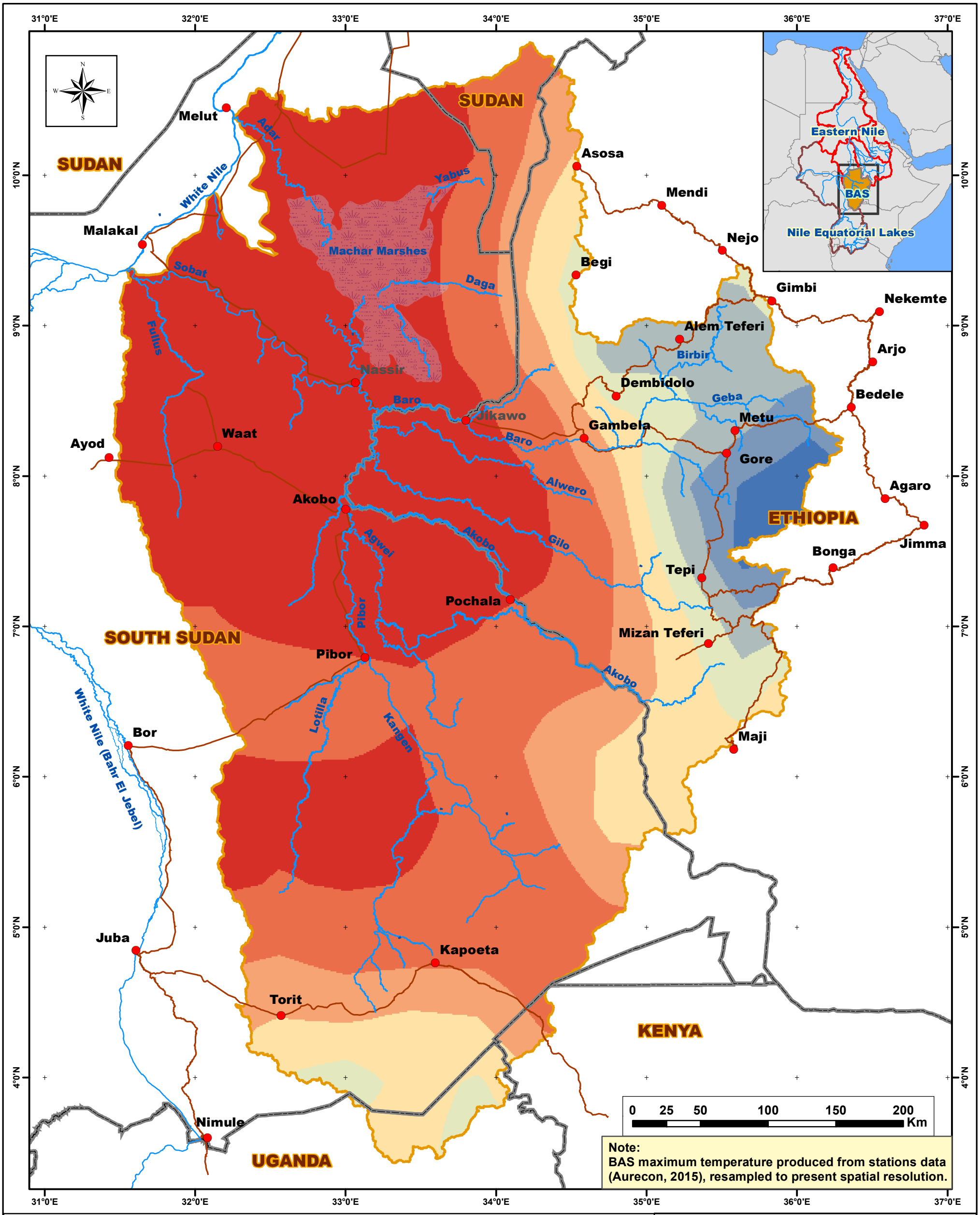
Map Title: BAS Mean Annual Rainfall

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: MAXIMUM TEMPERATURE



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Maximum Temperature (^{0}C)

- < 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 28
- 28 - 30
- 30 - 32
- > 32

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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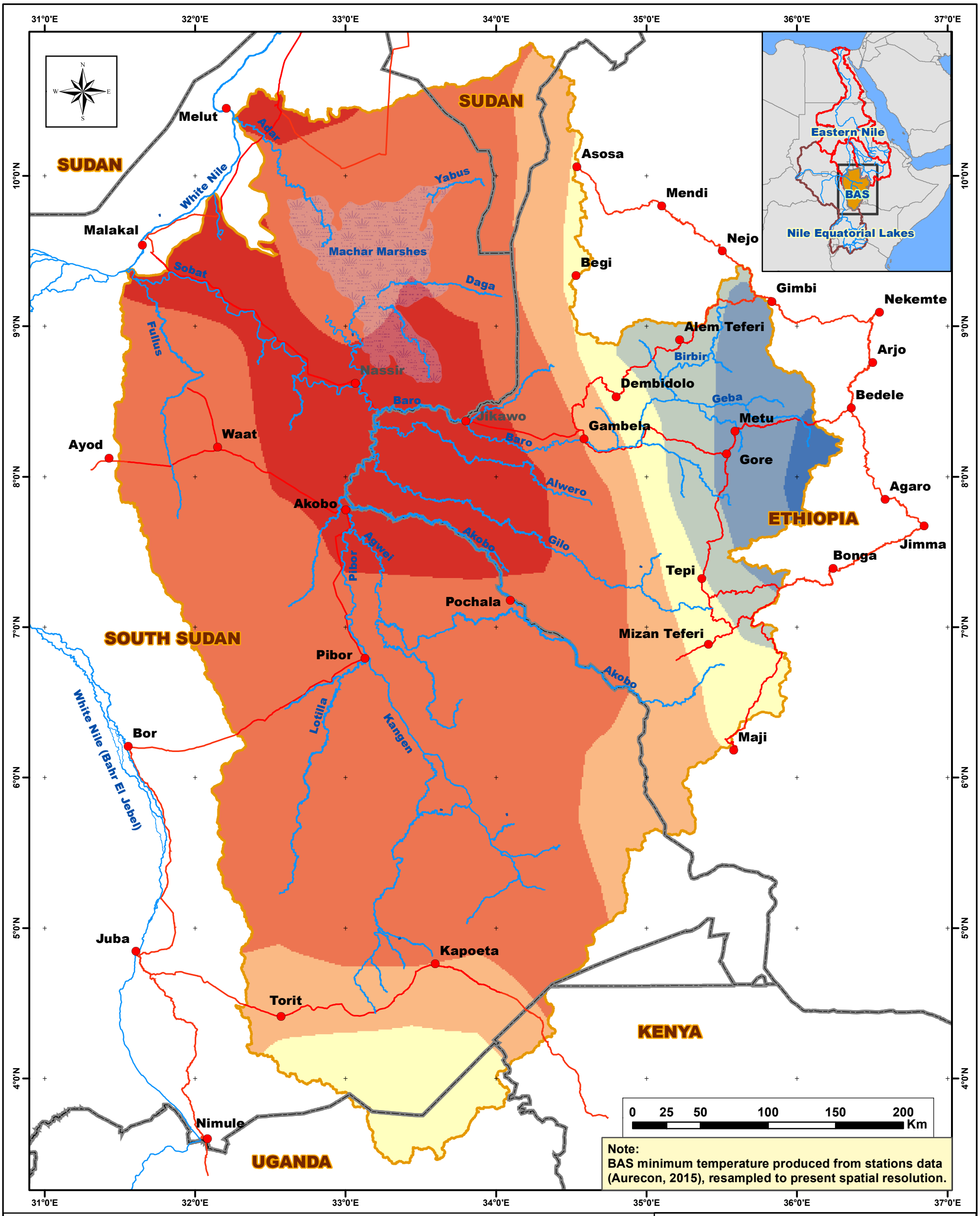
Map Title: BAS Maximum Temperature

Date: March 2016 | **Rev:** Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: MINIMUM TEMPERATURE



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Minimum Temperature (^{0}C)

- < 11
- 11 - 13
- 13 - 15
- 15 - 17
- 17 - 19
- 19 - 21
- > 21

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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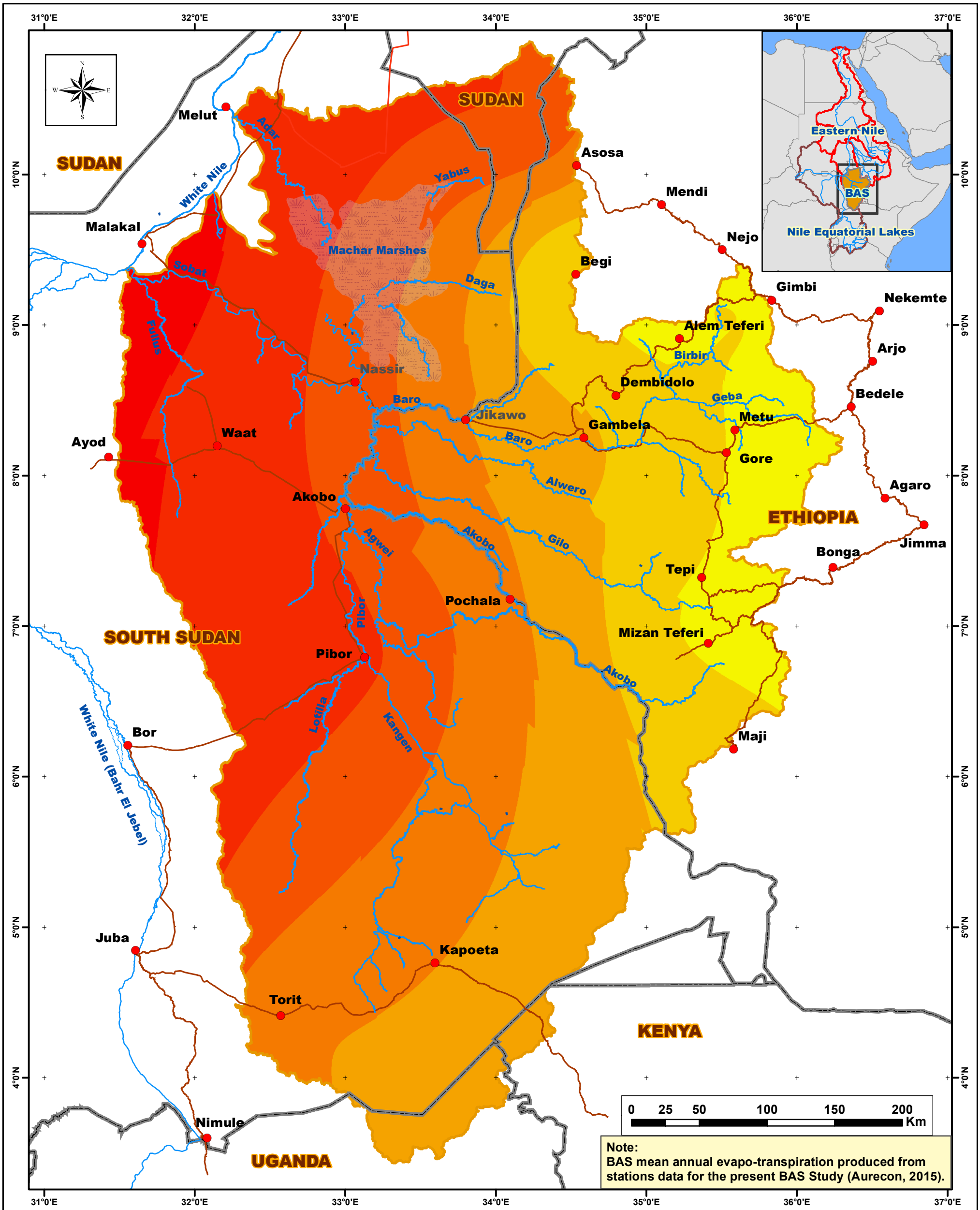
Map Title: BAS MinimumTemperature

Date: March 2016 | **Rev:** Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: POTENTIAL EVAPO-TRANSPIRATION



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Mean Annual Potential Evapo-Transpiration (mm)

- < 1,400
- 1,400 - 1,500
- 1,500 - 1,600
- 1,600 - 1,700
- 1,700 - 1,800
- 1,800 - 1,900
- > 1,900

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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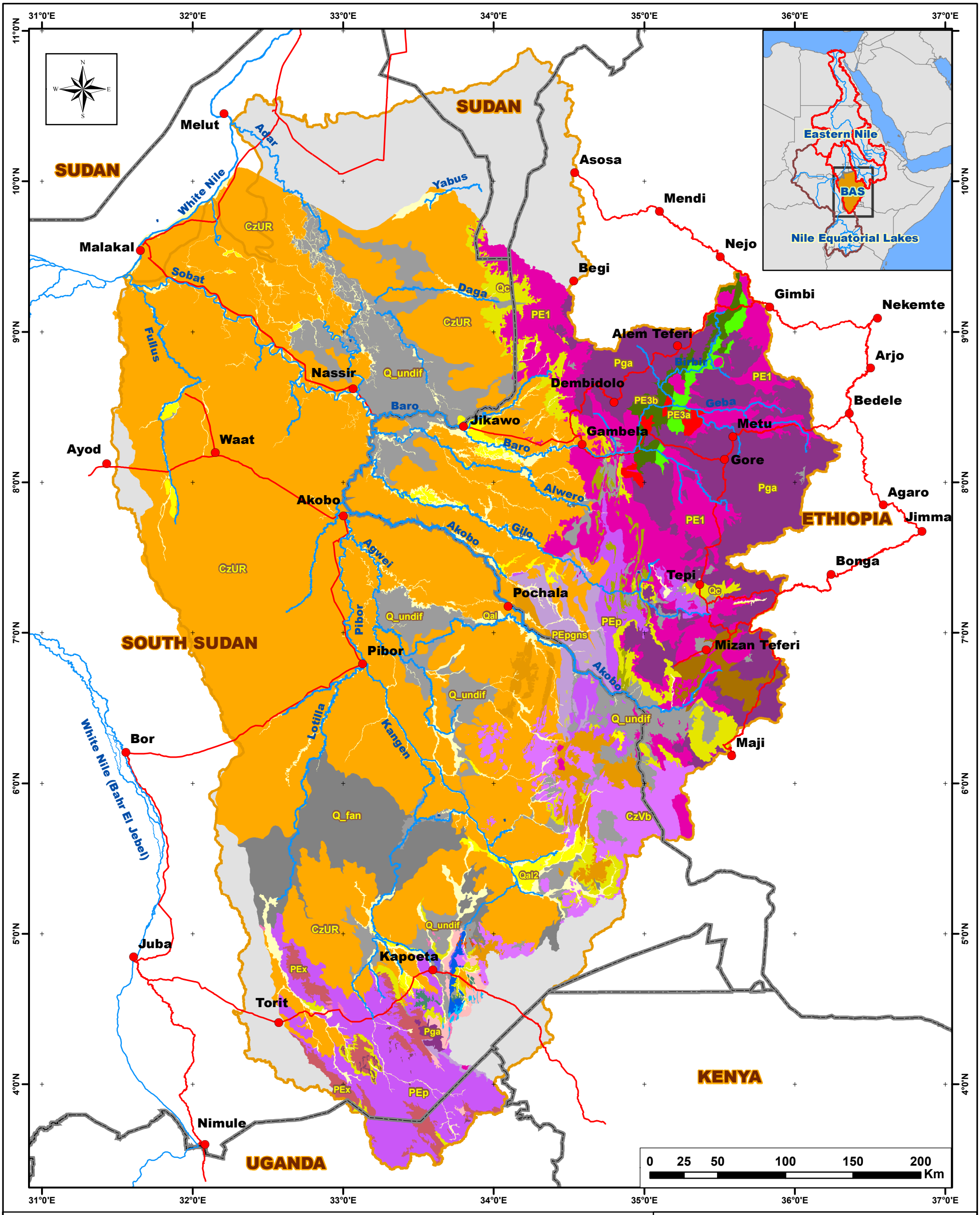
Map Title: BAS Potential Evapo-Transpiration

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: SURFICIAL GEOLOGY



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

Notes:
BAS surficial geology produced for the present Study by TTI Production-BRL Ingenierie.

Legend for the map codes provided on a separate page.

Note: Boundaries of countries and admin units are not authoritative. **Coordinate System: GCS_WGS84**

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

aurecon BRL Ingénierie

Map Title: BAS Surficial Geology

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

LEGEND FOR BARO-AKOBO-SOBAT (BAS) SUB-BASIN: SURFICIAL GEOLOGY MAP CODES

Tertiary - Quaternary Sediments

Q_undif	Undifferentiated alluviums and unconsolidated recent deposits
Q_fan	Fan deltas type deposits with rapid lateral facies changes
Qal	Recent alluvium in active river beds and wadi undifferentiated deposits
Qc	Colluvium - unconsolidated screes and slope deposits - undifferentiated talus materials
Qal2	Older alluviums deposits - raised or incised terraces and large levees - abandonned distributary channels
CzUR	Unconsolidated sands with some gravels, silts and clays

Tertiary - Quaternary Volcanic Rocks

VL	Small volcanoes or plugs and ring complex
CzVa	Rhyolitic volcanic rocks
CzVb	Basaltic volcanic rocks
Pga	Trap basaltic series - Alkali olivine basalt and tuffs with rare rhyolites

Precambrian Basement Rocks

PE_Gabbro	Gabbroic rocks
PEGr	Granitic rocks
Gt1	Syntectonic granitoid rocks
Gt2	Post-tectonic intrusive granites
PE3a	Amphibolite, chlorite, talc schists, greenstones and quartzites
PE3lb	Chlorite schists, quartzites and intermediate metavolcanics
UB	Ultrabasic rocks
PEs	Undifferentiated metasediments (amphibolite facies of metamorphism)
PEsa	Amphibolites
PEsm	Marbles - amphibolite facies of metamorphism
PEsq	Quartzites rocks
PEsy	Undifferentiated Syenitic rocks
PEum	Ultramafic rocks - Peridotites, Dunites, Harzburgites and Lherzolites
PE1	Basement lower complex - undifferentiated magmatic and metasediments
PE1_hard	Basement lower complex - undifferentiated magmatic and metasediments (competent facies)
PEp	Undifferentiated metamorphic rocks
PEpgns	Undifferentiated gneissic rocks
PEps	Schistose supercrustal metasediments - amphibolite facies of metamorphism
PE1b	Basement complex - Burji Gneiss (fine foliated biotite gneisses and schists)
PEx	Undifferentiated Granulite and Mylonitic facies rocks
Unmapped	Unmapped area

Notes:
BAS surficial geology produced for the present Study by TTI Production-BRL Ingenierie.

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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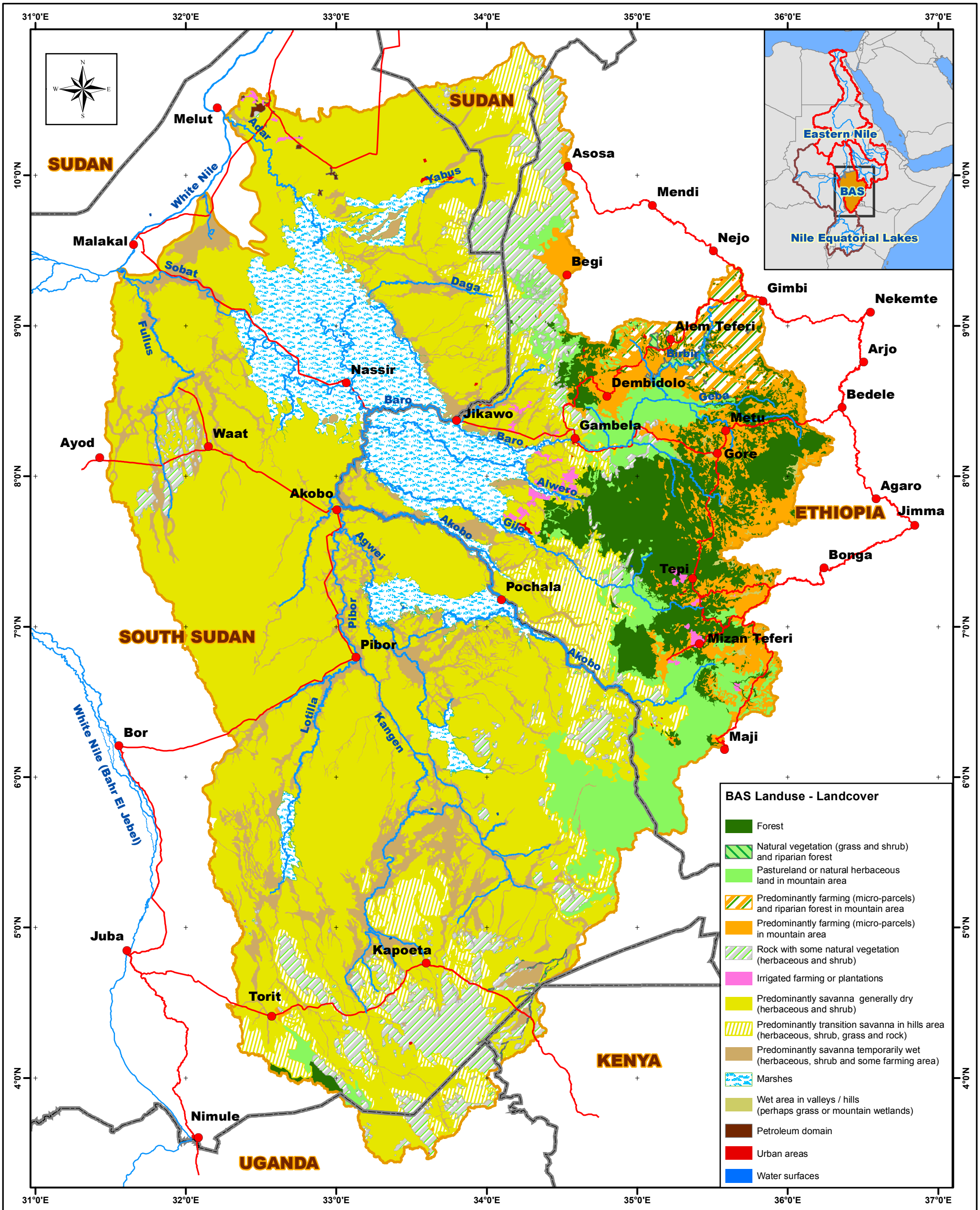
Title: Legend for BAS Surficial Geology Map Codes

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: LANDUSE - LANDCOVER



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

0 25 50 100 150 200 Km

Source:
BAS landuse - lancover map produced for the present Study by TTI Production-BRL Ingenierie.

Note: Boundaries of countries and admin units are not authoritative. **Coordinate System: GCS_WGS84**

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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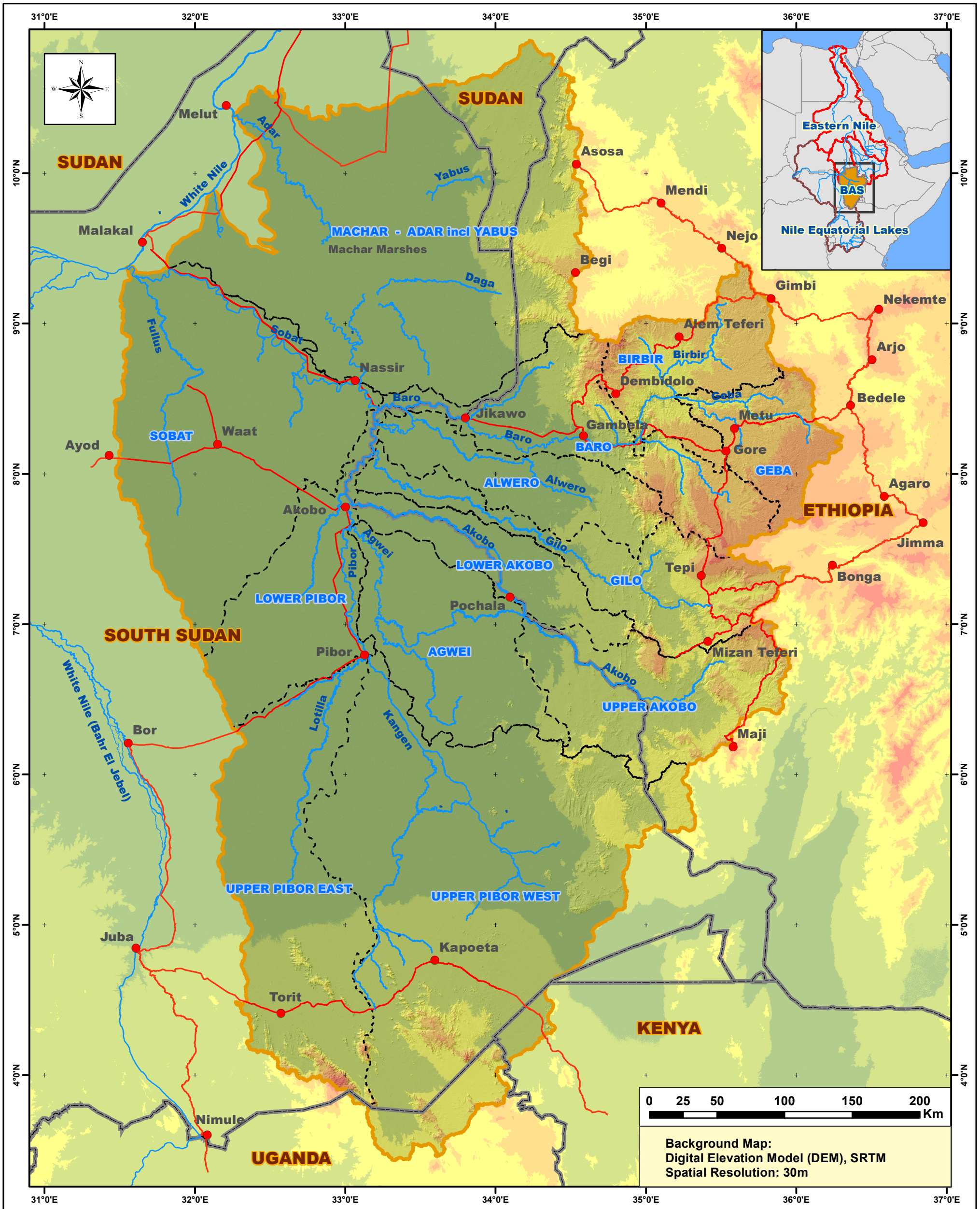
Map Title: BAS Landuse - Landcover

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: RELIEF & DRAINAGE



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

DEM / Digital Elevation Model (masl)

- < 500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,000
- 2,000 - 2,500
- > 2,500

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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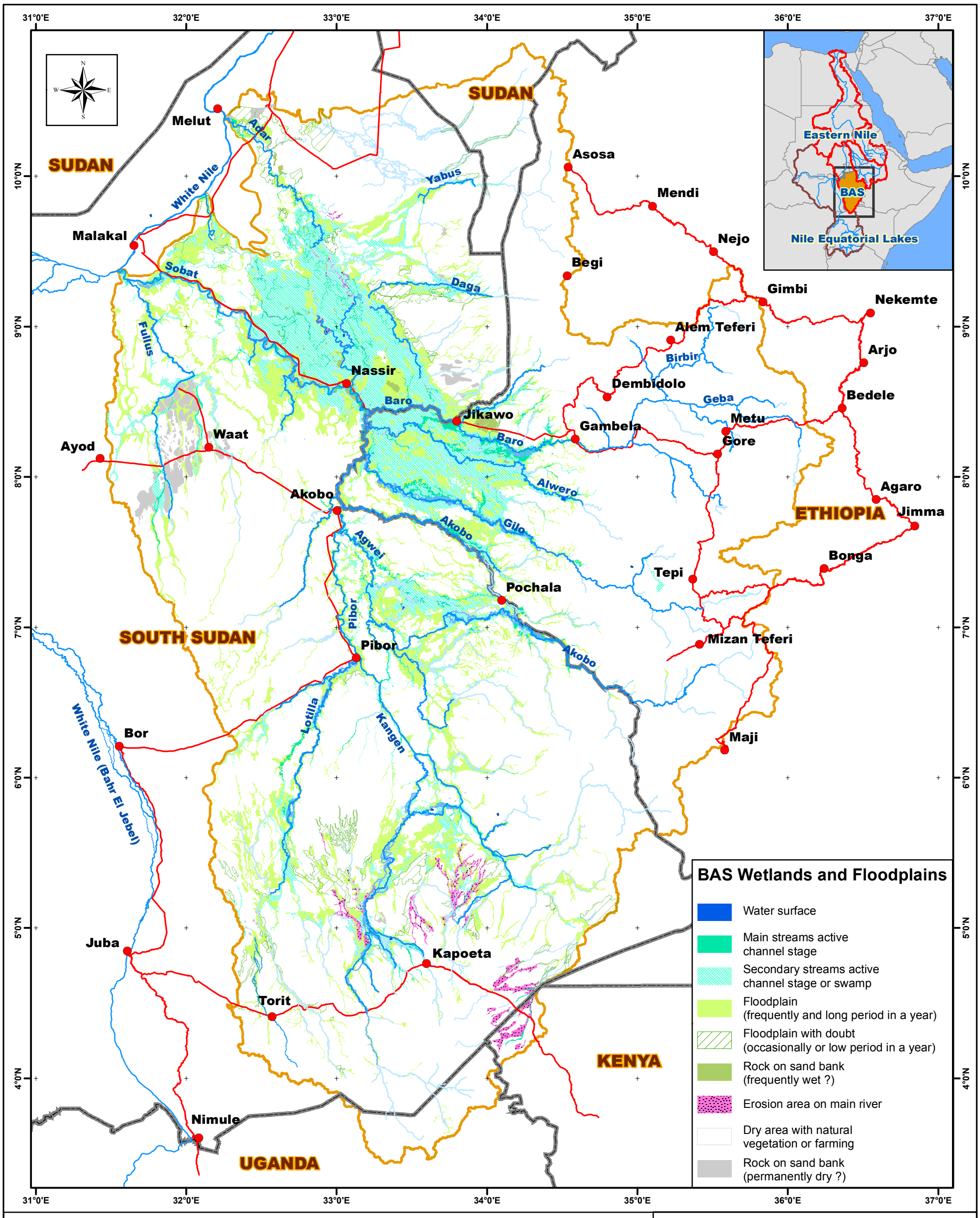
Map Title: BAS Relief & Drainage

Date: March 2016 | **Rev:** Final Draft

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: WETLANDS & FLOODPLAINS



Legend

- BAS Main Towns
- BAS River/Stream Network
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

0 25 50 100 150 200 Km

Source:
BAS Wetlands and Floodplains prepared for the present Study by TTI Production-BRL Ingenierie.

Note: Boundaries of countries and admin units are not authoritative. **Coordinate System: GCS_WGS84**

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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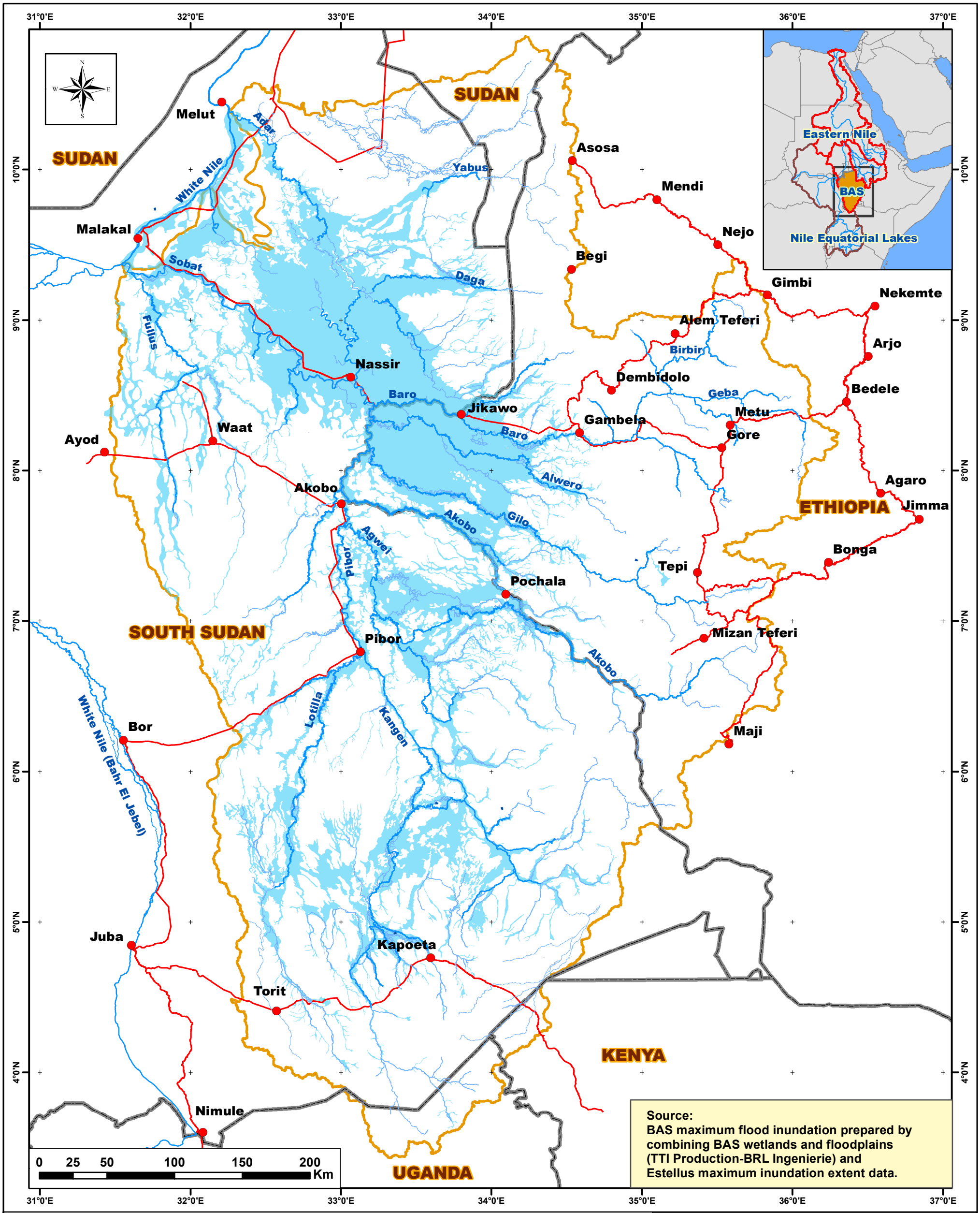
Map Title: BAS Wetlands & Floodplains

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: MAXIMUM FLOOD INUNDATION



Source:
BAS maximum flood inundation prepared by combining BAS wetlands and floodplains (TTI Production-BRL Ingenierie) and Estellus maximum inundation extent data.

Legend

- BAS Main Towns
- BAS River/Stream Network
- BAS Main Roads
- BAS Maximum Flood Inundation
- BAS Sub-Basin
- Country Boundaries

Note: Boundaries of countries and admin units are not authoritative. **Coordinate System: GCS_WGS84**

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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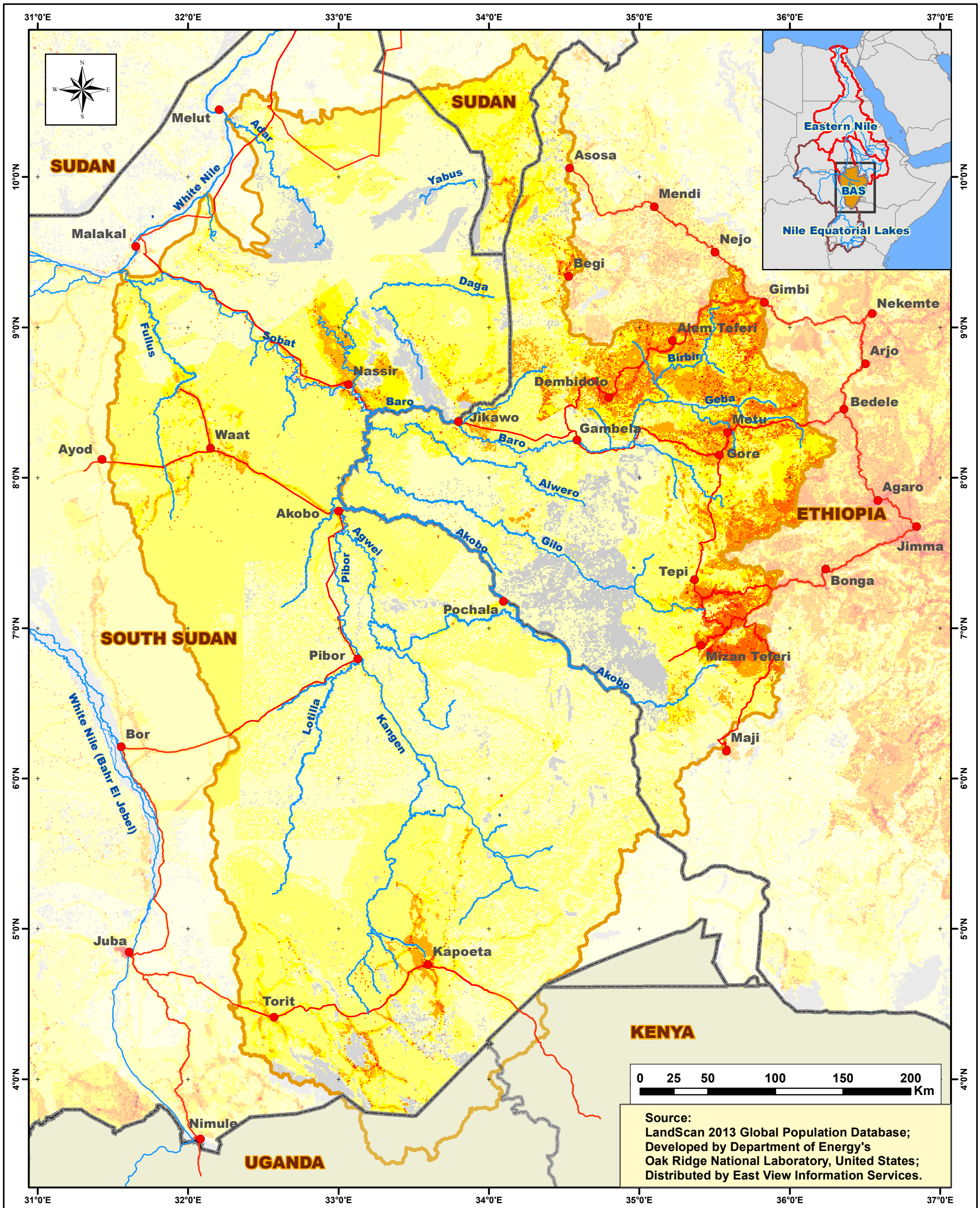
Map Title: BAS Maximum Flood Inundation

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

3. SOCIO-ECONOMIC INDICATORS

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: POPULATION DENSITY



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

Population Density (Year 2013)

People per 30 arc-second (about 1 km^2)

< 1	101 - 500
1 - 5	501 - 2,500
6 - 25	2,501 - 5,000
26 - 50	> 5,000
51 - 100	No Data

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

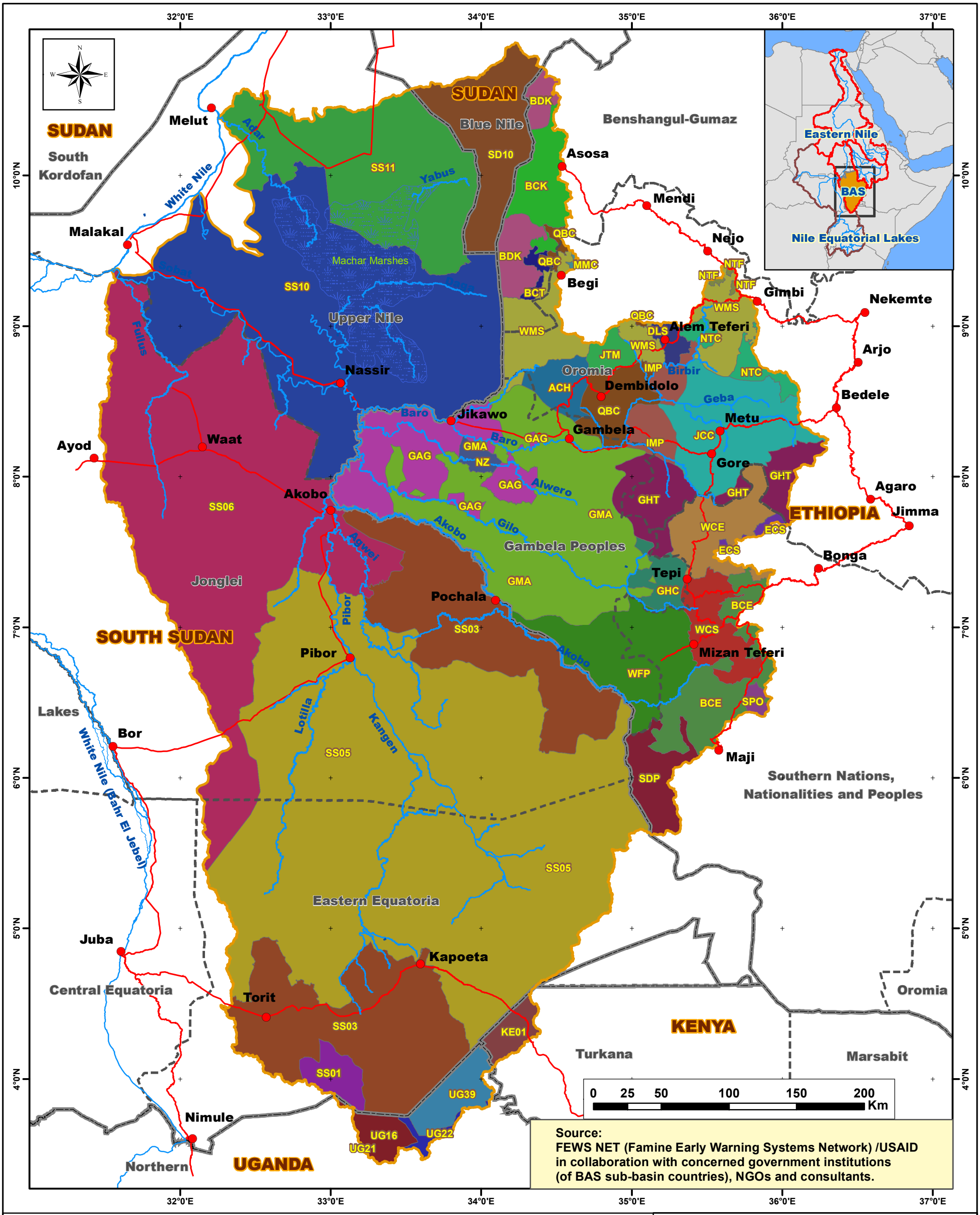
aurecon BRL Ingénierie

Map Title: BAS Population Density

Date: March 2016 | **Rev:** Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: LIVELIHOOD ZONES



Source:
FEWS NET (Famine Early Warning Systems Network) /USAID in collaboration with concerned government institutions (of BAS sub-basin countries), NGOs and consultants.

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- ETH Regions/SSD States/SDN States KEN Counties/UGA Sub-Region
- Country Boundaries

Legend for the livelihood zone codes provided on a separate page:

- ETH (Ethiopia) Livelihood Zones
- SSD (South Sudan) Livelihood Zones
- SDN (Sudan) Livelihood Zones
- UGA (Uganda) Livelihood Zones
- KEN (Kenya) Livelihood Zones

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

aurecon BRL Ingénierie

Map Title: BAS Livelihood Zones

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

LEGEND FOR BARO-AKOBO-SOBAT (BAS) SUB-BASIN LIVELIHOOD ZONES MAP

Legend for BAS Livelihood Zone Codes

BAS Ethiopia (ETH) Livelihood Zones

ACH	Anfilo Coffee Monoculture & Honey
BCE	Bench-Keffa Cereal & Enset
BCK	Central Kolla Sorghum, Maize & Millet
BCT	Midland Teff & Coffee
BDK	Western Dry Kolla Sorghum, Maize & Mining
DLS	Dale-Lalo Sorghum & Maize
ECS	Western Coffee & Spices - Eastern Sub-Zone
GAG	Gambella Agropastoral
GHC	Gambella Coffee, Honey & Cereal
GHT	Gera-Setema-Sale Forest Teff, Honey & Cattle
GMA	Gambella Mixed Agriculture
IMP	Illu-Wellega-Birbir Maize, Peppers & Sesame
JCC	Jimma-Illubabur Coffee, Cereals & Chat
JTM	Jimma-Yama Logi Teff & Maize
MMC	Mendi-Dabisu Maize, Sesame & Cattle
NTC	Nole-Meko-Diga Teff & Cattle
NTF	Nejo-Dilla Teff, Finger Millet & Nug
NZ	No Data
QBC	Keto-Begi Cereals & Cattle
SDP	Surma Agro-Pastoral
SPO	Salamago Pastoral
WCE	Sheka Cereal & Enset
WCS	Western Coffee & Spices - Western Sub-Zone
WFP	Western Forest Products
WMS	Wellega Coffee, Maize & Sorghum

BAS South Sudan (SSD) Livelihood Zones

SS01	Equatorial Maize & Cassava
SS03	Highland Forest & Sorghum
SS04	Western Groundnuts, Sesame & Sorghum
SS05	Eastern Semi-Arid Pastoral
SS06	Eastern Plains Sorghum & Cattle
SS10	Northeastern Maize & Cattle
SS11	Northern Sorhgum & Livestock

BAS Sudan (SDN) Livelihood Zones

SD10	Southeast Rainfed Semi-Mechanized Agriculture

BAS Uganda (UGA) Livelihood Zones

UG16	North Kitgum Gulu Amuru West Nile Simsim Sorghum Livestock Zone
UG21	South Kitgum Pader Abim Simsim Groundnuts Sorghum Cattle Zone
UG22	NE sorghum Simsim Maize Livestock Zone
UG39	National Park

BAS Kenya (KEN) Livelihood Zones

KE01	Northwestern Pastoral Zone

Source:
FEWS NET (Famine Early Warning Systems Network) /USAID in collaboration with concerned government institutions (of BAS sub-basin countries), NGOs and consultants.

Legend for BAS livelihood zone codes:

- **Ethiopia (ETH) Livelihood Zones**
- **South Sudan (SSD) Livelihood Zones**
- **Sudan (SDN) Livelihood Zones**
- **Uganda (UGA) Livelihood Zones**
- **Kenya (KEN) Livelihood Zones**

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

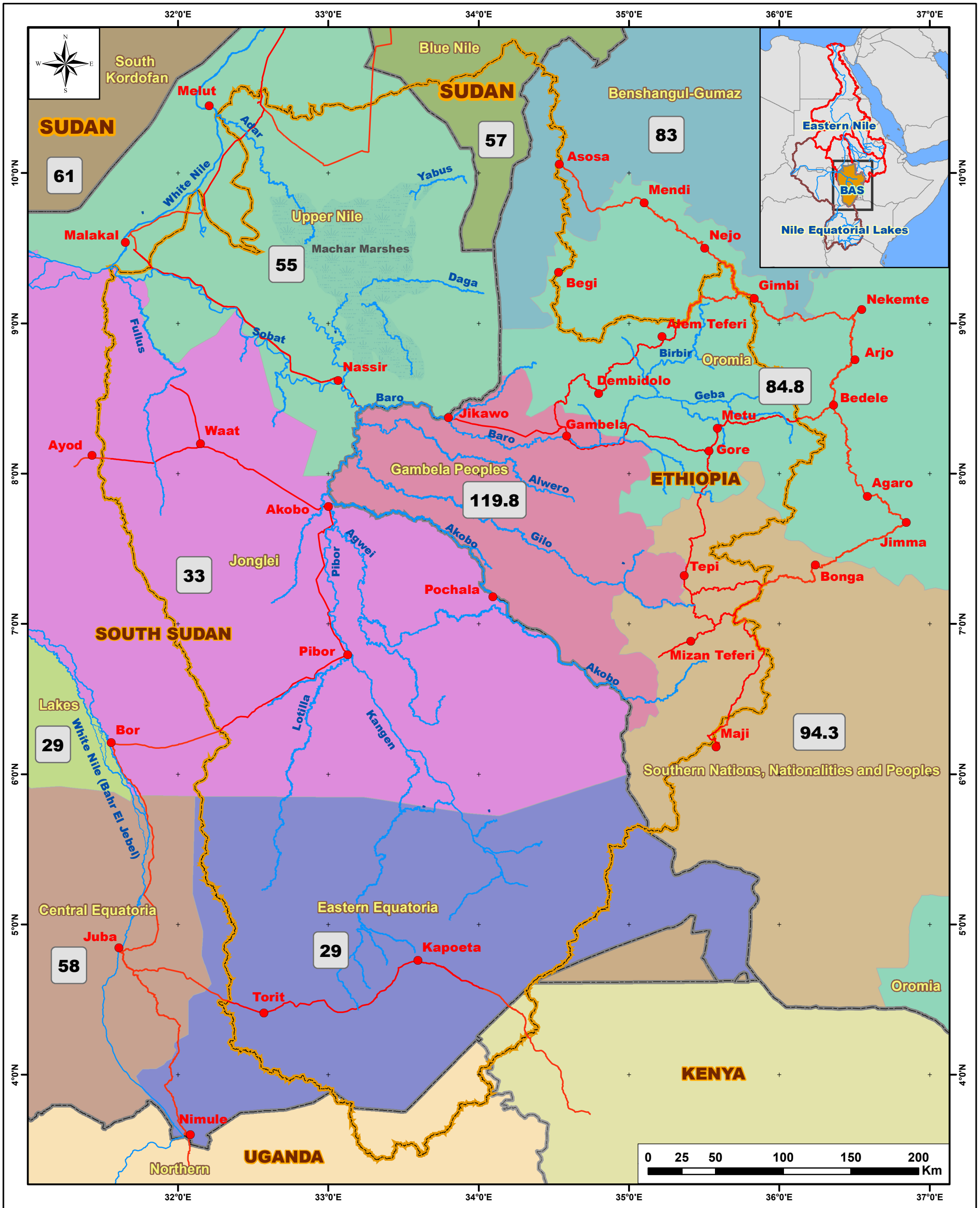
aurecon BRL Ingénierie

Title: Legend for BAS Livelihood Zones Map

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: PRIMARY SCHOOL NET ENROLLMENT RATE



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

Notes:

Ethiopia (ETH):
Primary School Net Enrollment Rate by Region (Year 2013/14)
Source: Education Statistics Annual Abstract 2006 Eth Calendar (i.e. 2013/14); Ministry of Education, Ethiopia (released in 2015).
South Sudan (SSD):
Primary School Net Enrollment Rate by State (Year 2009)
Source: South Sudan National Bureau of Statistics 2012; (National Baseline Household Survey, 2009).
Sudan (SSD):
Net Primary School Attendance Rates by State (World Bank analysis of NBHS 2009)
Source: A Poverty Profile for the Northern States of Sudan (2011).

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

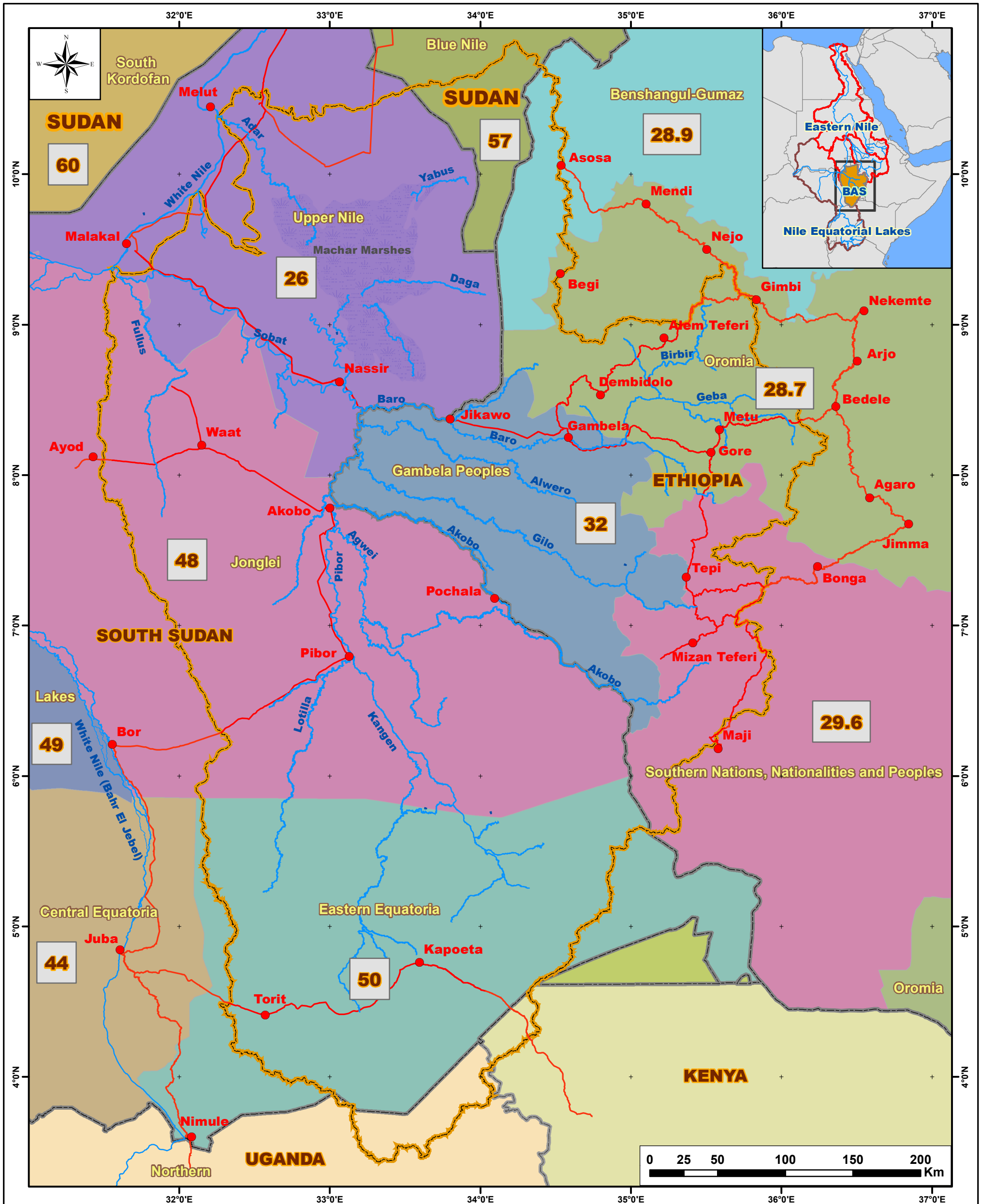
aurecon BRL Ingénierie

Map Title: BAS Primary School Net Enrollment Rate

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: POVERTY INCIDENCE



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

Notes:

Ethiopia (ETH):
Poverty Headcount by Region for Year 2011;
Souce: Ethiopia Poverty Assessment (World Bank Group, 2014).
South Sudan (SSD):
Poverty Headcount by State (World Bank analysis of NBHS 2009);
Source: A Poverty Profile for the Southern States of Sudan (2011).
Sudan (SSD):
Poverty Headcount by State (World Bank analysis of NBHS 2009);
Source: A Poverty Profile for the Northern States of Sudan (2011).

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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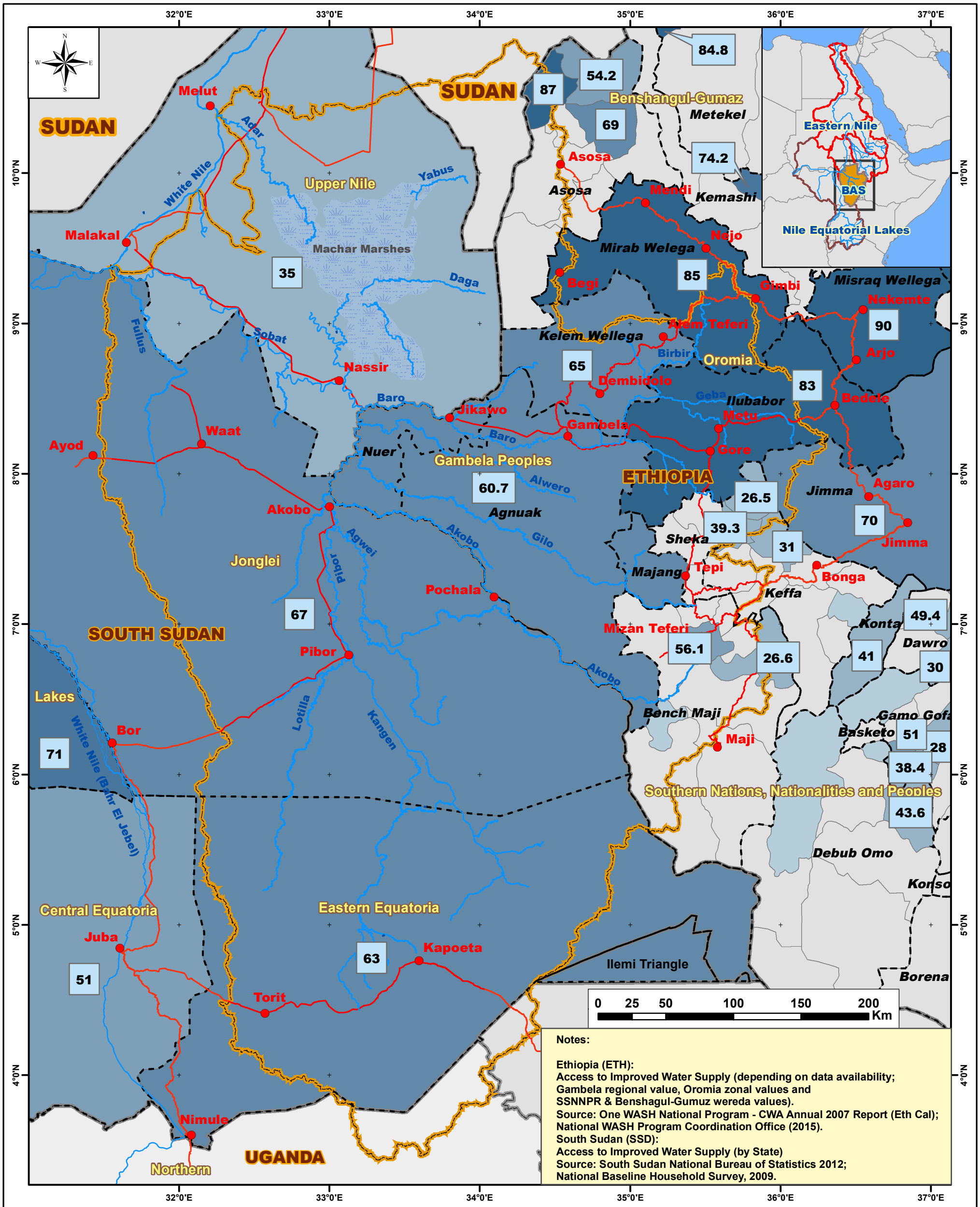
Map Title: BAS Poverty Incidence

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: ACCESS TO IMPROVED WATER SUPPLY



Notes:

Ethiopia (ETH):
Access to Improved Water Supply (depending on data availability; Gambela regional value, Oromia zonal values and SSNNPR & Benshagul-Gumuz wereda values).
Source: One WASH National Program - CWA Annual 2007 Report (Eth Cal); National WASH Program Coordination Office (2015).

South Sudan (SSD):
Access to Improved Water Supply (by State)
Source: South Sudan National Bureau of Statistics 2012; National Baseline Household Survey, 2009.

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- ETH Regions/SSD States
- Country Boundaries

BAS Access to Improved Water Supply
percentage (%)

- < 25
- 25 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- No data

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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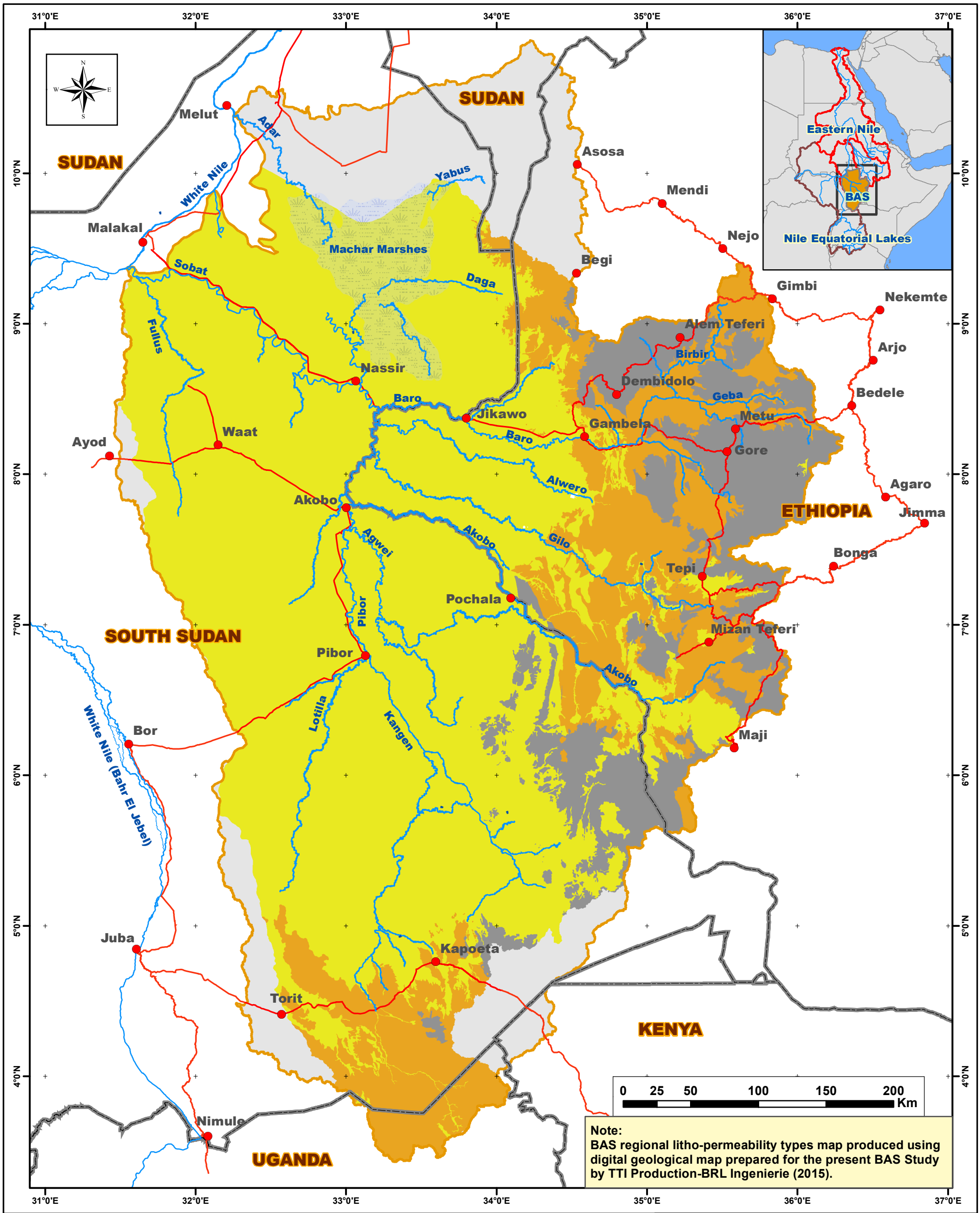
Title: BAS Access to Improved Water Supply

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

4. GROUNDWATER POTENTIAL

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: REGIONAL LITHO-PERMEABILITY TYPES



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Regional Litho-Permeability Type

- Volcanic rocks, mainly fracture permeability
- Sediments/Sedimentary rocks, mainly intergranular permeability
- Basement rocks, mainly fracture permeability
- Unmapped area

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

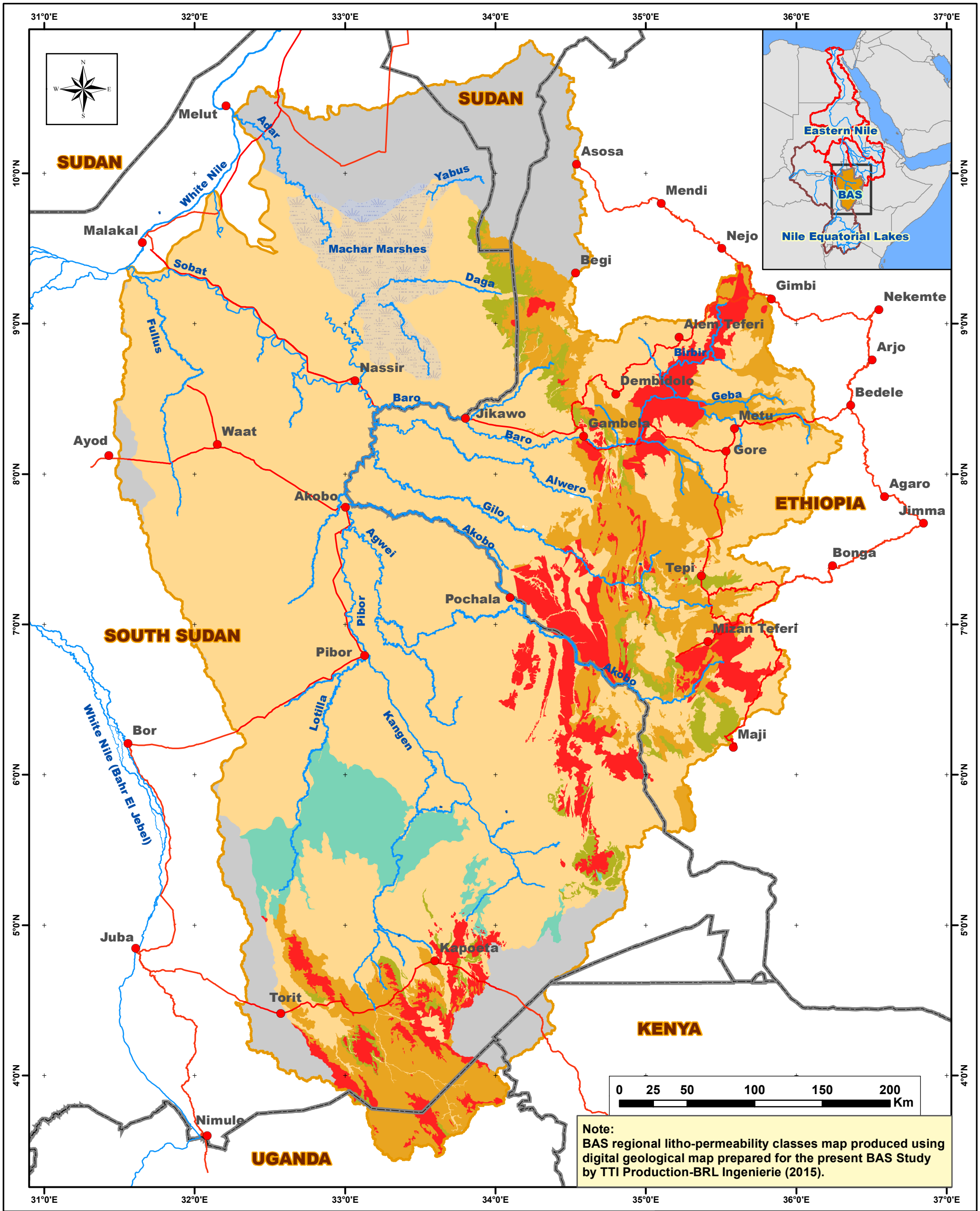
aurecon BRL Ingénierie

Map Title: BAS Regional Litho-Permeability Types

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: REGIONAL LITHO-PERMEABILITY CLASSES



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Regional Litho-Permeability Class

- Low
- Low to Medium
- Medium
- Medium to High
- High
- Unmapped area

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

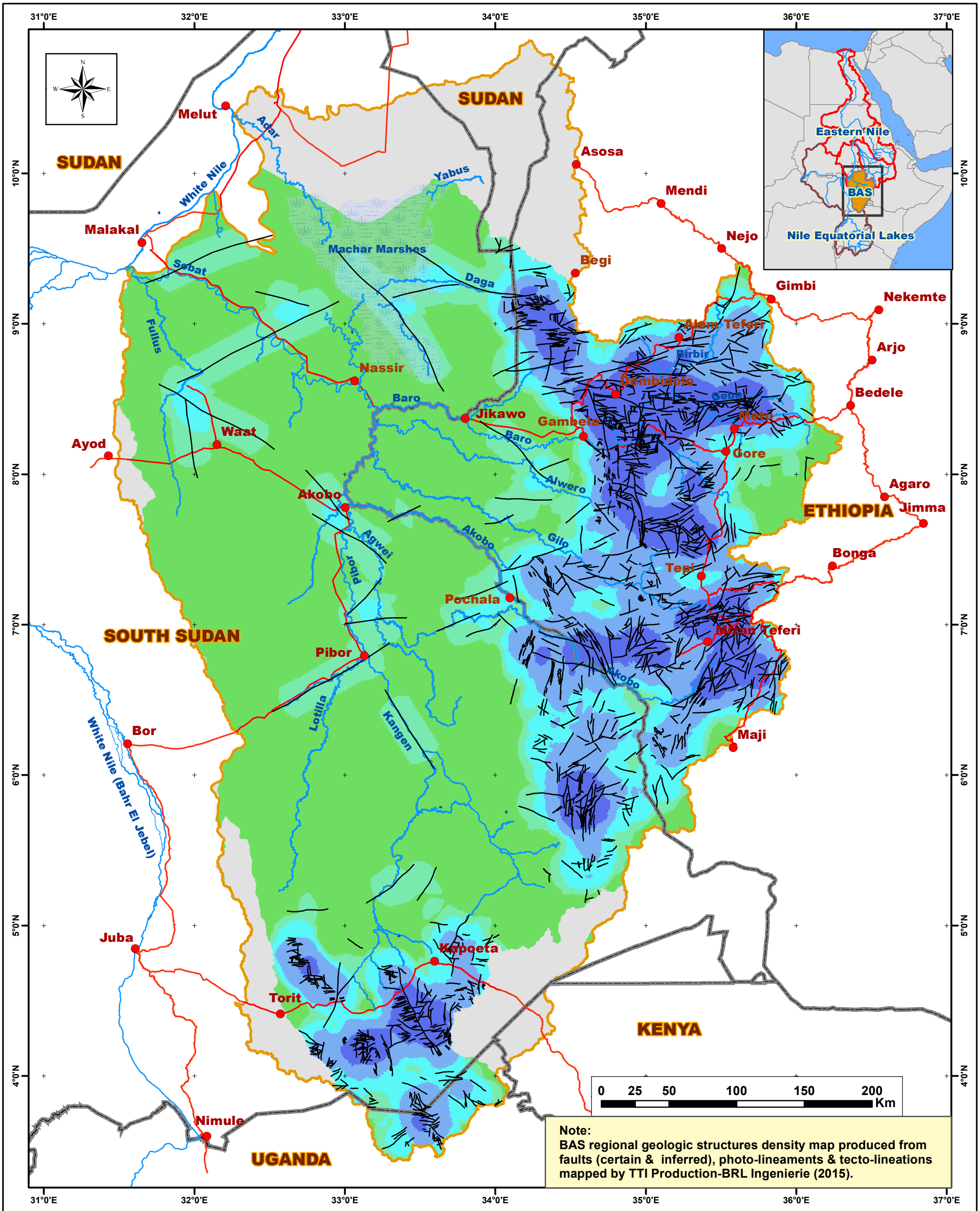
aurecon BRL Ingénierie

Map Title: BAS Regional Litho-Permeability Classes

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: REGIONAL GEO-STRUCTURES DENSITY



Note:
BAS regional geologic structures density map produced from faults (certain & inferred), photo-lineaments & tecto-lineations mapped by TTI Production-BRL Ingenierie (2015).

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- Regional Geologic Structures
- BAS Sub-Basin
- Country Boundaries

BAS Regional Geo-Structures Density (per square Km)

- 0 - 0.025
- 0.025 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Unmapped area

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

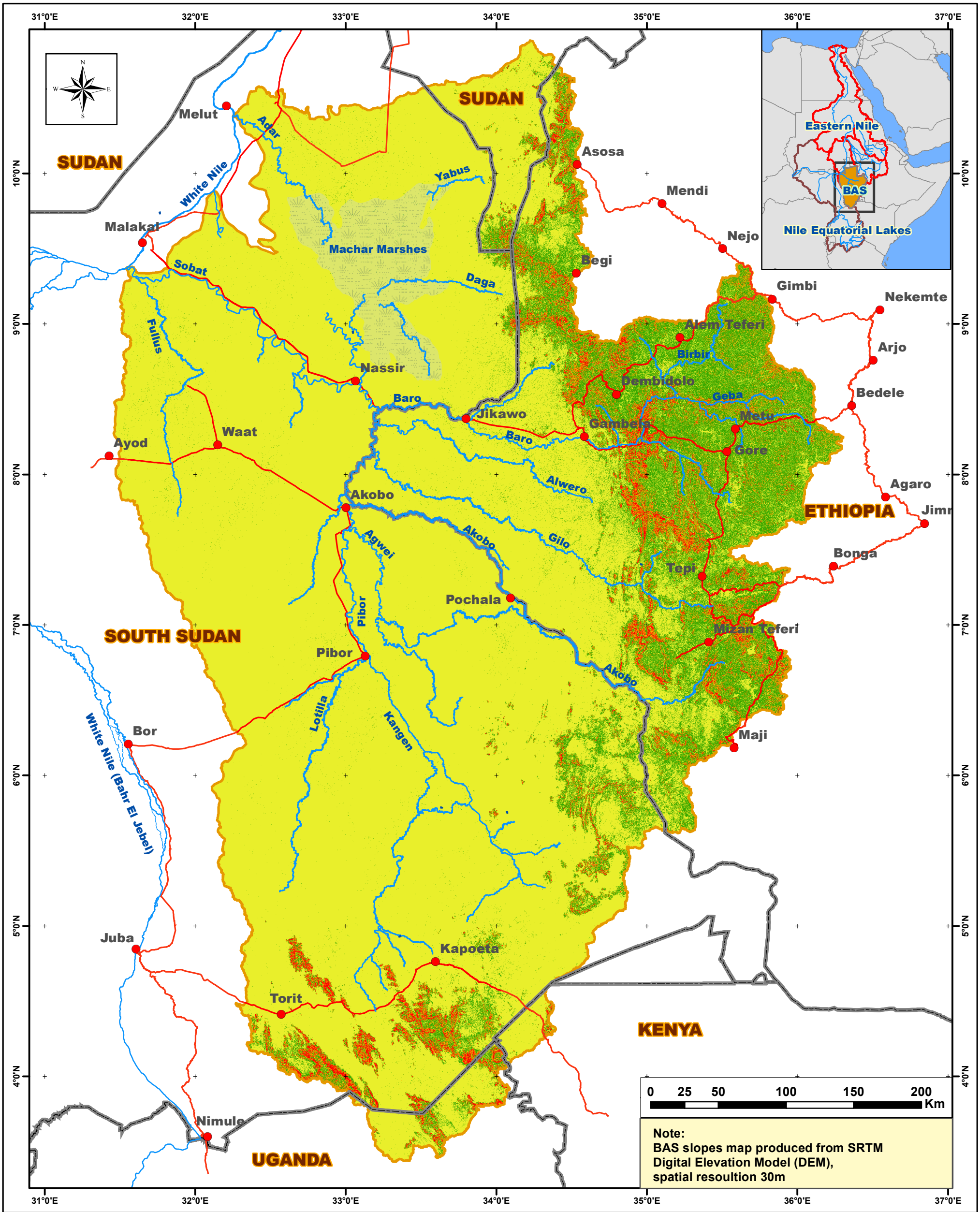
aurecon BRL Ingénierie

Map Title: BAS Regional Geo-Structures Density

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: SLOPES MAP



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Slope
Degrees

- < 5
- 5 - 15
- 15 - 25
- > 25

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

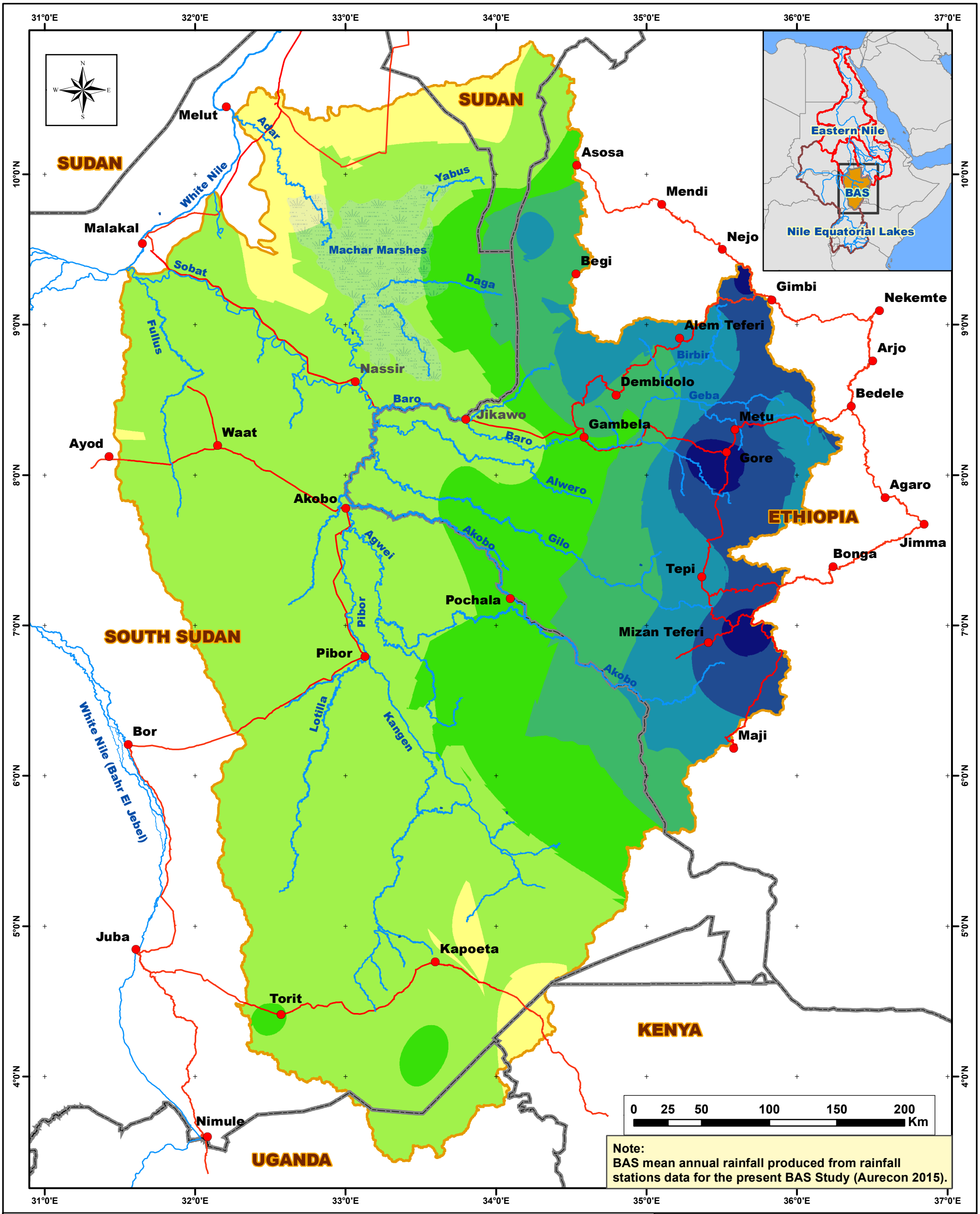
aurecon BRL Ingénierie

Map Title: BAS Slopes

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: MEAN ANNUAL RAINFALL



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Mean Annual Rainfall (mm)

- < 750
- 750 - 1,000
- 1,000 - 1,250
- 1,250 - 1,500
- 1,500 - 1,750
- 1,750 - 2,000
- > 2,000

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

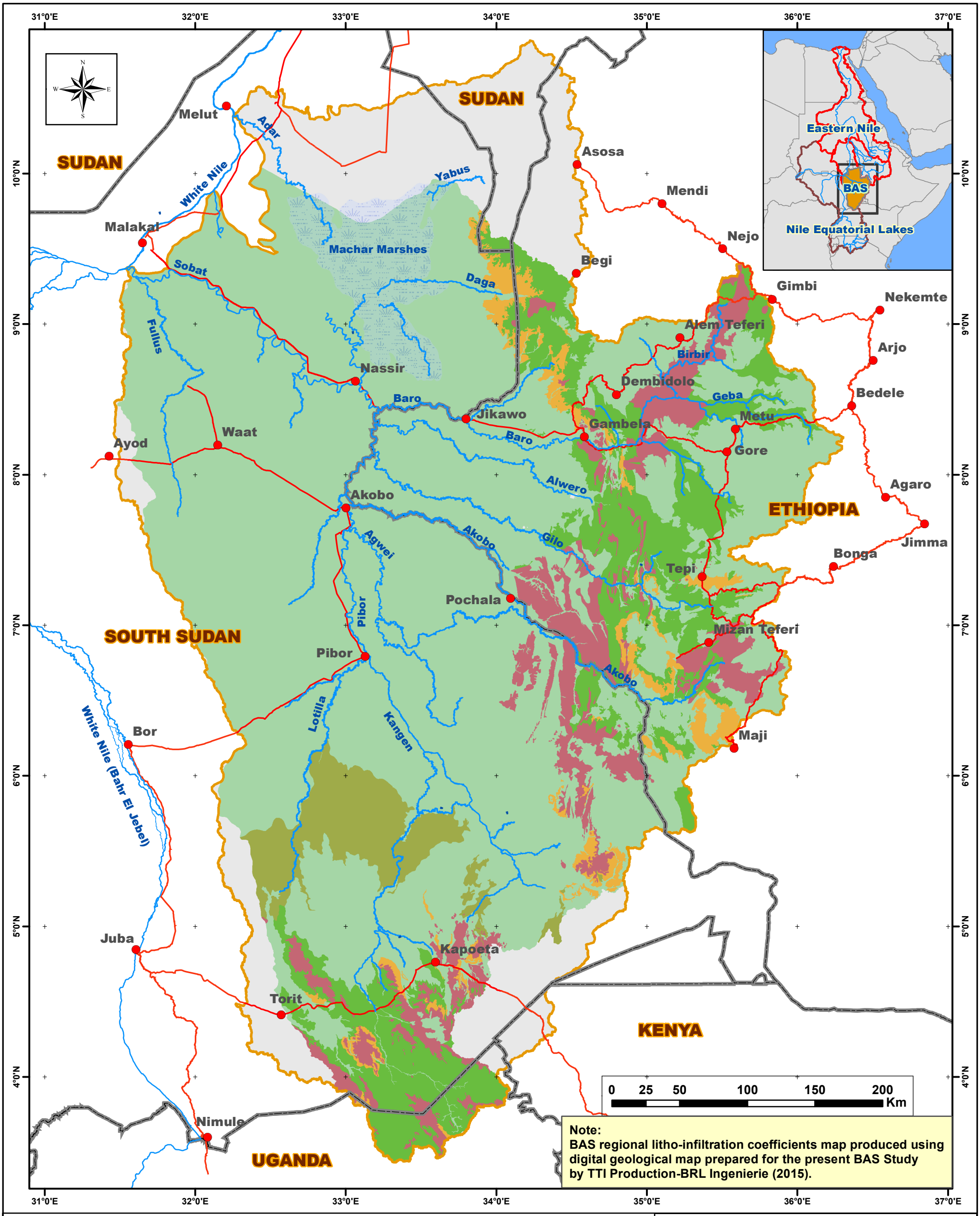
aurecon BRL Ingénierie

Map Title: BAS Mean Annual Rainfall

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: REGIONAL LITHO-INFILTRATION COEFFICIENTS



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Regional Litho-Infilitration Coefficient

Percentage decimals

- 0.05
- 0.08
- 0.1
- 0.15
- 0.175
- Unmapped area

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

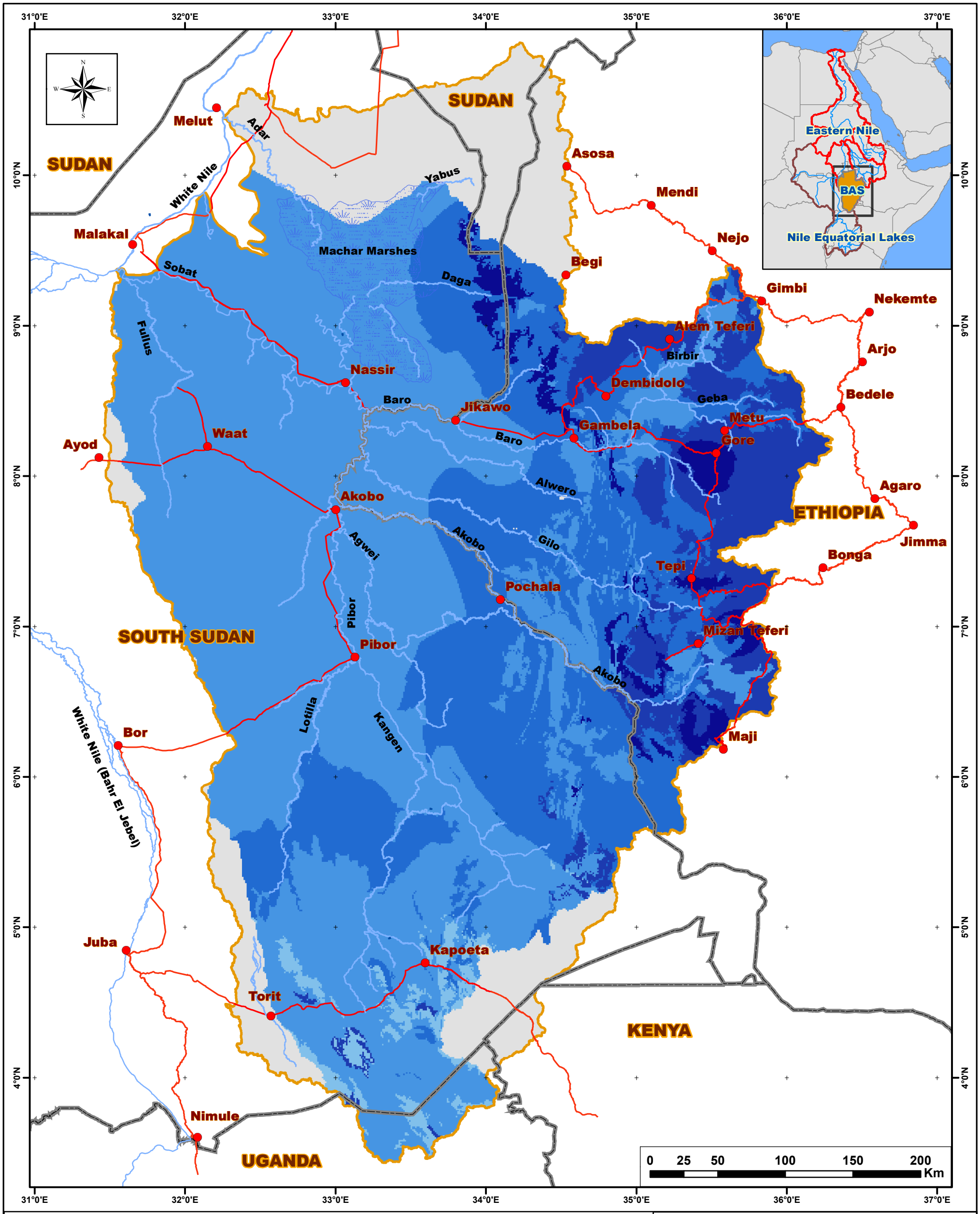
aurecon BRL Ingénierie

Map Title: BAS Litho-Infiltration Coefficients

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: REGIONAL GROUNDWATER RECHARGE



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Regional Groundwater Recharge (mm/yr)

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 350
- Unmapped area

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

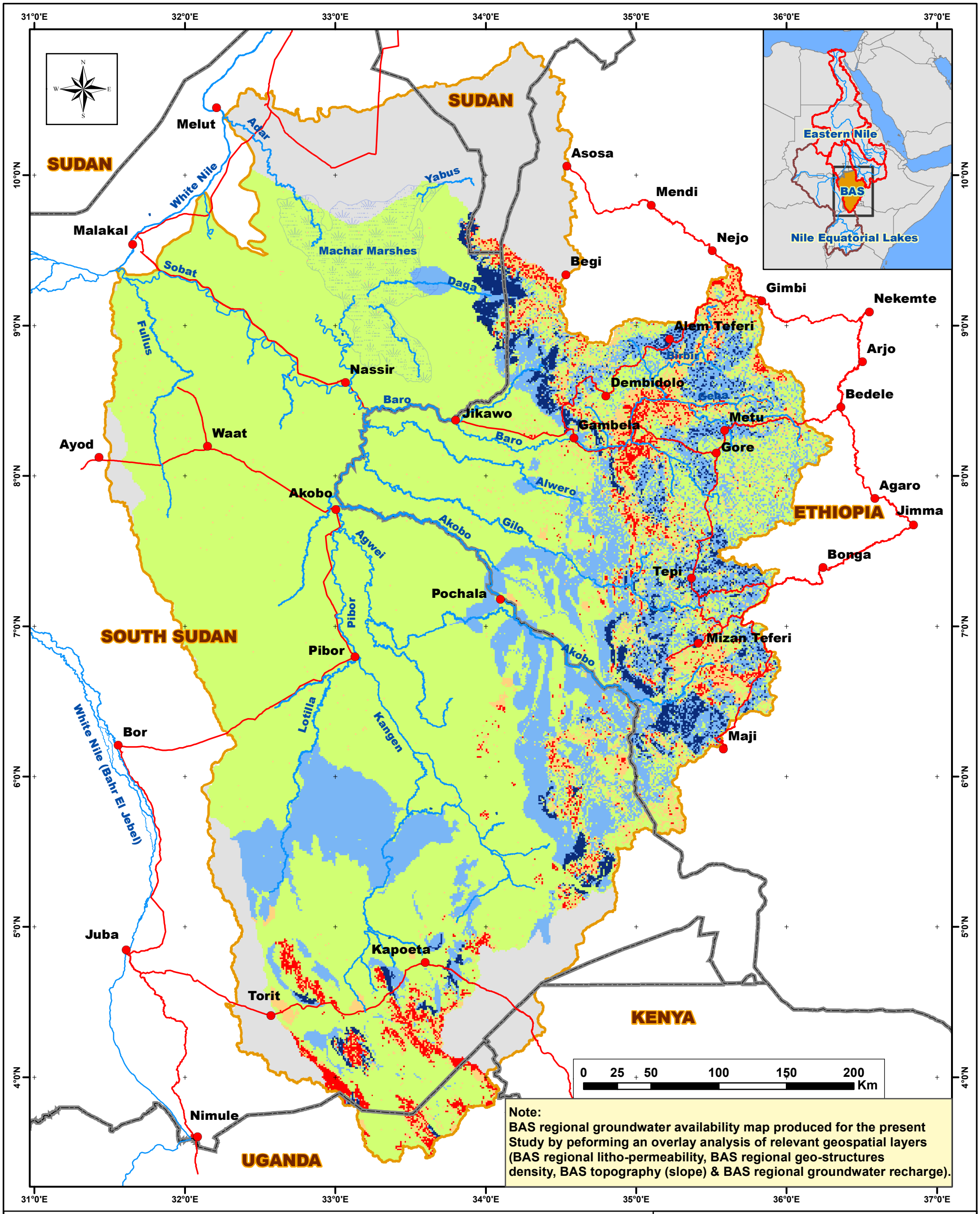
Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

Map Title: BAS Regional Groundwater Recharge

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: REGIONAL GROUNDWATER AVAILABILITY



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Regional Groundwater Availability

- Low
- Low to Medium
- Medium
- Medium - High
- High
- Unmapped

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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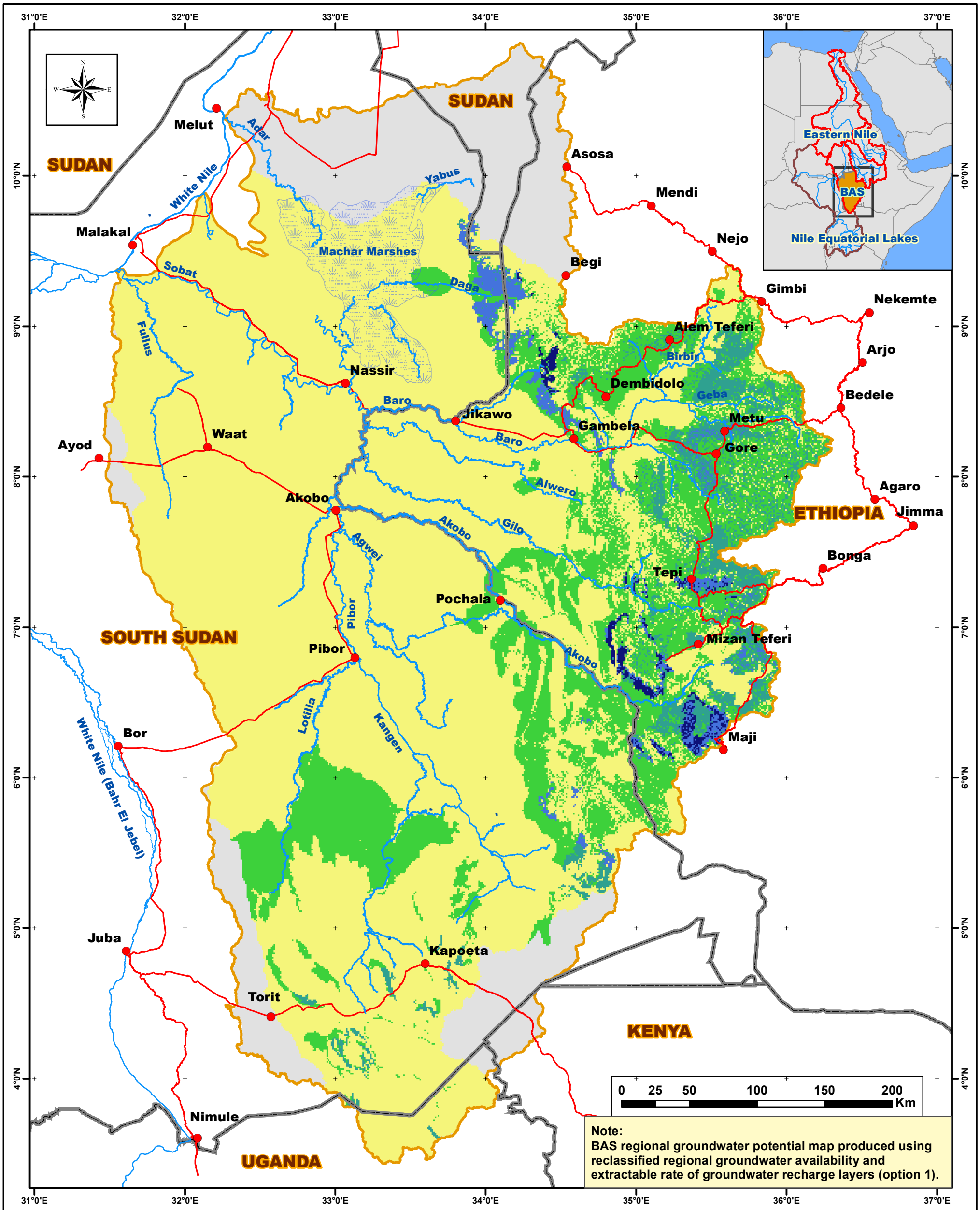
Map Title: BAS Regional Groundwater Availability

Date: March 2016 | **Rev:** Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: REGIONAL GROUNDWATER POTENTIAL



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

Extractable Rate of GW Recharge (option 1) ($10^3 m^3/Km^2/yr$)

- < 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 133.9
- Unmapped

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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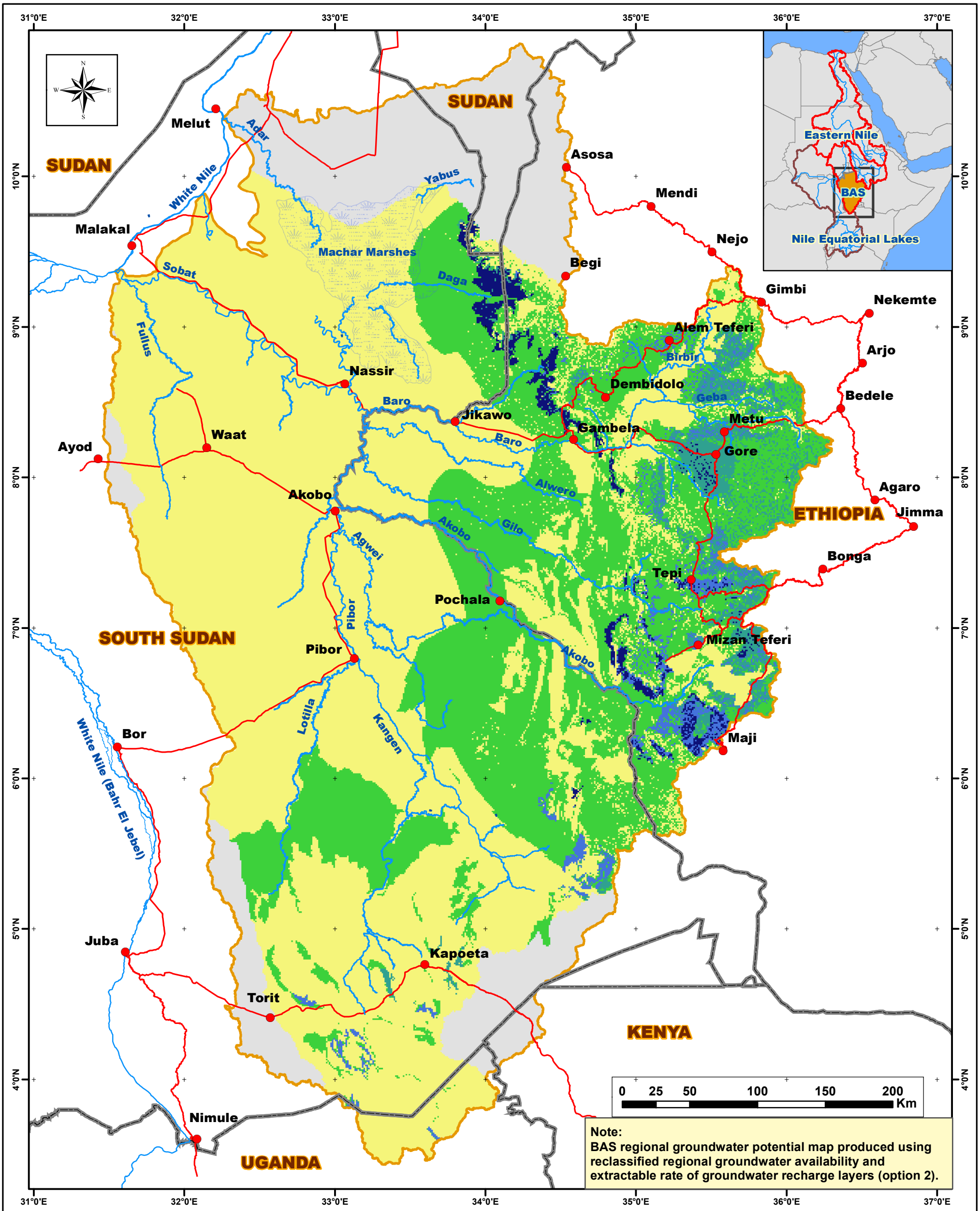
Map Title: BAS Groundwater Potential (option1)

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: REGIONAL GROUNDWATER POTENTIAL



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

Extractable Rate of GW Recharge (option 2) ($10^3 m^3/Km^2/yr$)

- < 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 167.4
- Unmapped

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

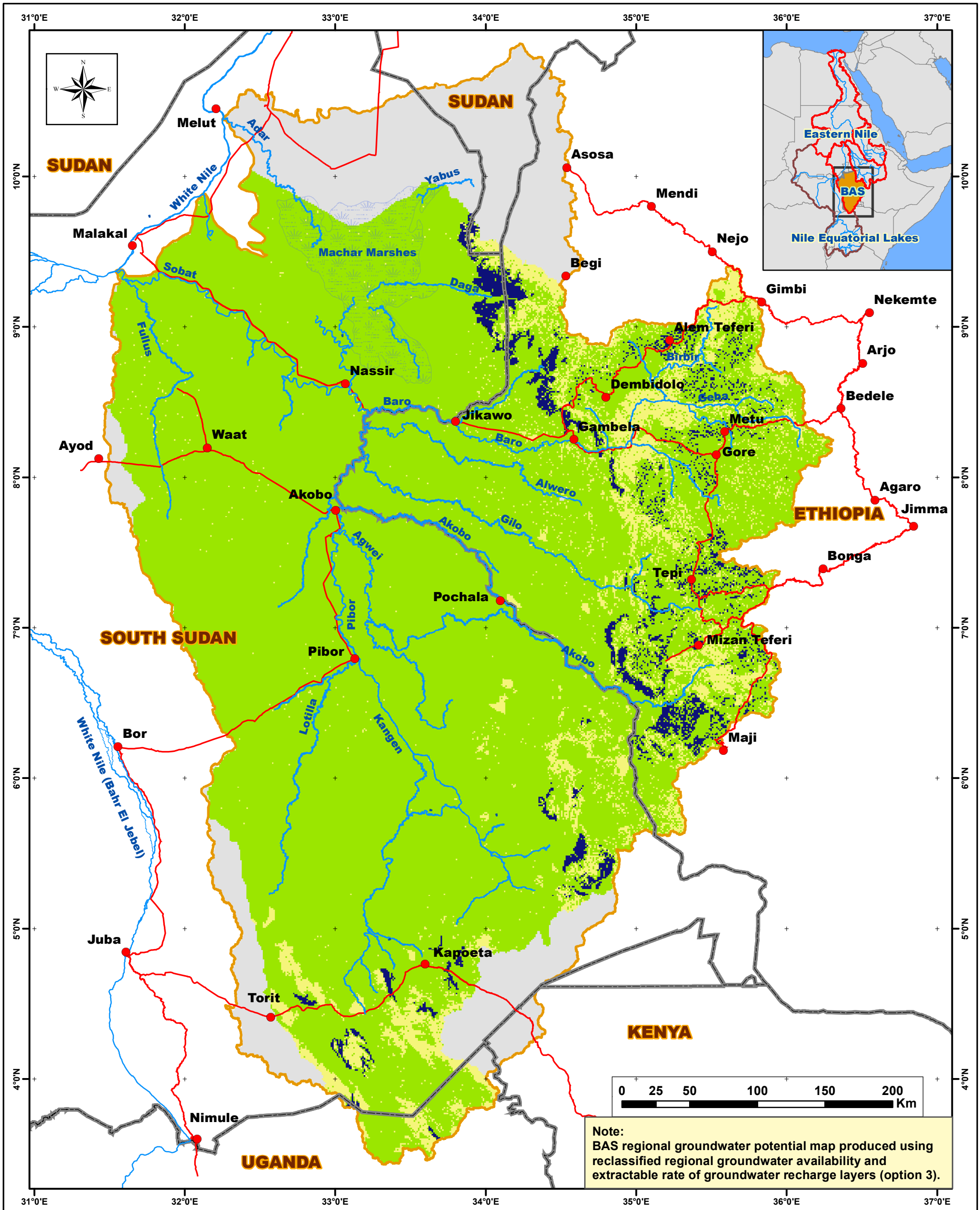
aurecon BRL Ingénierie

Map Title: BAS Groundwater Potential (option2)

Date: March 2016 | **Rev:** Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: REGIONAL GROUNDWATER POTENTIAL



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

Extractable Rate of GW Recharge (option 3) ($10^3 m^3/Km^2/yr$)

- < 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 167.4
- Unmapped

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

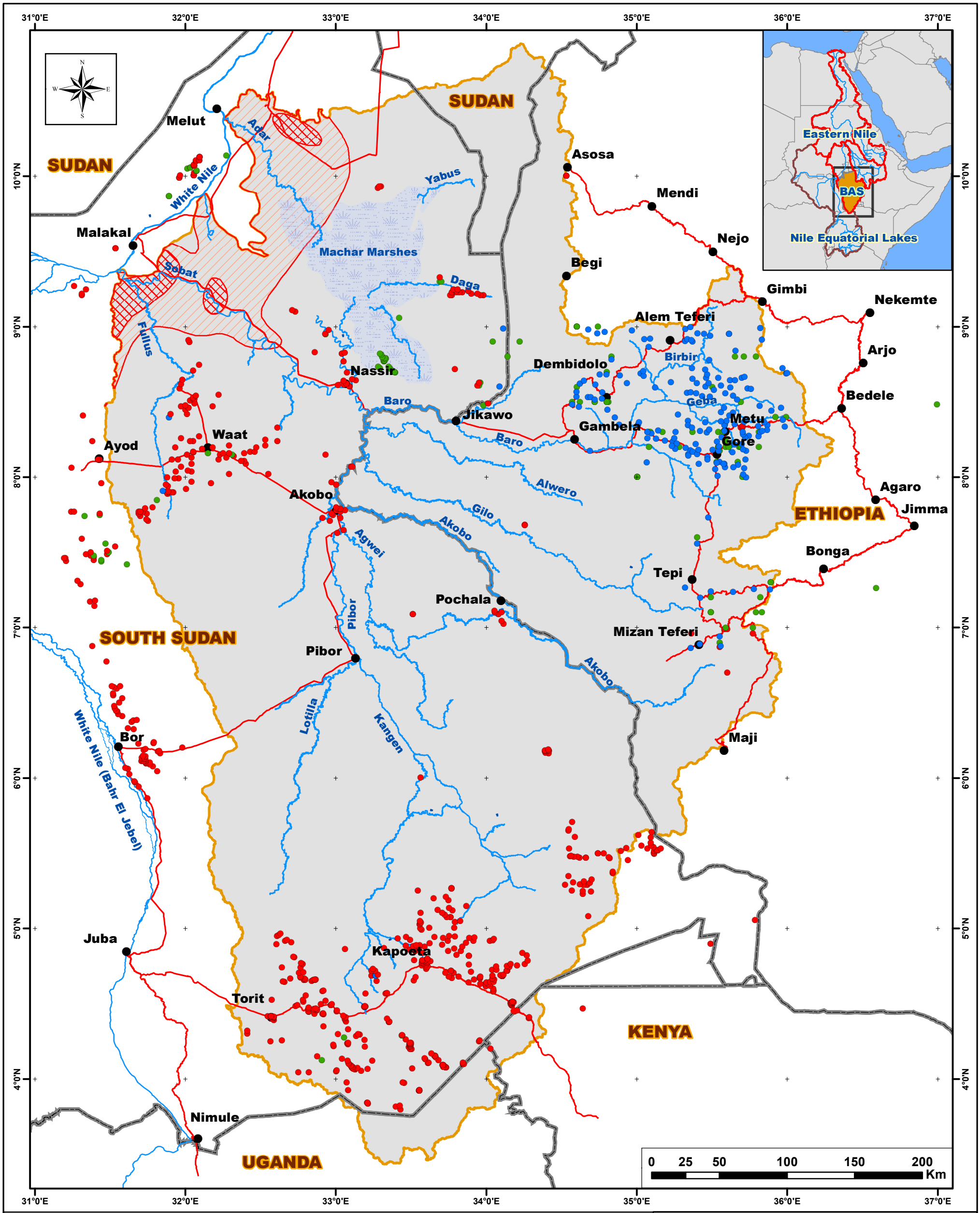
aurecon BRL Ingénierie

Map Title: BAS Groundwater Potential (option3)

Date: March 2016 | **Rev:** Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: WATER POINTS



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- Country Boundaries
- BAS Sub-Basin

BAS Water Points

- Springs & Water Harvesting Points
- Hand-dug Wells
- Boreholes

Saline Groundwater

- 1500 - 5000 ppm (Brackish)
- > 5000 ppm (Saline)

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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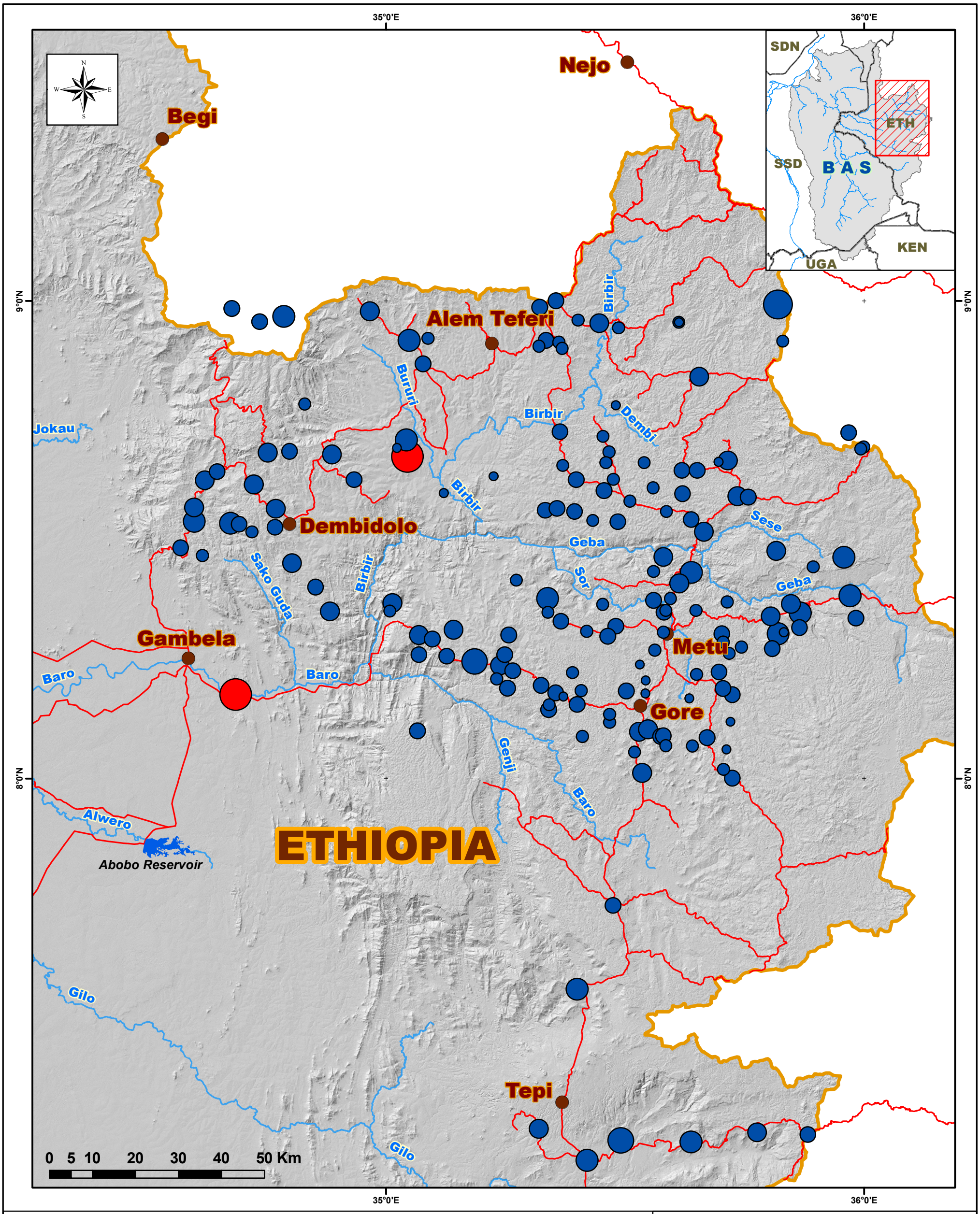
Map Title: BAS Water Points

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: ETHIOPIAN HIGHLAND SPRINGS WATER QUALITY (TDS)



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Relief
- BAS Sub-Basin

Springs (TDS, mg/l)

- No data
- < 50
- 50 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400- 500
- > 2000 (exceptionally mineralized)

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

aurecon BRL Ingénierie

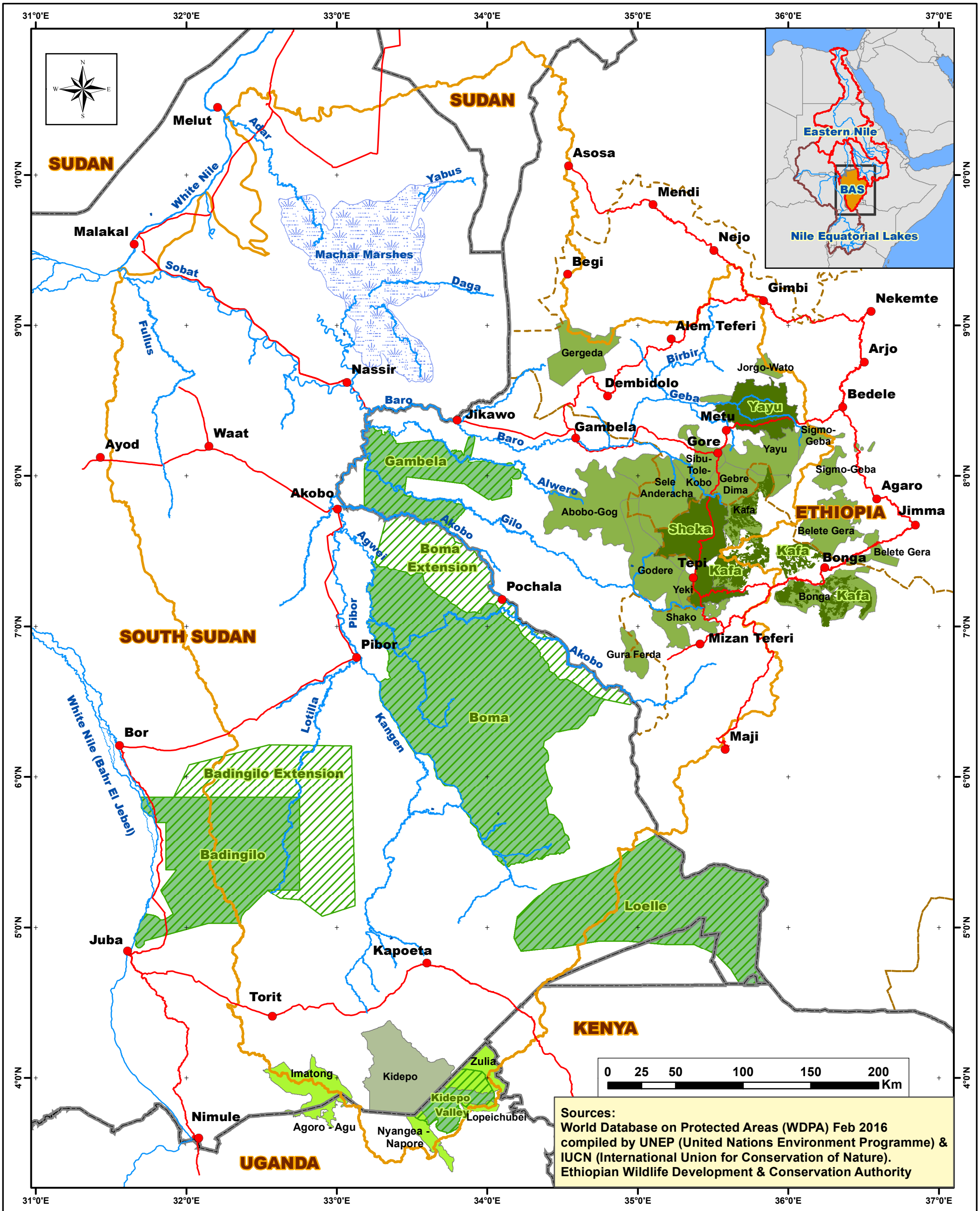
Map Title: BAS Ethiopian Highland Springs TDS

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

5. PROTECTED AREAS AND ECO-TOURISM

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: PROTECTED AREAS



Sources:
World Database on Protected Areas (WDPA) Feb 2016 compiled by UNEP (United Nations Environment Programme) & IUCN (International Union for Conservation of Nature).
Ethiopian Wildlife Development & Conservation Authority

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Potected Areas (Feb 2016)

- National Parks
- Park Extensions
- Forest Reserves
- National Forest Priority Areas
- Game Reserve
- UNESCO-MAB Biosphere Reserve

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

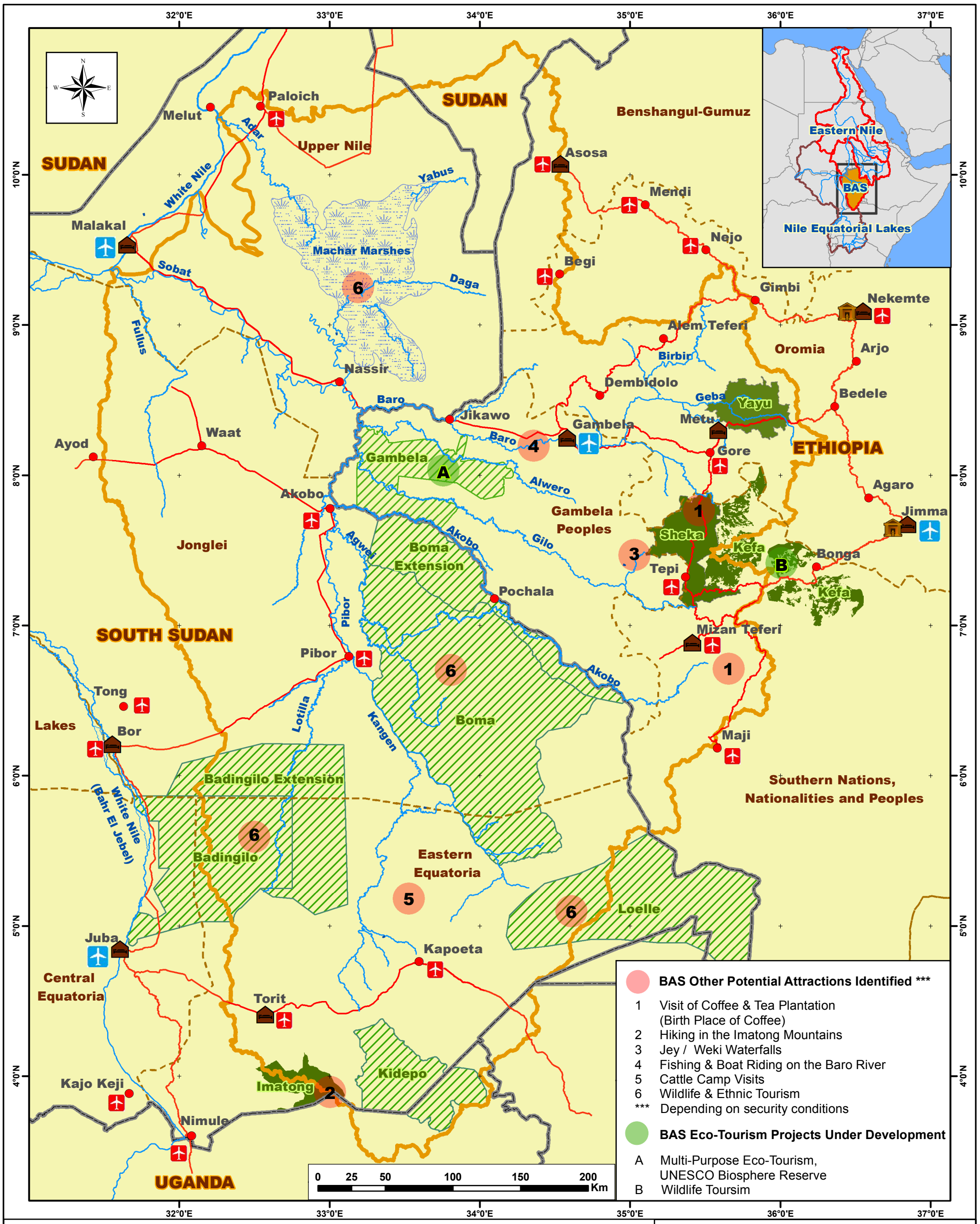
aurecon BRL Ingénierie

Map Title: BAS Protected Areas

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: ECO-TOURISM



BAS Other Potential Attractions Identified ***

1 Visit of Coffee & Tea Plantation (Birth Place of Coffee)
2 Hiking in the Imatong Mountains
3 Jey / Weki Waterfalls
4 Fishing & Boat Riding on the Baro River
5 Cattle Camp Visits
6 Wildlife & Ethnic Tourism
*** Depending on security conditions

BAS Eco-Tourism Projects Under Development

A Multi-Purpose Eco-Tourism, UNESCO Biosphere Reserve
B Wildlife Toursim

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- Admin Boundaries
- BAS Sub-Basin
- Country Boundaries
- Main Airports
- Airfields
- Hotels (Better Accomodation)
- Museums

BAS Potential Attractions

- BAS National Parks
- UNESCO-MAB Biosphere Reserves/ Selected Forest Reserve
- BAS Main Wetland (Marshes)

Sources for BAS National Parks and Biopsphere Reserves:
- **World Database on Protected Areas/WDPA (IUCN and UNEP-WCMC, Feb 2016)**
- **Ethiopian Wildlife Development & Conservation Authority**
- **Sheka Forest Biosphere Reserve Management Plan**
- **Network Creation & Capacity Building in Yayu Biosphere Reserve**

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

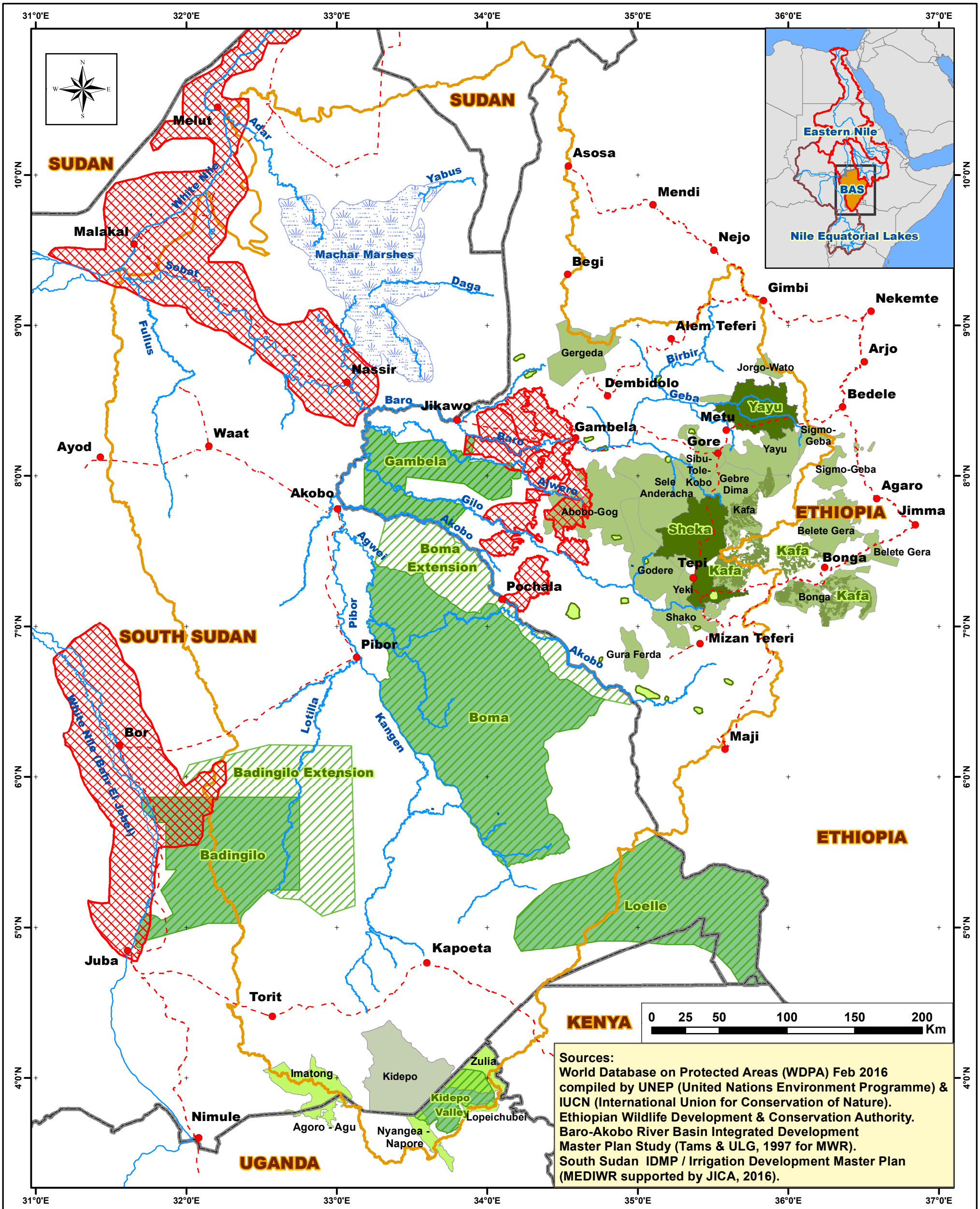
aurecon BRL Ingénierie

Map Title: BAS Sub-Basin Eco-Tourism

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: SSEA
PROTECTED AREAS vs. PROPOSED IRRIGATION PROJECTS



Sources:
World Database on Protected Areas (WDPA) Feb 2016 compiled by UNEP (United Nations Environment Programme) & IUCN (International Union for Conservation of Nature).
Ethiopian Wildlife Development & Conservation Authority.
Baro-Akobo River Basin Integrated Development Master Plan Study (Tams & ULG, 1997 for MWR).
South Sudan IDMP / Irrigation Development Master Plan (MEDIWR supported by JICA, 2016).

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- Proposed Irrigation Projects
- BAS Sub-Basin
- Country Boundaries

BAS Protected Areas (Feb 2016)

- National Parks
- Park Extensions
- Forest Reserves
- National Forest Priority Areas
- Game Reserve
- UNESCO-MAB Biosphere Reserve

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

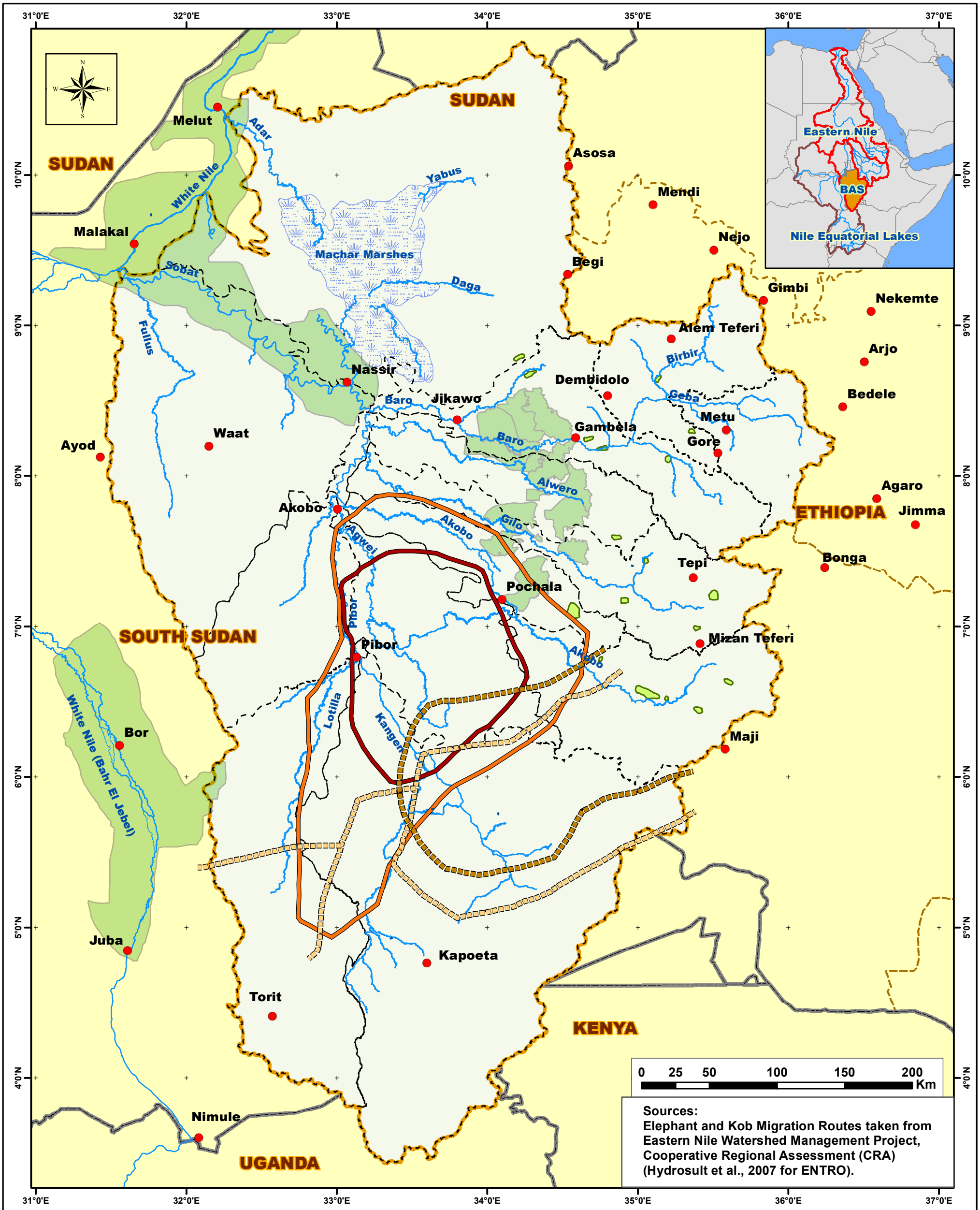
aurecon BRL Ingénierie

Map Title: BAS SSEA
Protected Areas vs. Proposed Irrigation Projects

Date: September 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: SSEA
(Full HPP& IRR Development with Elephant & Kob Migration Routes)



Sources:
Elephant and Kob Migration Routes taken from Eastern Nile Watershed Management Project, Cooperative Regional Assessment (CRA) (Hydrosult et al., 2007 for ENTRO).

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Sub-Catchments
- BAS Sub-Basin
- Country Boundaries

BAS Proposed Irrigation Schemes
- Medium to Large Scale
- Small Scale

BAS Elephant Migration Routes
- 1980 Elephant Migration Route
- 2001 Elephant Migration Route

BAS Kob Migration Routes
- 1980 Kob Migration Route
- 2001 Kob Migration Route

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

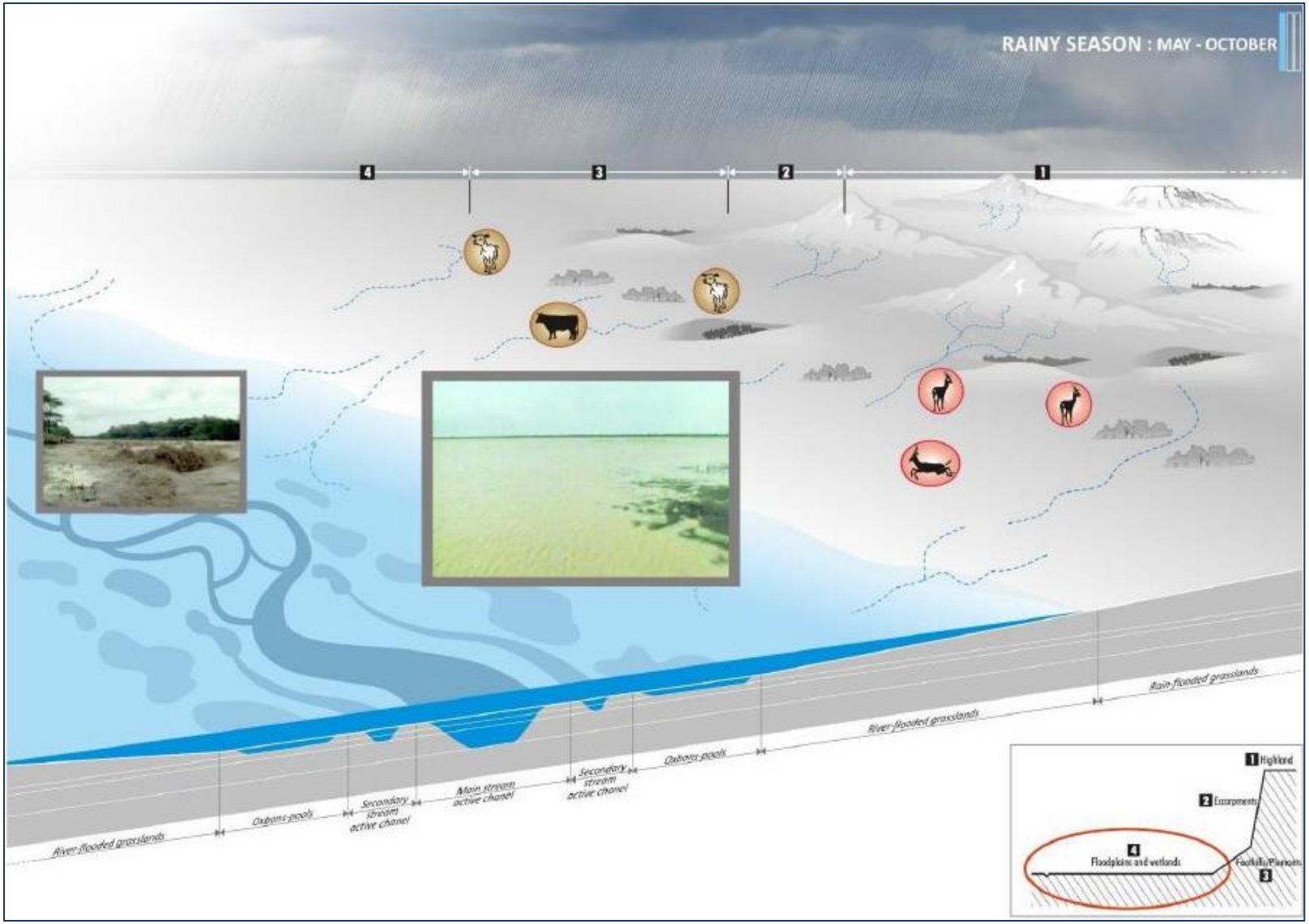
aurecon BRL Ingénierie

Map Title: BAS SSEA (Full HPP & IRR Development Elephant & Kobs Migration Routes)

Date: August 2016 | **Rev:** Draft Map

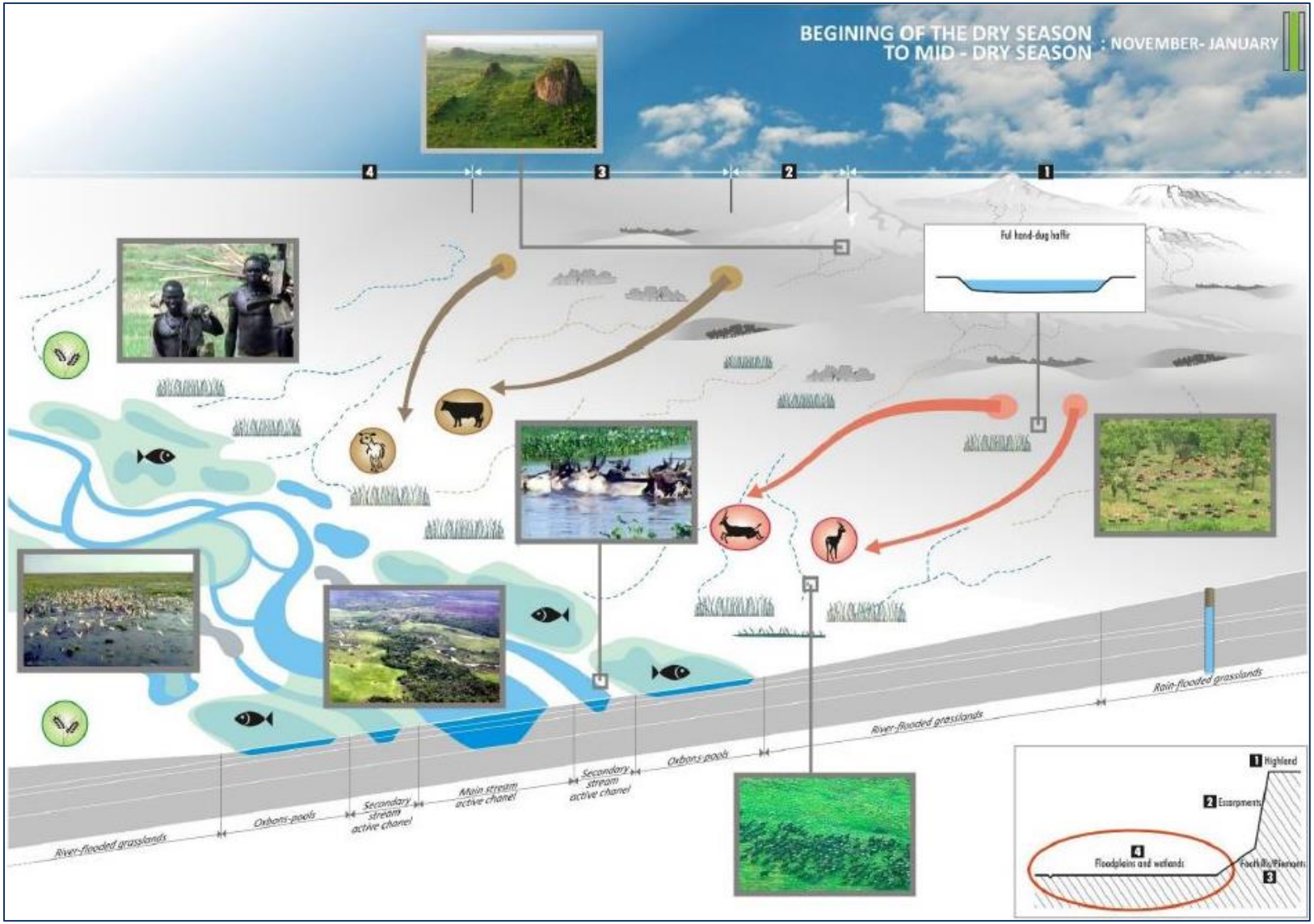
Prepared by: GTS Services (gtshsig@gmail.com)

BAS FLOODPLAINS SEASONAL USES: Rainy Season (May - October)



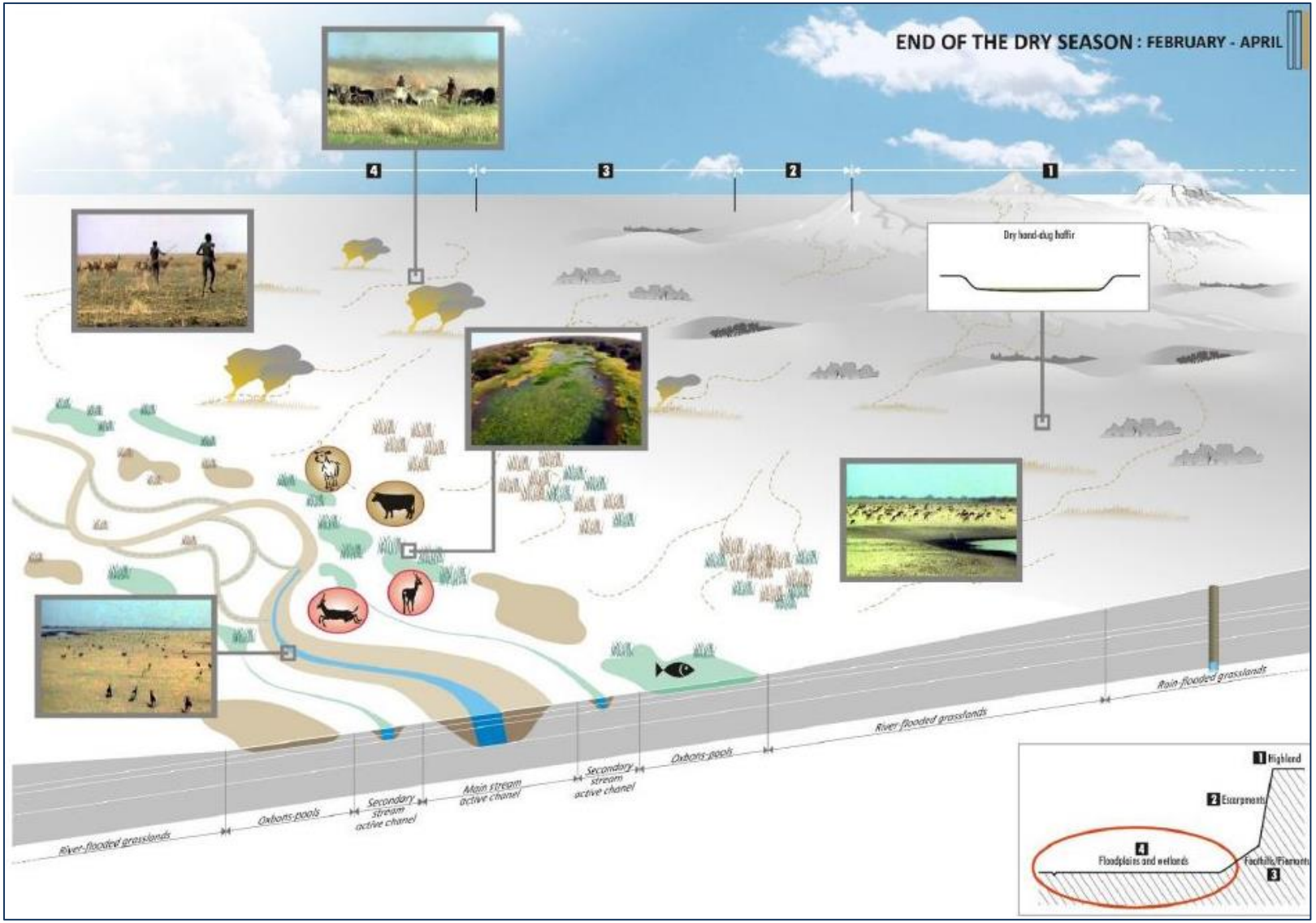
Source:
This Study (BAS MPWRDSP, Baseline, Development Potentials, Key Issues and Objectives Report; Annex 2- Biological Environment). Consultants: BRL Ing., Aurecon and Yerer Consultants, March 2016.

BAS FLOODPLAINS SEASONAL USES: Beginning of Dry Season to Mid Dry Season (November - January)



Source:
This Study (BAS MPWRDSP, Baseline, Development Potentials, Key Issues and Objectives Report; Annex 2- Biological Environment). Consultants: BRL Ing., Aurecon and Yerer Consultants, March 2016.

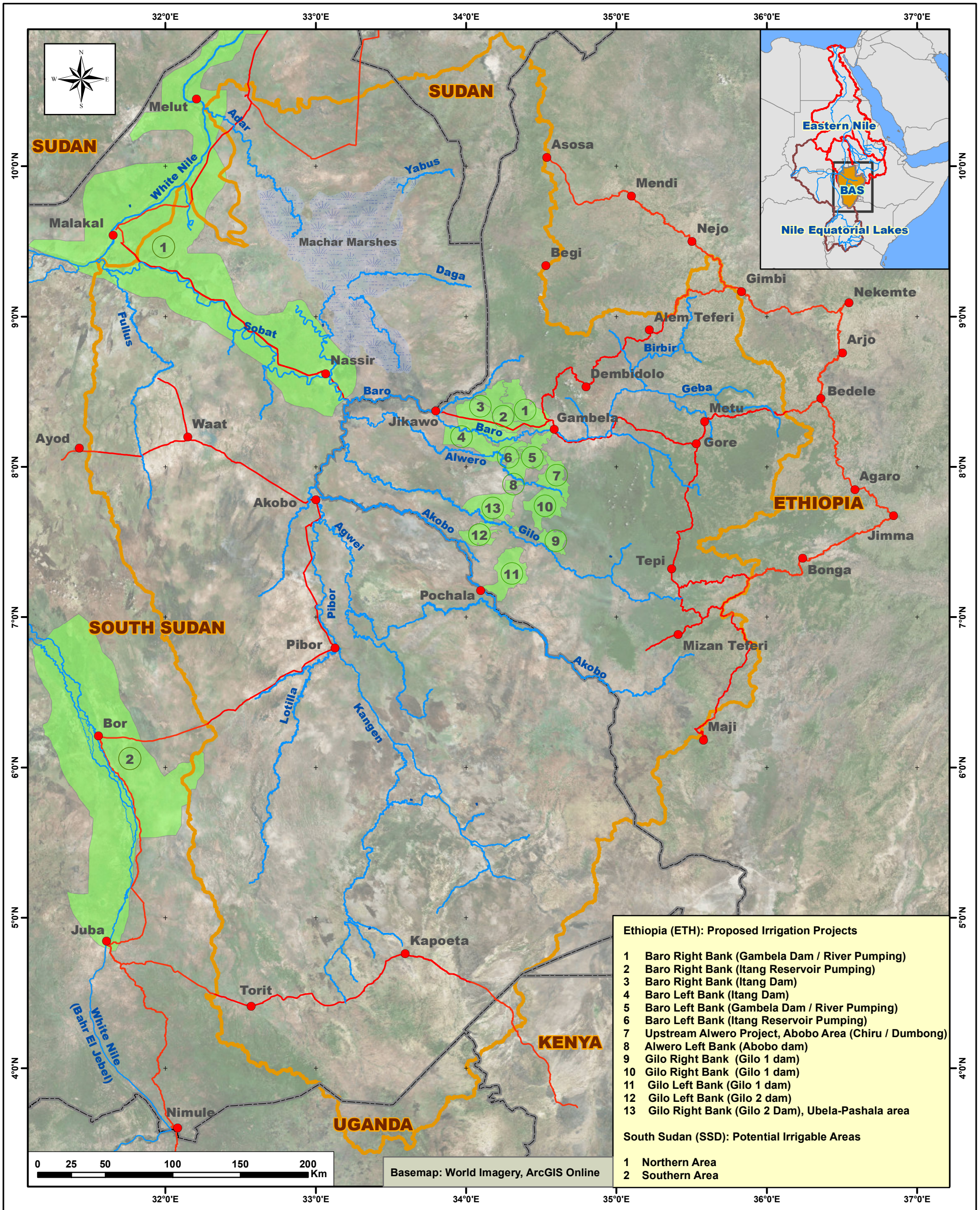
BAS FLOODPLAINS SEASONAL USES: End of Dry Season (February - April)



Source:
This Study (BAS MPWRDSP, Baseline, Development Potentials, Key Issues and Objectives Report; Annex 2- Biological Environment). Consultants: BRL Ing., Aurecon and Yerer Consultants, March 2016.

6. IRRIGATION AND HYDROPOWER

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: POTENTIAL IRRIGATION PROJECTS



Ethiopia (ETH): Proposed Irrigation Projects

1 Baro Right Bank (Gambela Dam / River Pumping)
2 Baro Right Bank (Itang Reservoir Pumping)
3 Baro Right Bank (Itang Dam)
4 Baro Left Bank (Itang Dam)
5 Baro Left Bank (Gambela Dam / River Pumping)
6 Baro Left Bank (Itang Reservoir Pumping)
7 Upstream Alwero Project, Abobo Area (Chiru / Dumbong)
8 Alwero Left Bank (Abobo dam)
9 Gilo Right Bank (Gilo 1 dam)
10 Gilo Right Bank (Gilo 1 dam)
11 Gilo Left Bank (Gilo 1 dam)
12 Gilo Left Bank (Gilo 2 dam)
13 Gilo Right Bank (Gilo 2 Dam), Ubela-Pashala area

South Sudan (SSD): Potential Irrigable Areas

1 Northern Area
2 Southern Area

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Sub-Basin Irrigation

- ETH: Proposed Irrigation Projects
- SSD: Potential Irrigable Areas

Source:
Baro-Akobo River Basin Integrated Development Master Plan, 1997 (MWR, Ethiopia; Tams & ULG, 1997).
South Sudan Irrigation Study (2015).

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

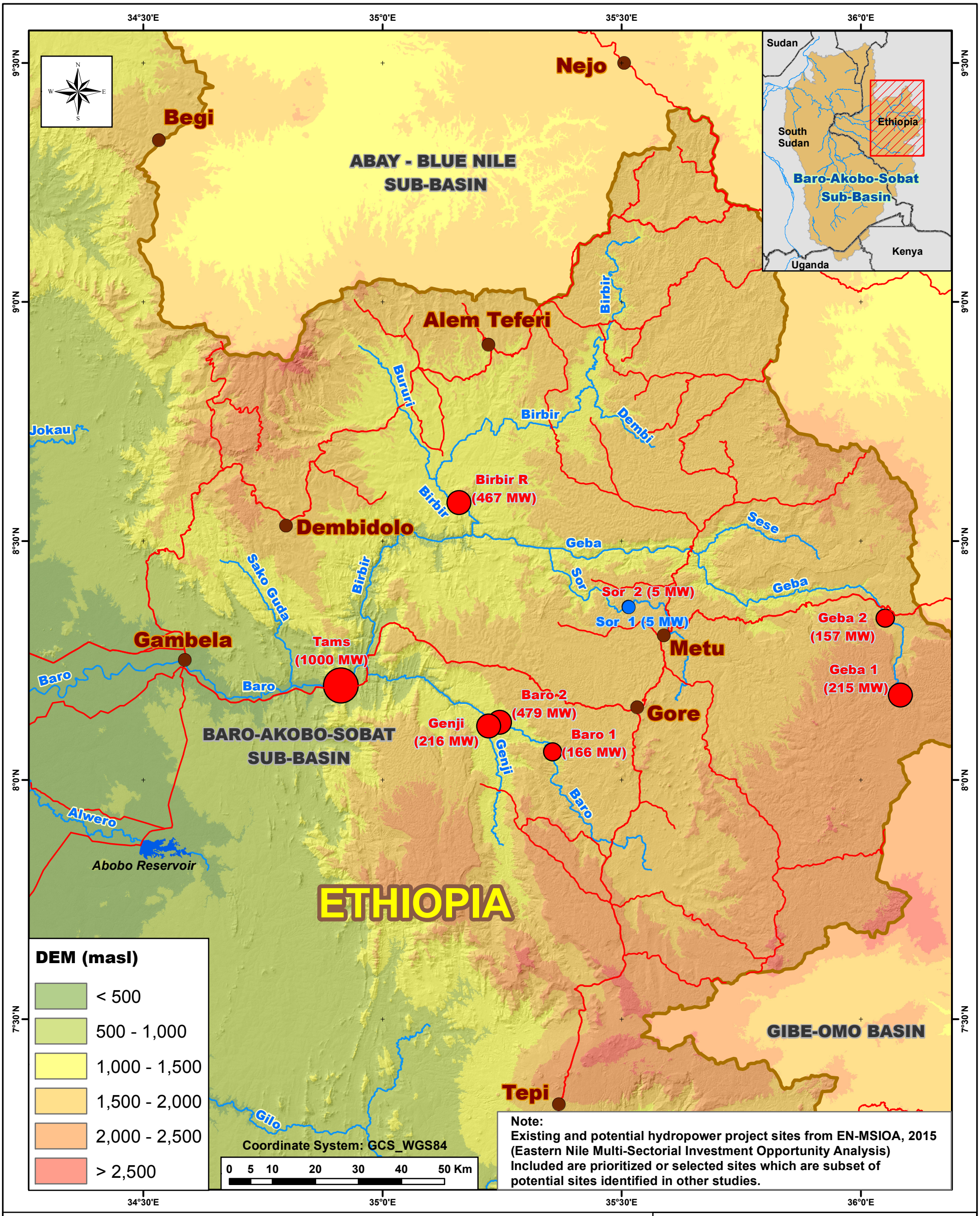
aurecon BRL Ingénierie

Map Title: BAS Potential Irrigation Projects

Date: March 2016 | **Rev:** Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: ETHIOPIAN HYDROPOWER PROJECT SITES



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Reservior

BAS Ethiopian Hydropower Project Sites

Existing	Proposed
< 50 MW	< 50 MW
	51 - 200 MW
	201 - 500 MW
	501 - 800 MW
	> 800 MW

Note: Boundaries of countries and admin units are not authoritative.

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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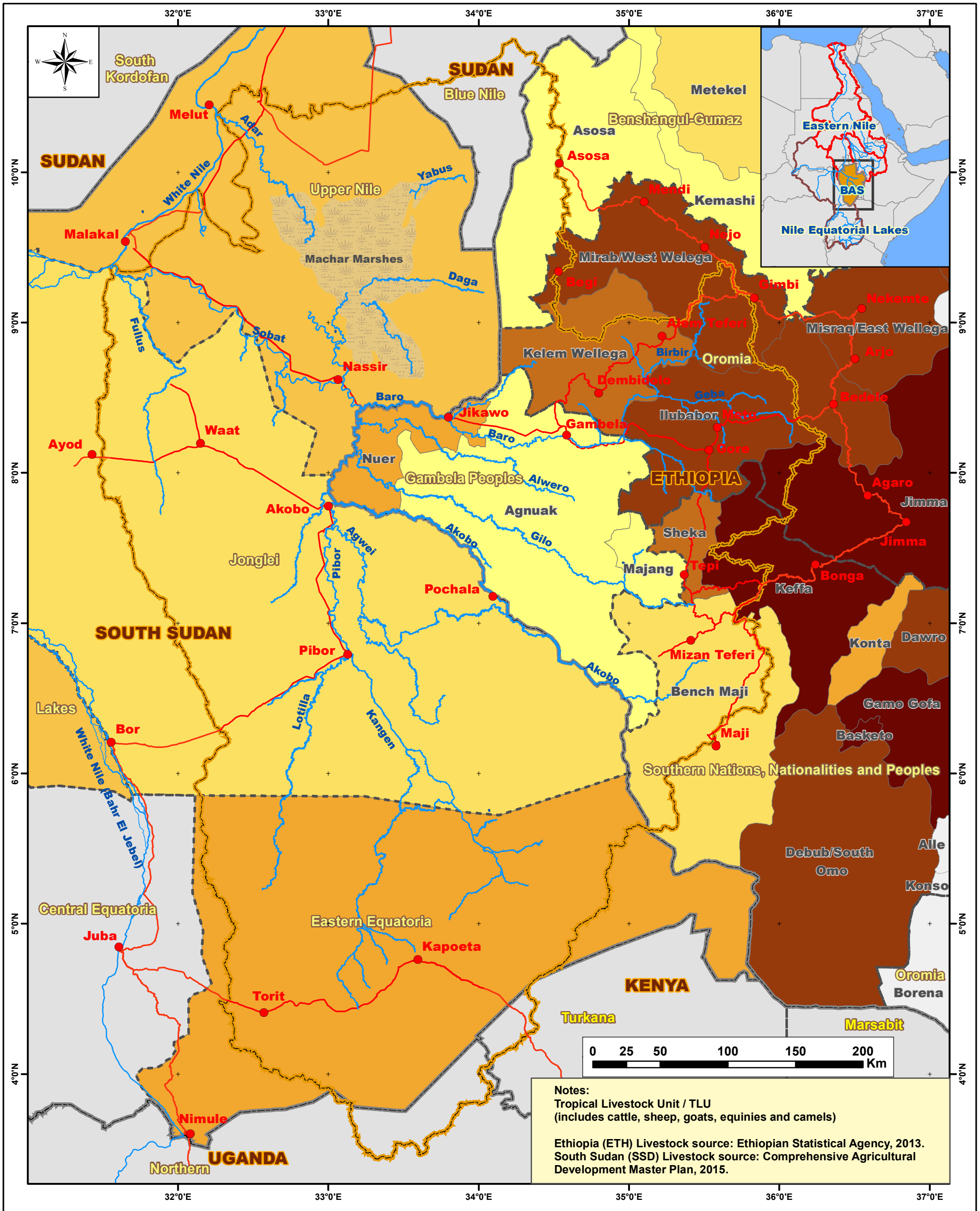
Map Title: BAS Hydropower Project Sites

Date: March 2016 | Rev: Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

7. LIVESTOCK AND FISHERY

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: LIVESTOCK DISTRIBUTION



Notes:
Tropical Livestock Unit / TLU
(includes cattle, sheep, goats, equinies and camels)

Ethiopia (ETH) Livestock source: Ethiopian Statistical Agency, 2013.
South Sudan (SSD) Livestock source: Comprehensive Agricultural Development Master Plan, 2015.

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- ETH Regions/SSD States/SDN States KEN Counties/UGA Sub-Region
- BAS Sub-Basin
- Country Boundaries

BAS Livestock Distribution (TLU per Km²)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 70
- > 70
- Complete data required / no data

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

aurecon BRL ingénierie

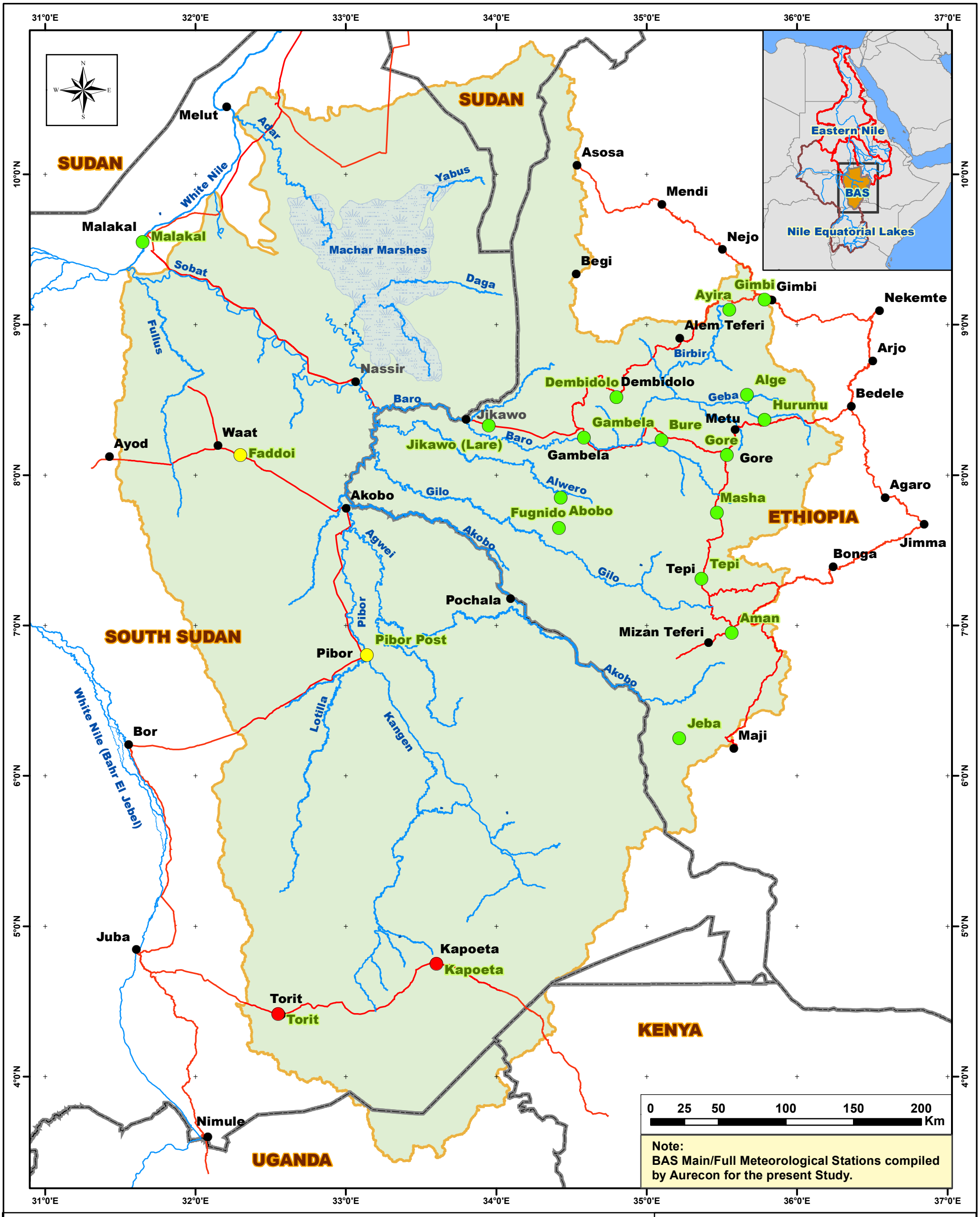
Map Title: BAS Livestock Distribution (TLU)

Date: March 2016 | **Rev:** Draft Map

Prepared by: GTS Services (gtshsig@gmail.com)

8. WATER RESOURCES MODELING

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: MAIN/FULL METEOROLOGICAL STATIONS



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Main/Full Meteorological Stations

- Active
- Inactive
- Proposed

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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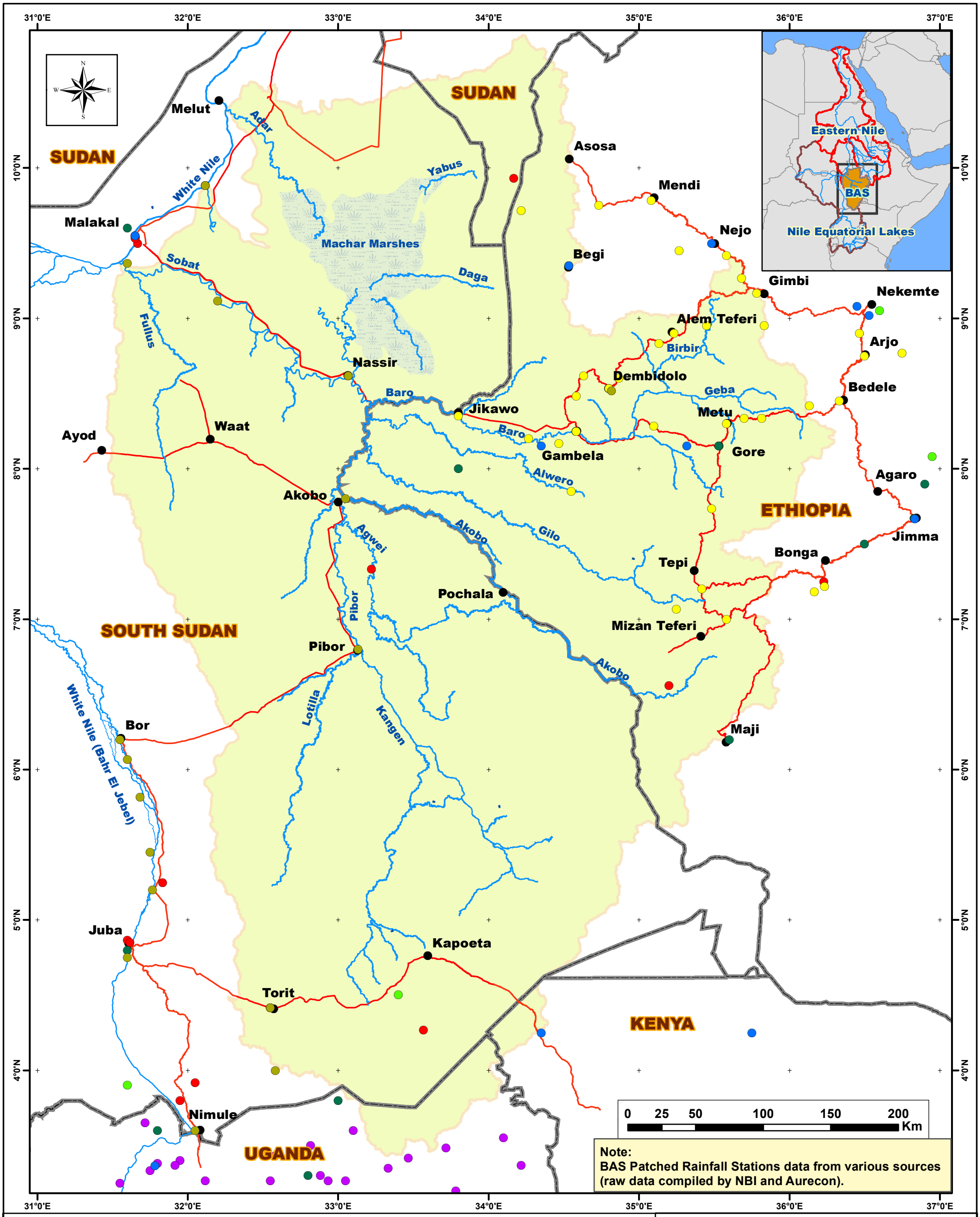
Map Title: BAS Main/Full Meteorological Stations

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: PATCHED RAINFALL STATIONS



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Patched Rainfall Stations

Source

- EMP (Baro-Akobo Ethiopian Master Plan Study)
- NBE (Nile Basin Encyclopedia)
- DST (Nile Decision Support Tool)
- FAO (Food & Agriculture Organization)
- GHCN (Global Historical Climate Network)
- MWE (Ministry of Water & Energy, Uganda)
- NBRP (Nile Basin Research Program)

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

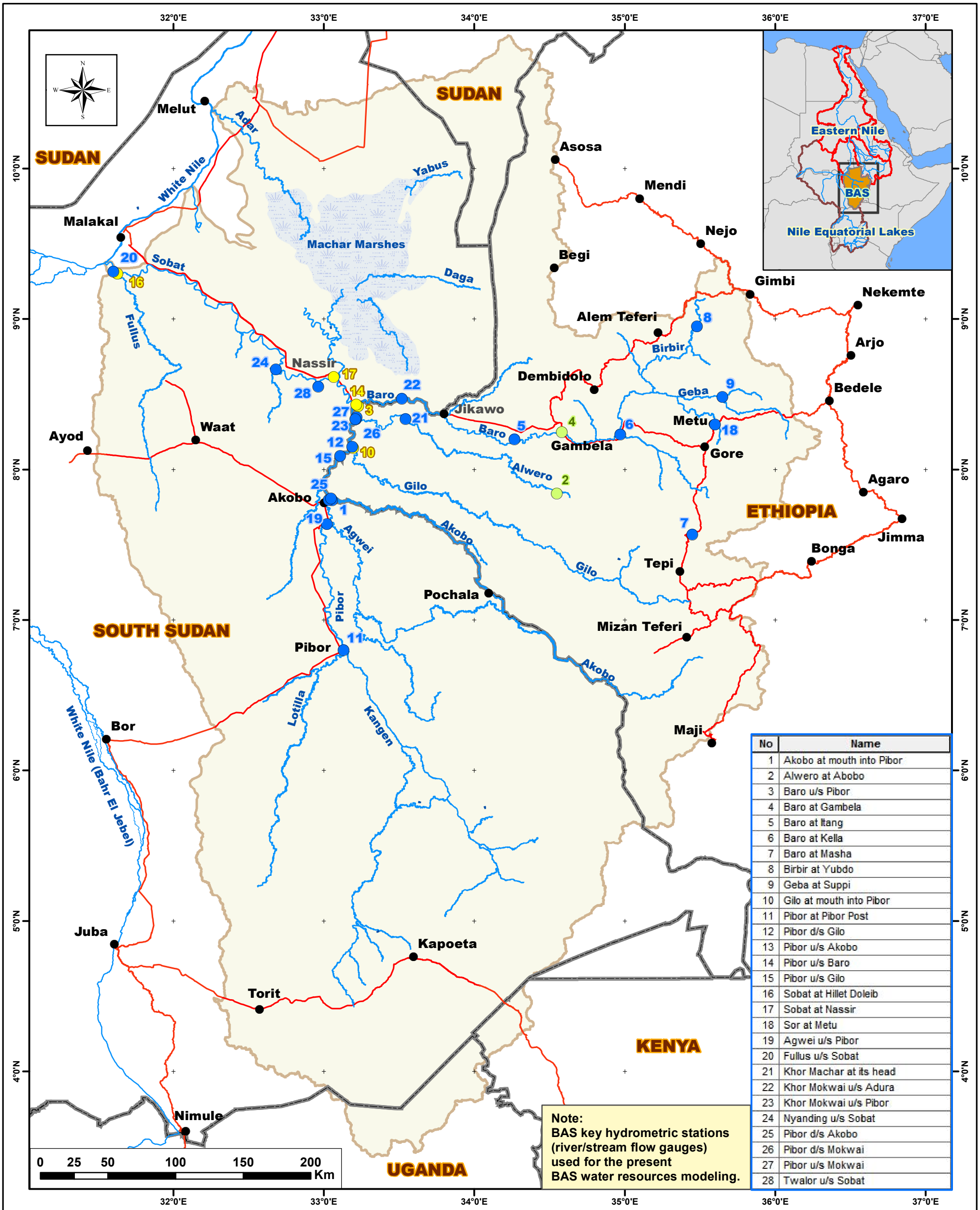
aurecon BRL Ingénierie

Map Title: BAS Patched Rainfall Stations

Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

BARO-AKOBO-SOBAT (BAS) SUB-BASIN: KEY HYDROMETRIC STATIONS



No	Name
1	Akobo at mouth into Pibor
2	Alwero at Abobo
3	Baro u/s Pibor
4	Baro at Gambela
5	Baro at Itang
6	Baro at Kella
7	Baro at Masha
8	Birbir at Yubdo
9	Geba at Suppi
10	Gilo at mouth into Pibor
11	Pibor at Pibor Post
12	Pibor d/s Gilo
13	Pibor u/s Akobo
14	Pibor u/s Baro
15	Pibor u/s Gilo
16	Sobat at Hillet Doleib
17	Sobat at Nassir
18	Sor at Metu
19	Agwei u/s Pibor
20	Fullus u/s Sobat
21	Khor Machar at its head
22	Khor Mokwai u/s Adura
23	Khor Mokwai u/s Pibor
24	Nyanding u/s Sobat
25	Pibor d/s Akobo
26	Pibor d/s Mokwai
27	Pibor u/s Mokwai
28	Twalor u/s Sobat

Note:
BAS key hydrometric stations (river/stream flow gauges) used for the present BAS water resources modeling.

Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Main Roads
- BAS Sub-Basin
- Country Boundaries

BAS Key Hydrometric Stations

- Calibration Stations (2 & 4)
- Validation Stations (3, 10, 14, 16 & 17)
- Other Stations

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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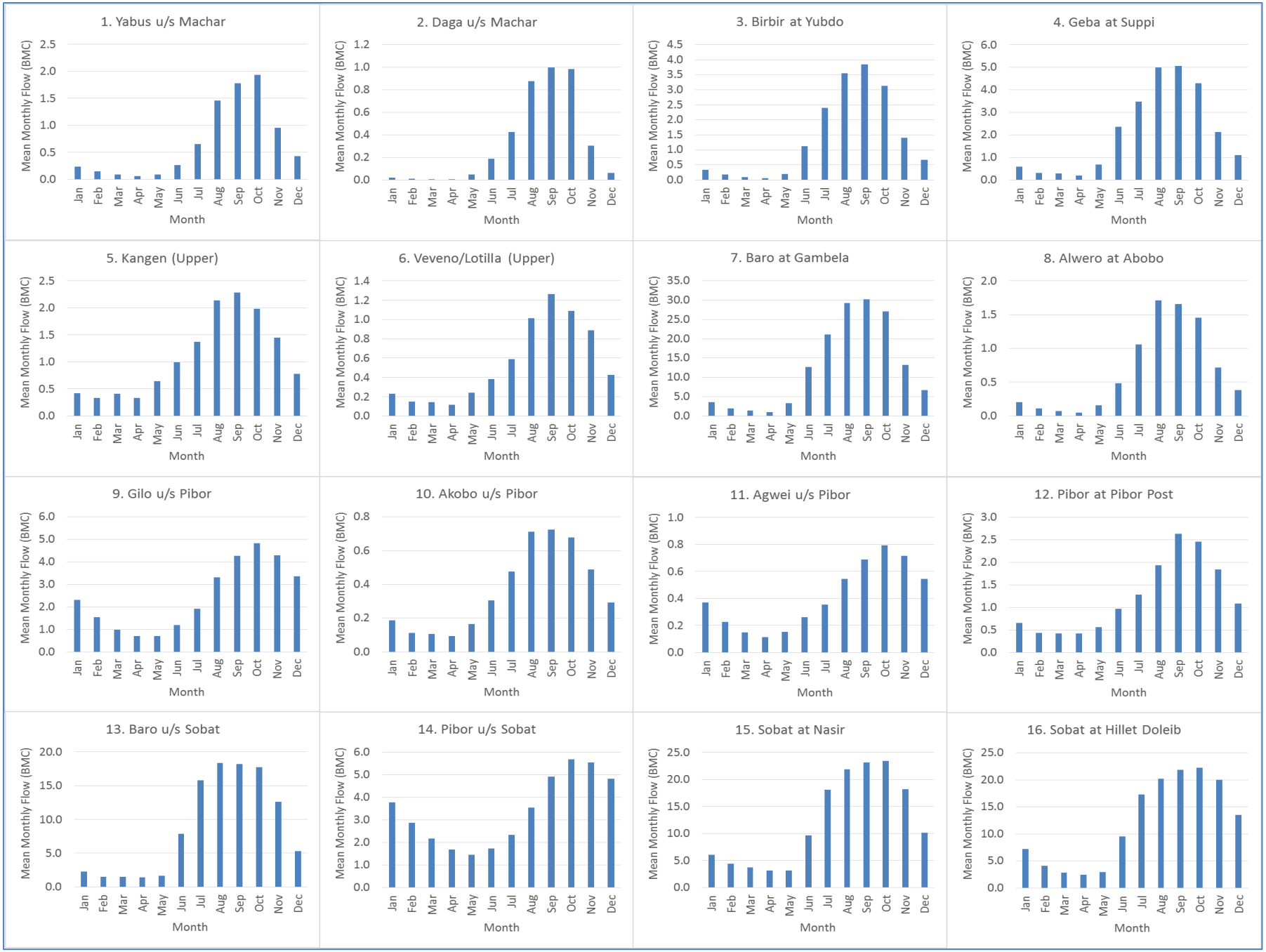
Map Title: BAS Key Hydrometric Stations

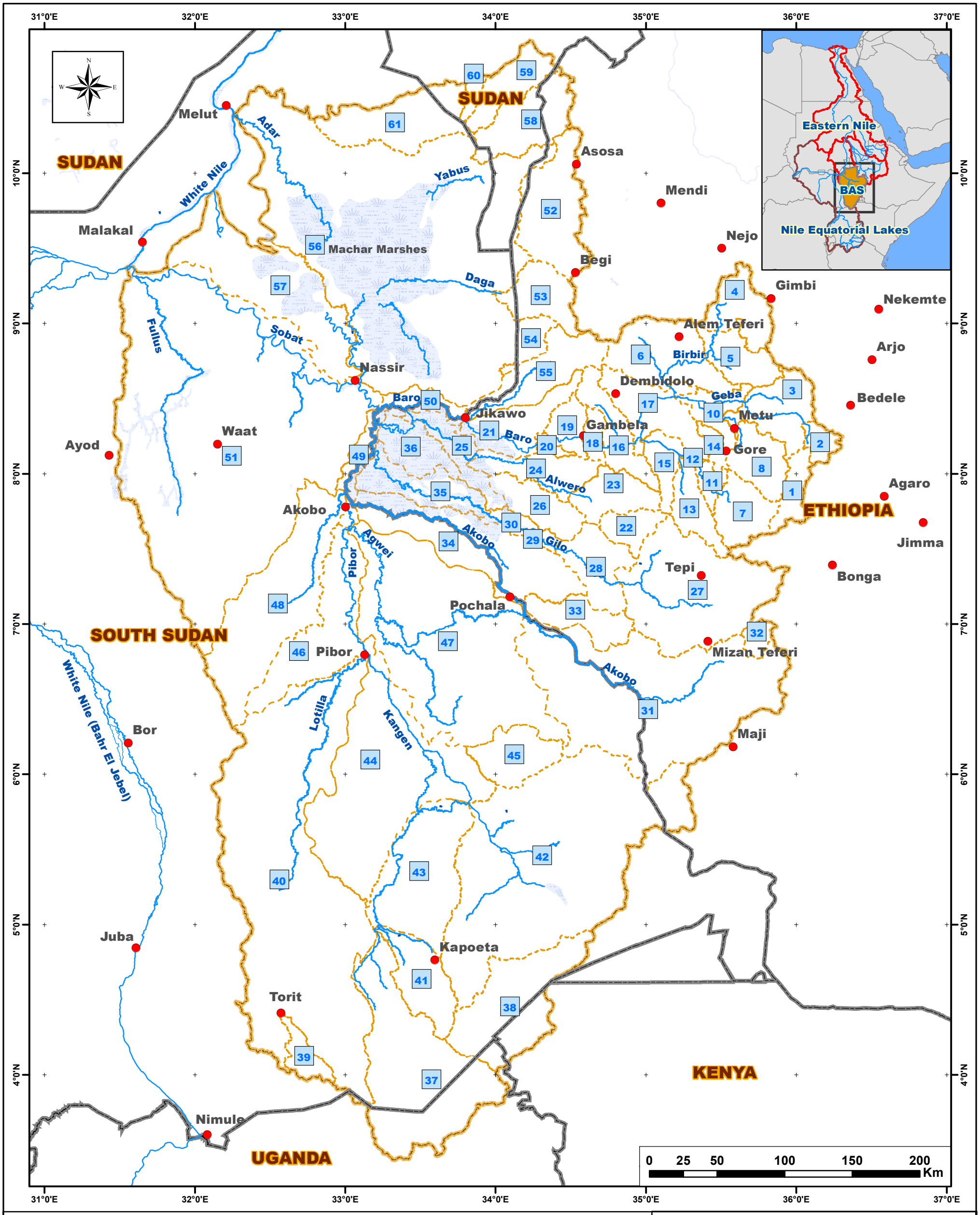
Date: March 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

MEAN MONTHLY FLOW AT KEY HYDROMETRIC STATIONS



BARO-AKOBO-SOBAT (BAS) SUB-CATCHMENTS FOR WATER RESOURCES MODELLING



Legend

- BAS Main Towns
- BAS Main Rivers
- BAS Sub-Catchments
- BAS Sub-Basin
- Country Boundaries

Note:

Refer to BAS sub-catchments used to perform water resources modeling in BAS Baseline SSEA (Strategic Social & Environmental Assesment). Few modifications have been made to the BAS modelled sub-catchments when presented here.

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

aurecon BRL Ingénierie

Map Title:
BAS Sub-Catchments for Water Resources Modeling

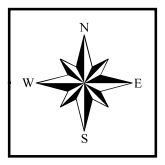
Date: March 2016 | **Rev: Final Draft**

Prepared by: GTS Services (gtshsig@gmail.com)

BAS SUB-CATCHMENTS FOR WATER RESOURCES MODELIING

BAS Sub-Catchments

1 Geba_Geba 1 dam
2 Geba_Geba 2 dam (d/s Geba 1)
3 Geba_Suppi St. (d/s Geba 2)
4 Birbir_Yubdo St.
5 Birbir A_d/s Yubdo
6 Birbir R_d/s Birbir A dam
7 Upper Baro_upto Masha area
8 Sor_Metu St
9 Sor_Sor 1 hp
10 Geba_d/s Suppi
11 Baro_Baro 1 dam (d/s Masha area)
12 Baro_Baro 2 dam (d/s Baro 1)
13 Genji_trib of Baro
14 Gumero_Gumero dam
15 Baro at Kella (d/s Baro 2)
16 Baro _Gambela dam (d/s Kella St.)
17 Baro_Tams dam (d/s Baro at Kella)
18 Baro_Gambela (d/s Gambela dam)
19 Baro_Itang dam (d/s Baro at Gambela)
20 Baro at Itang st_d/s Itang dam
21 Baro near Jikawo_d/s Itang station
22 Alwero_Dumbong dam
23 Alwero_Abobo dam (d/s Dumbong)
24 Alwero d/s Abobo
25 Lower Alwero 1
26 Bela/Ubela_trib of Alwero
27 Gilo_Gilo 1
28 Gilo_Gilo 2 (d/s Gilo 1)
29 Gilo _Punydo st (d/s Gilo 2 dam)
30 Gilo d/s Punydo station
31 Upper Akobo
32 Akobo_Kashu
33 Akula_trib of Akobo
34 Lower Akobo
35 Lower Gilo
36 Lower Alwero 2
37 Kidepo
38 Lomayen - Loyuro
39 Kinyeti_Torit
40 Veveno_Lotilla
41 Katiakin_Singaita
42 Naro_Kobowen (towards Kangen)
43 Sitiri-Nakua_towards Kangen
44 Kangen_to Pibor
45 Upper Kenamuke
46 Pibor_b/n Pibor Post & Akobo
47 Agwei_incl Kong Kong & Oboth
48 Nanaam - Geni (incl Tuni)
49 Lower Pibor Riverine_Akobo-Baro
50 Lower Baro_d/s Jikawo
51 Wang FulLuak-Torluar_trib of Sobat
52 Upper Yabus
53 Deke Sonka-Daga_u/s Daga Post
54 Lau_Kigili
55 Jokau/Jikawo_trib of Baro
56 Machar Eastern Marshes_Adar
57 Machar Western Marshes_Wal
58 Upper Tombak
59 Upper Ahmar_Kofa/Guffa
60 Agap_Kofa/Guffa (trib of Ahmar)
61 Ahmar_incl d/s marshes



BAS Sub-basin

Note:

Refer to the main map entitled BAS sub-catchments for water resources modeling. Few modifications have been made to the BAS modelled sub-catchments when presented here.

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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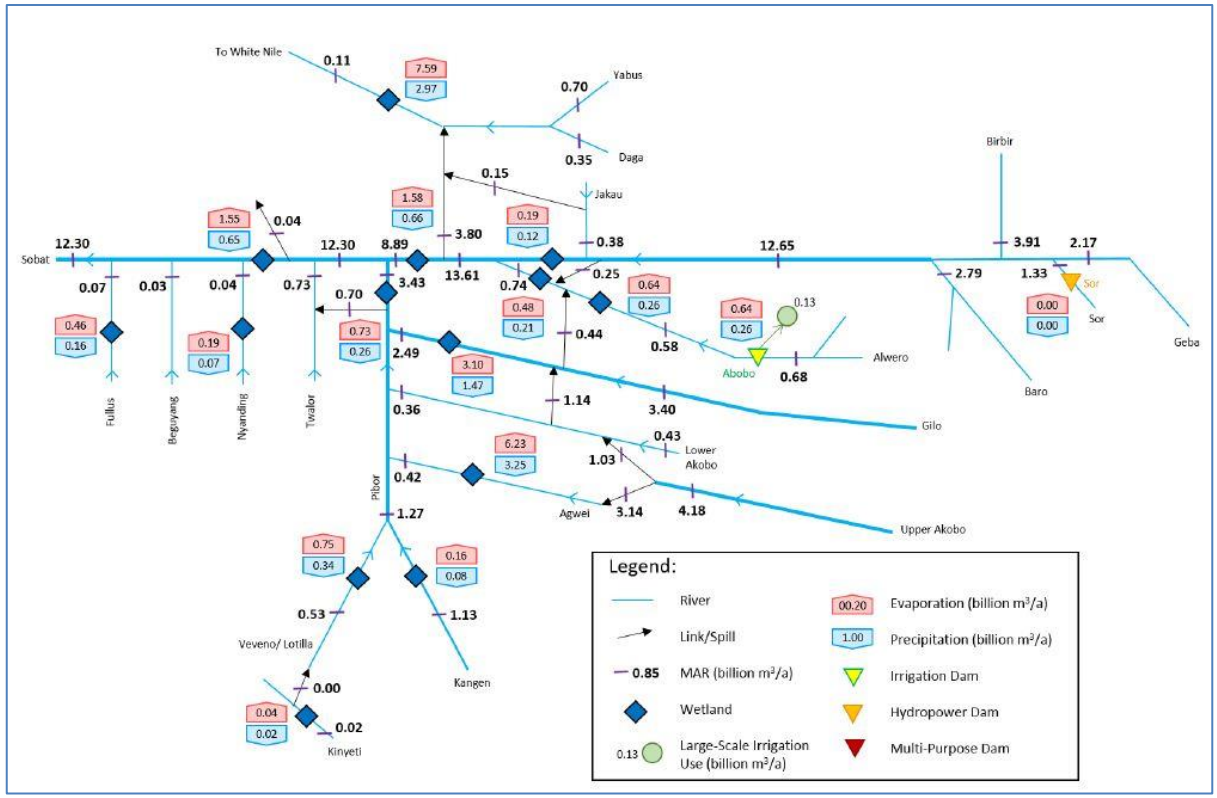
Map Title: BAS Sub-Catchments for Modeling

Date: March 2016 | **Rev: Final Draft**

Prepared by: GTS Services (gtshsig@gmail.com)

Water Balance Schematic of Baseline Scenario (Scenario 0)



Baseline Scenario (Scenario 0):

It is the status quo, which provides a benchmark for the SSEA. The Baseline case includes current domestic and livestock water use, current small-scale irrigation, 10 400 ha irrigation from Abobo Dam and 5 MW Sor Hydropower Dam.

Source:
This Study: BAS Multi-Purpose Water Resources Development Project, 2nd Draft SSEA Report, January 2017.
Consultants: BRL Ing., Aurecon and Yerer Consultants.

Note: Values (numbers) given in the above water balance diagram should be considered indicative. Refer to the source study document to check available and relevant data used, approaches and methodologies adopted and tools employed to carry out the required analysis.

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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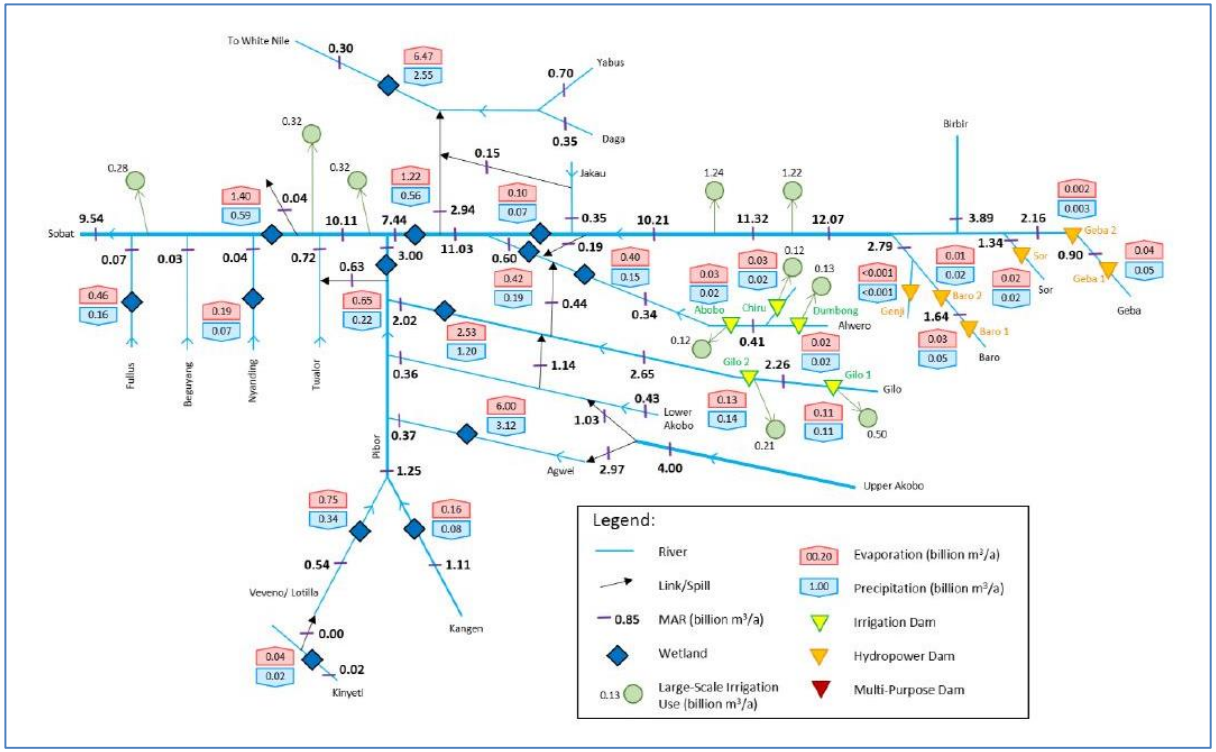
Map Title: Water Balance Schematic of Baseline Scenario (Scenario 0)

Date: January 2017

Prepared by: GTS Services (gtshsig@gmail.com)

Water Balance Schematic of Scenario 1



Scenario 1:

This is a Precautionary Principle case, using reduced irrigation areas (small-scale and large-scale) with no encroachment into environmentally sensitive areas. Irrigation dam storage volumes were also reduced where possible to account for the reduction in irrigation water requirements when this was the case. All potential hydropower dams were included, except Tams Dam and Birbir Dam. These two dams were excluded in order to limit the potential downstream effects of over-regulation.

Source:
This Study: BAS Multi-Purpose Water Resources Development Project, 2nd Draft SSEA Report, January 2017.
Consultants: BRL Ing., Aurecon and Yerer Consultants.

Note: Values (numbers) given in the above water balance diagram should be considered indicative. Refer to the source study document to check available and relevant data used, approaches and methodologies adopted and tools employed to carry out the required analysis.

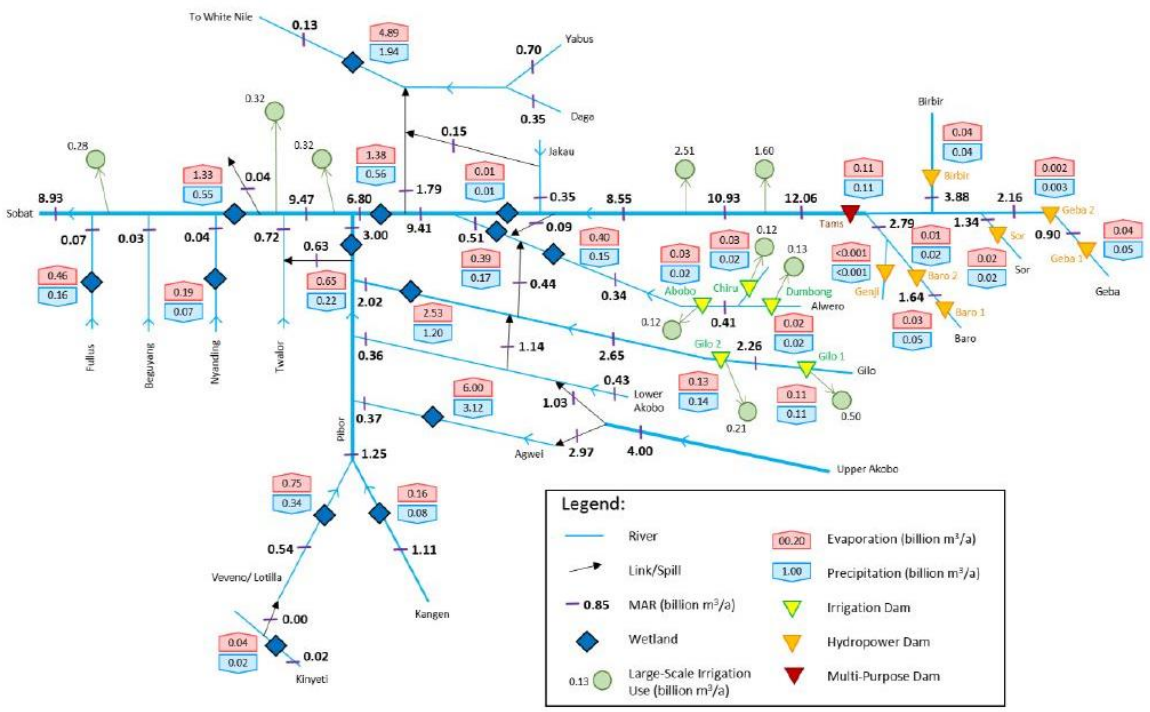
Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

Map Title Water Balance Schematic of Baseline Scenario 1

Date: January 2017

Prepared by: GTS Services (gtshsig@gmail.com)

Water Balance Schematic Scenario 2



Scenario 2:

This is an extension of the Precautionary Principle case, similar to Scenario 1, except that Tams Dam and Birbir Dam are included.

Source:
This Study: BAS Multi-Purpose Water Resources Development Project, 2nd Draft SSEA Report, January 2017.
Consultants: BRL Ing., Aurecon and Yerer Consultants.

Note: Values (numbers) given in the above water balance diagram should be considered indicative. Refer to the source study document to check available and relevant data used, approaches and methodologies adopted and tools employed to carry out the required analysis.

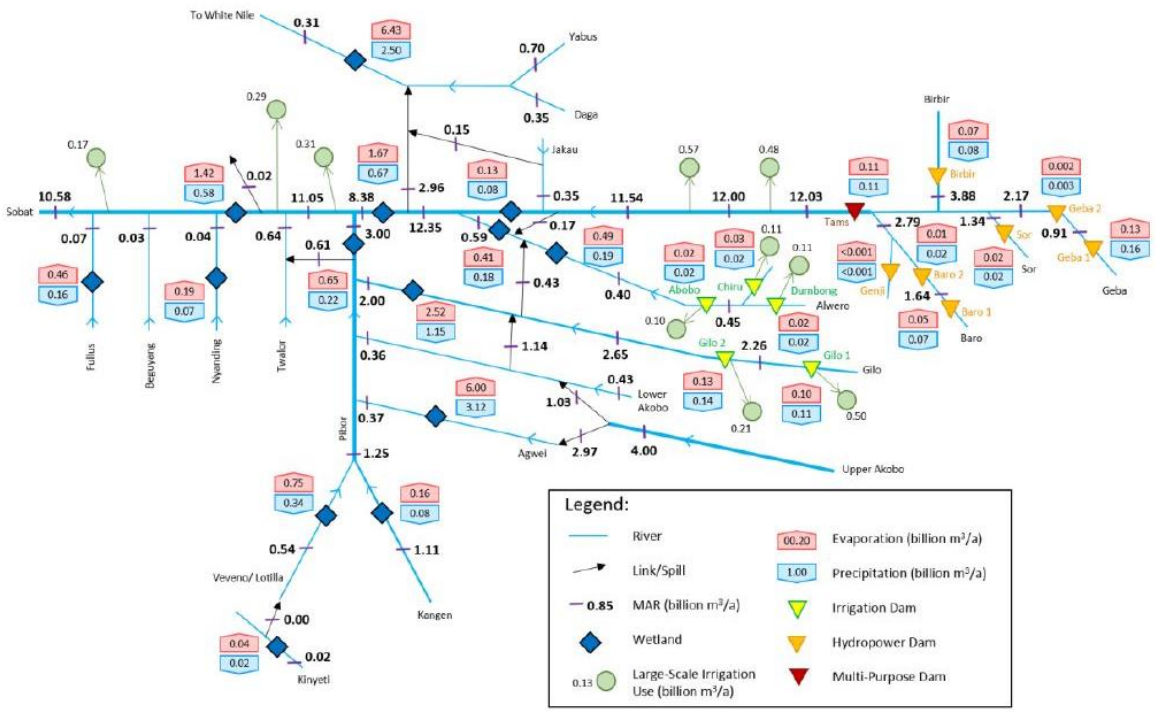
Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

Map Title Water Balance Schematic of Baseline Scenario 2

Date: January 2017

Prepared by: GTS Services (gtshsig@gmail.com)

Water Balance Schematic of Scenario 3a



Scenario 3a:

This is a Compromise case, similar to Scenario 2, but with environmental water releases imposed on all dams in order to conserve natural flow patterns.

Source:
This Study: BAS Multi-Purpose Water Resources Development Project, 2nd Draft SSEA Report, January 2017.
Consultants: BRL Ing., Aurecon and Yerer Consultants.

Note: Values (numbers) given in the above water balance diagram should be considered indicative. Refer to the source study document to check available and relevant data used, approaches and methodologies adopted and tools employed to carry out the required analysis.

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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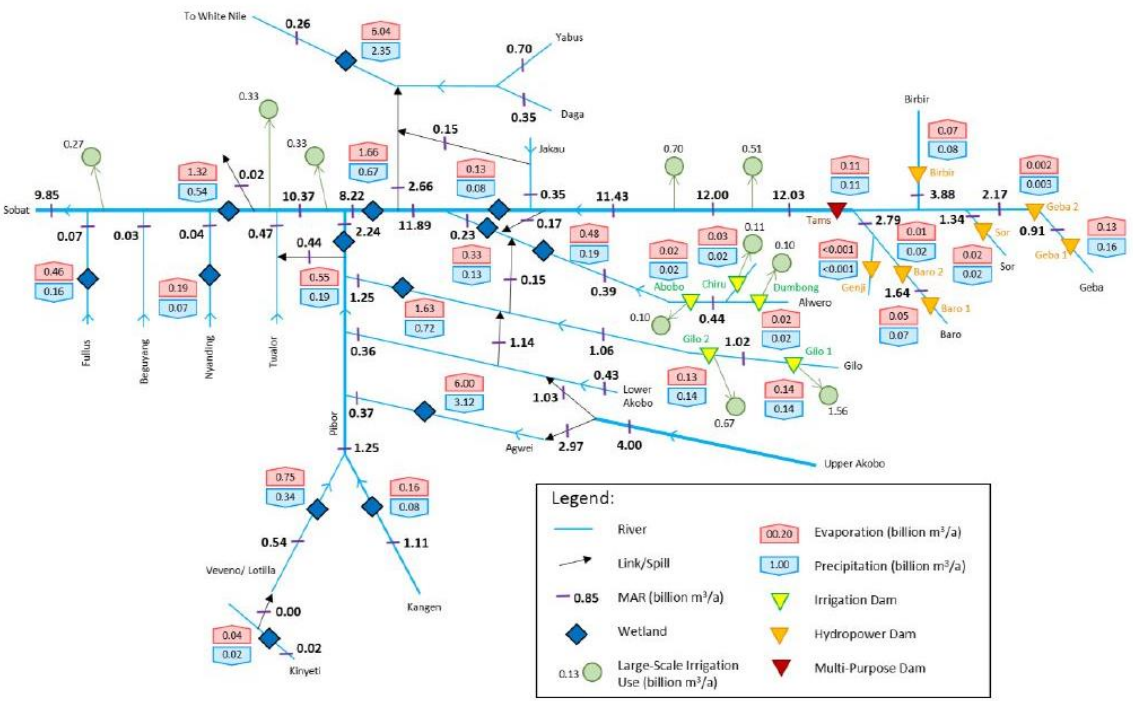
Map Title Water Balance Schematic of Baseline Scenario 3a

Date: January 2017

Prepared by: GTS Services (gtshsig@gmail.com)

Water Balance Schematic of Scenario 3b



Scenario 3b:

This is a Compromise case, similar to Scenario 4a, but with environmental water releases imposed on all dams in order to conserve natural flow patterns.

Source:
This Study: BAS Multi-Purpose Water Resources Development Project, 2nd Draft SSEA Report, January 2017.
Consultants: BRL Ing., Aurecon and Yerer Consultants.

Note: Values (numbers) given in the above water balance diagram should be considered indicative. Refer to the source study document to check available and relevant data used, approaches and methodologies adopted and tools employed to carry out the required analysis.

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

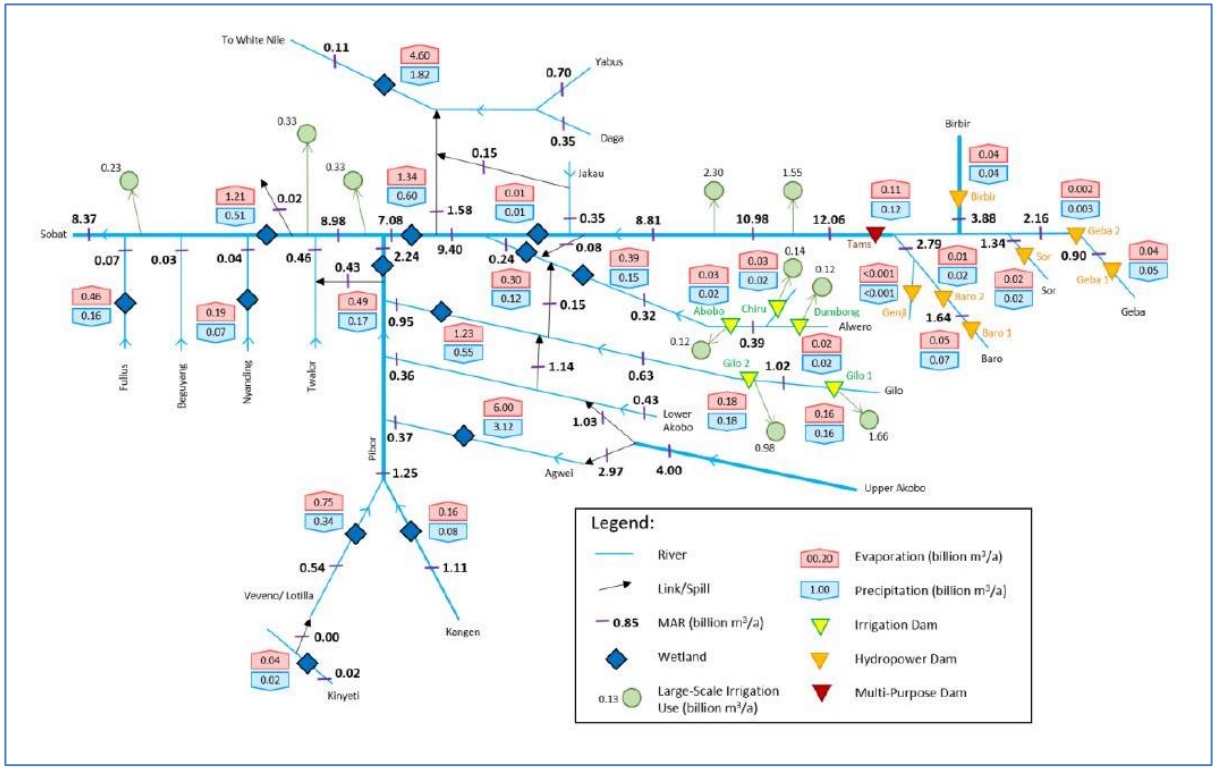
aurecon BRL Ingénierie

Map Title Water Balance Schematic of Baseline Scenario 3b

Date: January 2017

Prepared by: GTS Services (gtshsig@gmail.com)

Water Balance Schematic of Scenario 4a



Scenario 4a:

This is a Full-development case, with Tams Dam operated to maximise hydropower production. All future small-scale and all identified potential large-scale irrigation schemes are included. All identified potential hydropower schemes are also included.

Source:
This Study: BAS Multi-Purpose Water Resources Development Project, 2nd Draft SSEA Report, January 2017.
Consultants: BRL Ing., Aurecon and Yerer Consultants.

Note: Values (numbers) given in the above water balance diagram should be considered indicative. Refer to the source study document to check available and relevant data used, approaches and methodologies adopted and tools employed to carry out the required analysis.

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

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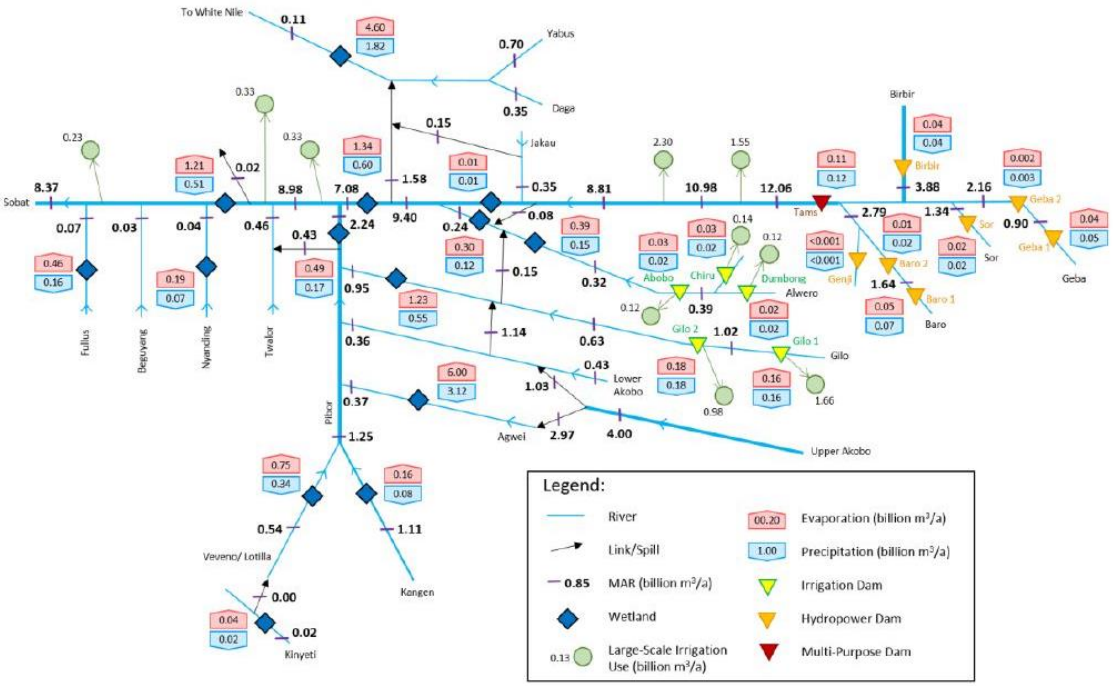
Map Title Water Balance Schematic of Baseline Scenario 4a

Date: January 2017

Prepared by: GTS Services (gtshsig@gmail.com)

Water Balance Schematic of Scenario 4b



Scenario 4b:

This is a Full-development case, with Tams Dam operated to optimise irrigation and flood control. All future small-scale and all identified potential large-scale irrigation schemes are included. All identified potential hydropower schemes are also included.

Source:
This Study: BAS Multi-Purpose Water Resources Development Project, 2nd Draft SSEA Report, January 2017.
Consultants: BRL Ing., Aurecon and Yerer Consultants.

Note: Values (numbers) given in the above water balance diagram should be considered indicative. Refer to the source study document to check available and relevant data used, approaches and methodologies adopted and tools employed to carry out the required analysis.

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

Map Title Water Balance Schematic of Baseline Scenario 4b

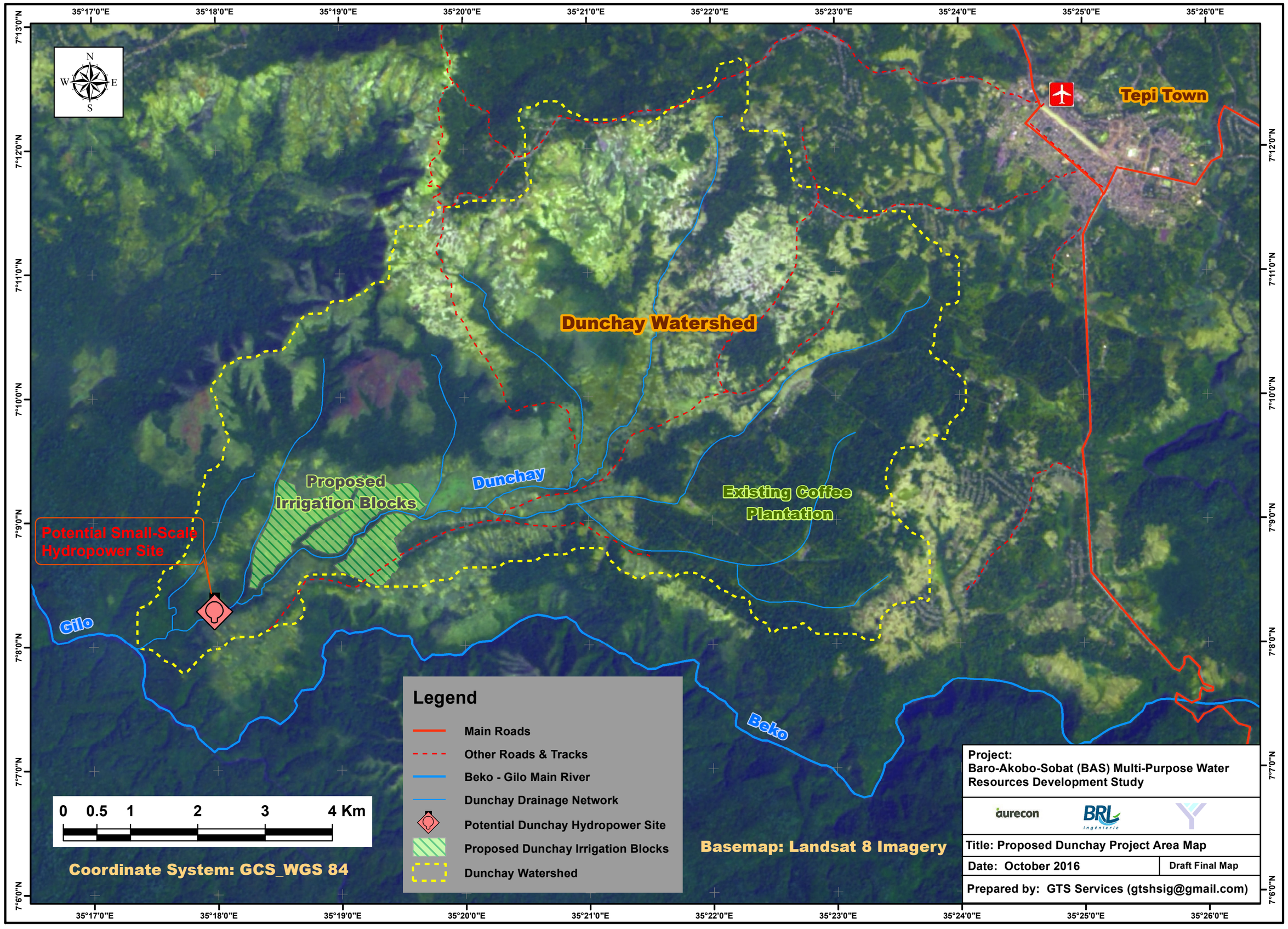
Date: January 2017

Prepared by: GTS Services (gtshsig@gmail.com)

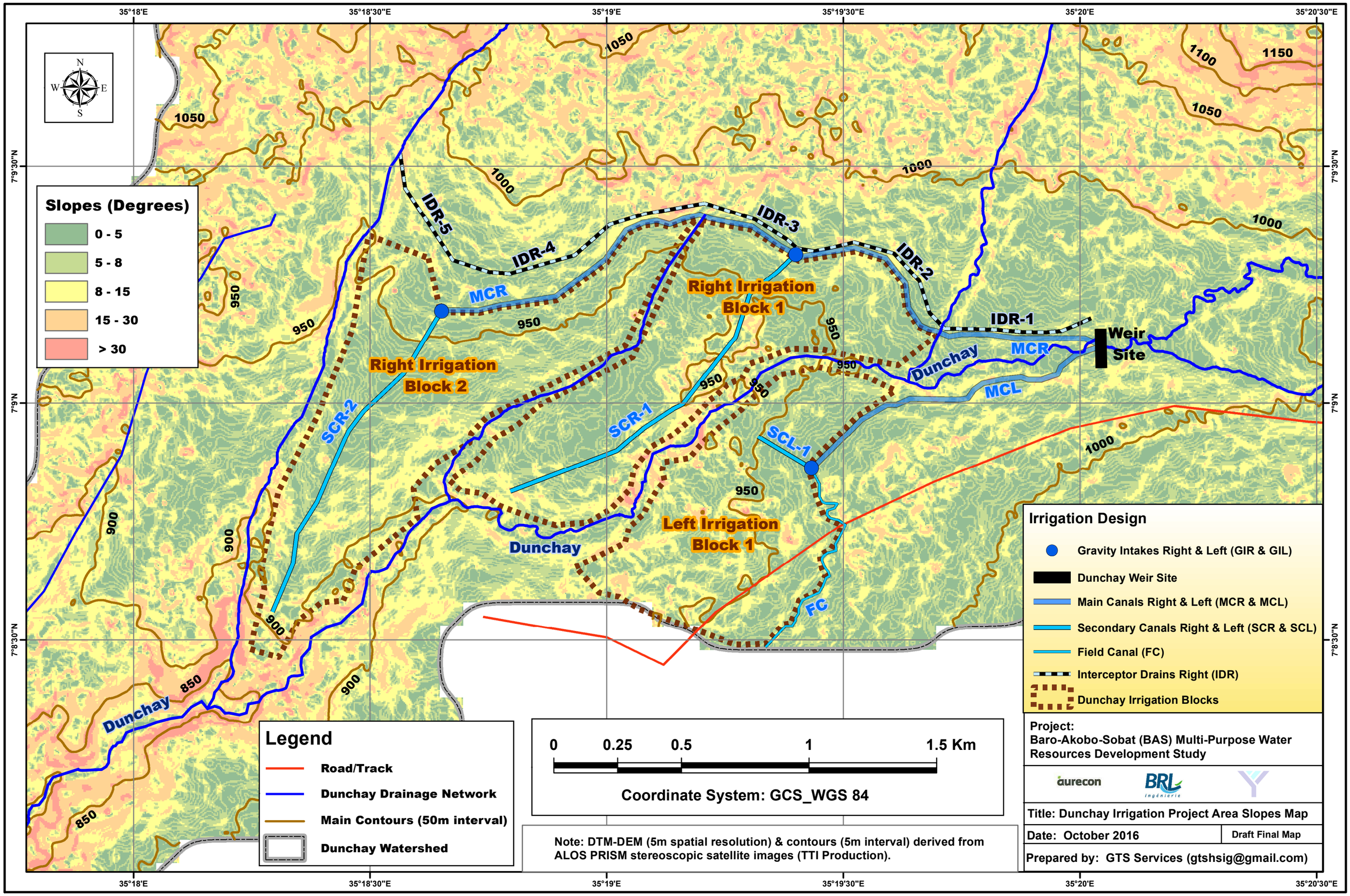
9. BAS SHORT-TERM PROJECTS

- Majang Multi-Purpose Project (Dunchay)
- Kinyeti River Multi-Purpose Development Project

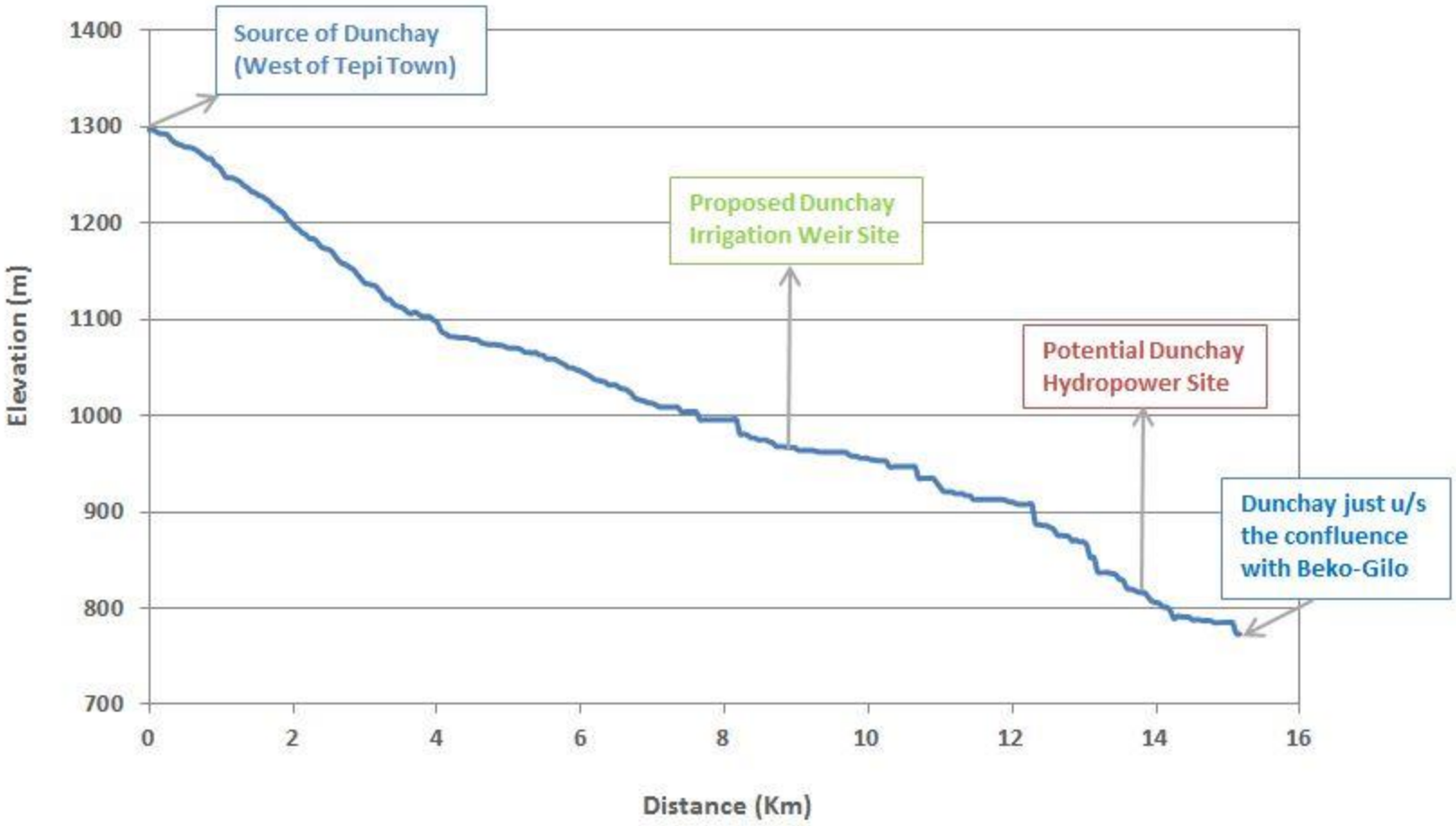
PROPOSED DUNCHAY PROJECT AREA MAP



PROPOSED DUNCHAY IRRIGATION PROJECT AREA: SLOPES MAP

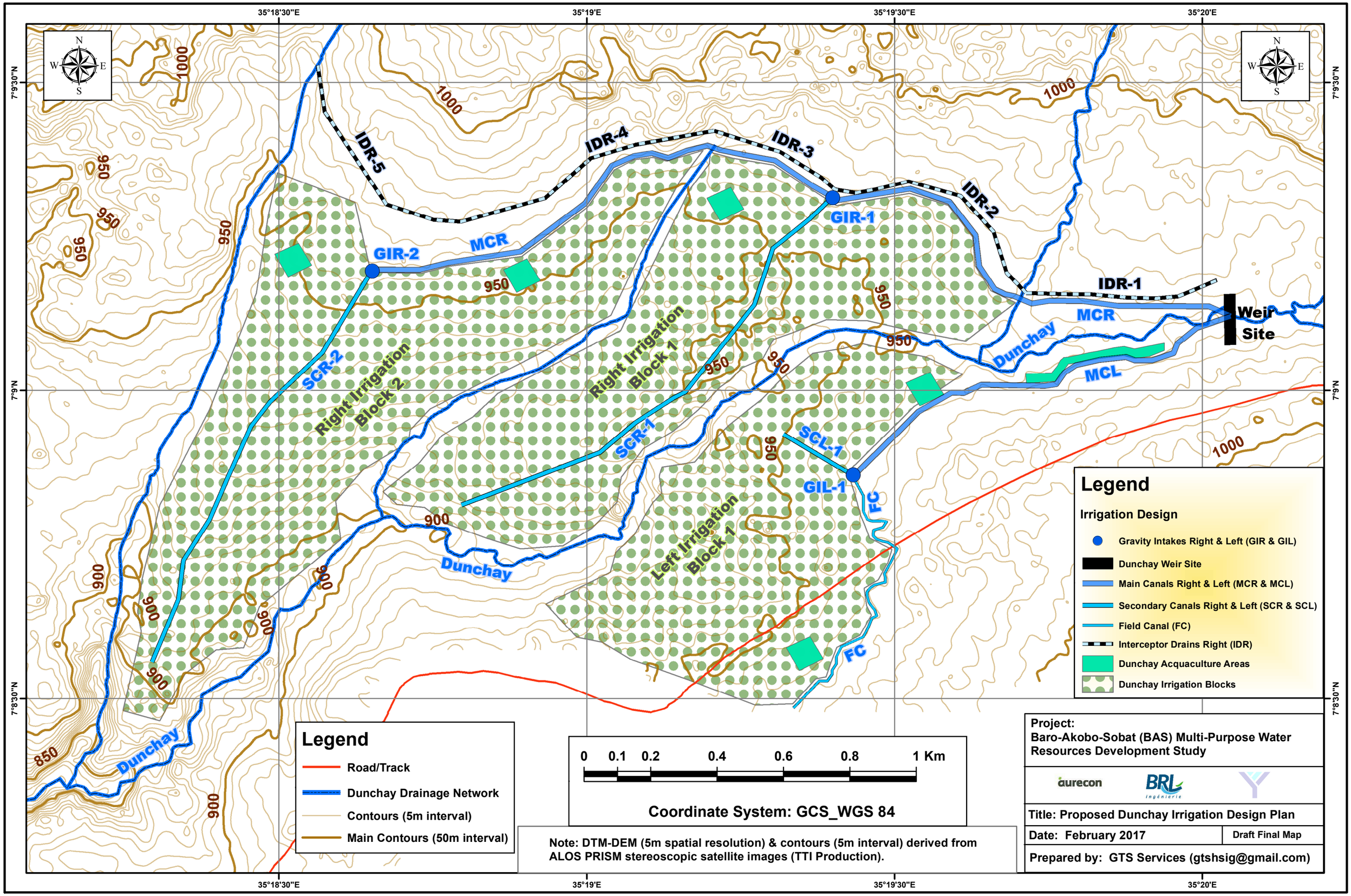


Longitudinal Profile of Dunchay River

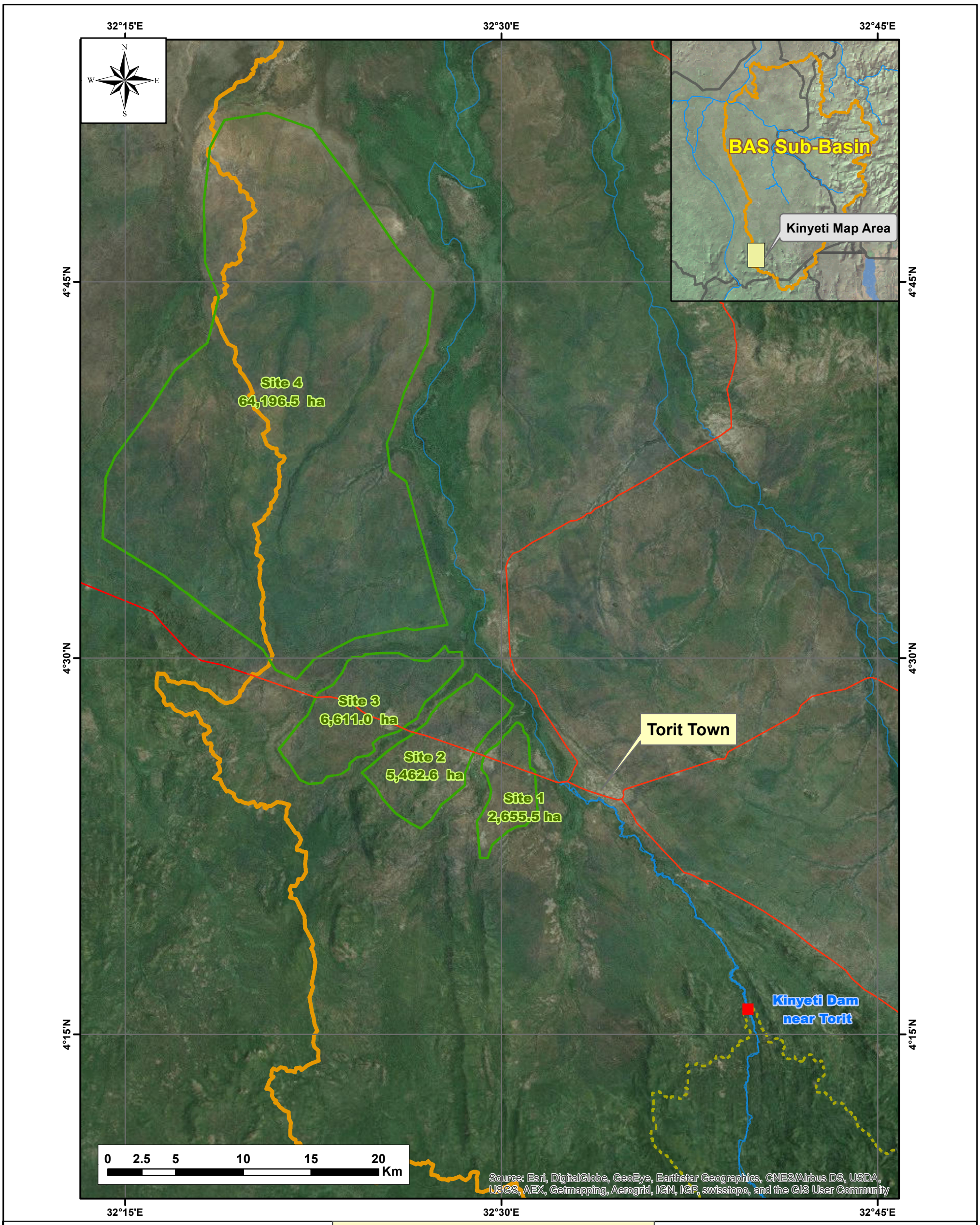


Source of Elevation Data: DTM - DEM derived from ALOS PRSIM stereoscopic high resolution satellite images

PROPOSED DUNCHAY IRRIGATION DESIGN PLAN



KINYETI POTENTIAL IRRIGATION SITES NEAR TORIT TOWN



Legend

- Kinyeti Dam near Torit
- Main Roads
- Mainstream Kinyeti
- Kinyeti Potential Irrigation Sites near Torit
- Kinyeti Dam near Torit Sub-Catchment
- BAS Sub-Basin Boundary

Note: Boundaries of countries and admin units are not authoritative. Coordinate System: GCS_WGS84

Background Map:
World Imagery from ArcGIS Online
(ESRI/Environmental Systems Research Institute)

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

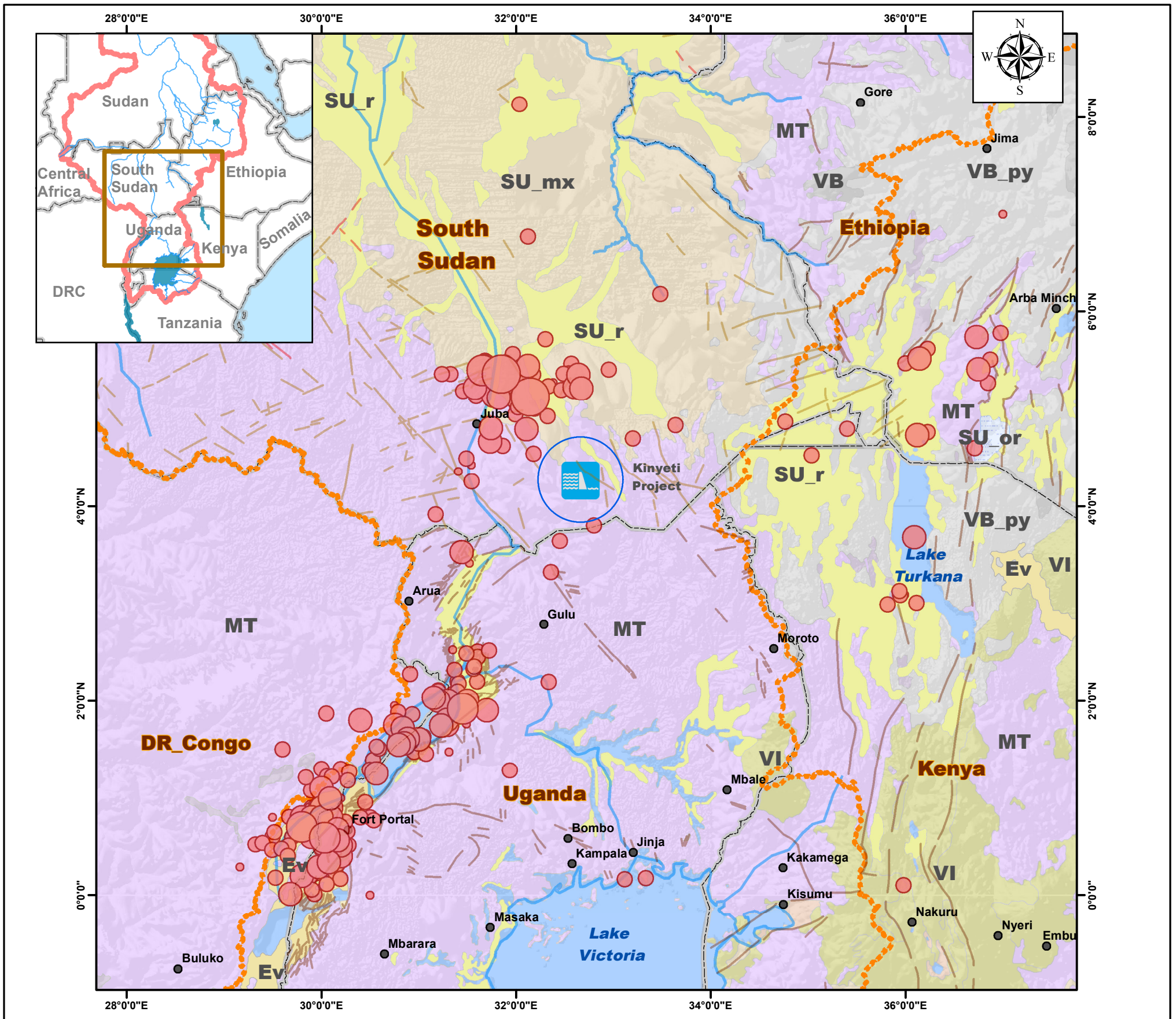
aurecon BRL Ingénierie

Title: Kinyeti Potential Irrigation Sites near Torit

Date: October 2016 | **Rev: Draft Map**

Prepared by: GTS Services (gtshsig@gmail.com)

KINYETI MULTI-PURPOSE DAM: REGIONAL GEOLOGY & EARTHQUAKES



Regional Geology (Lithology & Stratigraphy)

0 50 100 200 300 400 Km

Quaternary Sediments

- SU_r : Recent Unconsolidated Sediments
- SU_mx: Unconsolidated Sediments (mixed grain size)
- SU_or : Unconsolidated Sediments (swampy/lacustrine sediments, organic)
- Ev : Evaporitic Sediments

Quaternary - Tertiary Volcanic Rocks

- VB: Basic Volcanic Rocks
- VB_py: Basic Volcanic Rocks (pyroclastics mentioned)
- VI: Intermediate Volcanic Rocks

Pre-Cambrain Basement Complex

- MT : Metamorphic Rocks (includes certain granites)

Earthquake Magnitude (M)

- ≥ 7.0
- 6.0 - 6.9
- 5.0 - 5.9
- 4.0 - 4.9
- ≤ 4.0

Legend

- Cities / Towns
- Nile Basin_Main Rivers
- Geologic Structures/ Faults
- Kinyeti Dam near Torit
- NB Basin Boundary
- Country boundaries

Regional Geology (Stratigraphy, Lithology & Structures/Faults):
Surficial Geology of Africa (USGS)
Global Lithological Map Database (GLiM v1.1)
Geological Maps of Ethiopia, Sudan/SouthSudan & Kenya
Other Online Resources
Regional Historic Earthquakes Datatabase:
Commission for the Geological Map of the World
Background Layer:
Hillshade DEM (1km spatial resolution)
DEM (1km resolution), hillshade

Note: Boundaries of countries are not authoritative.

Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

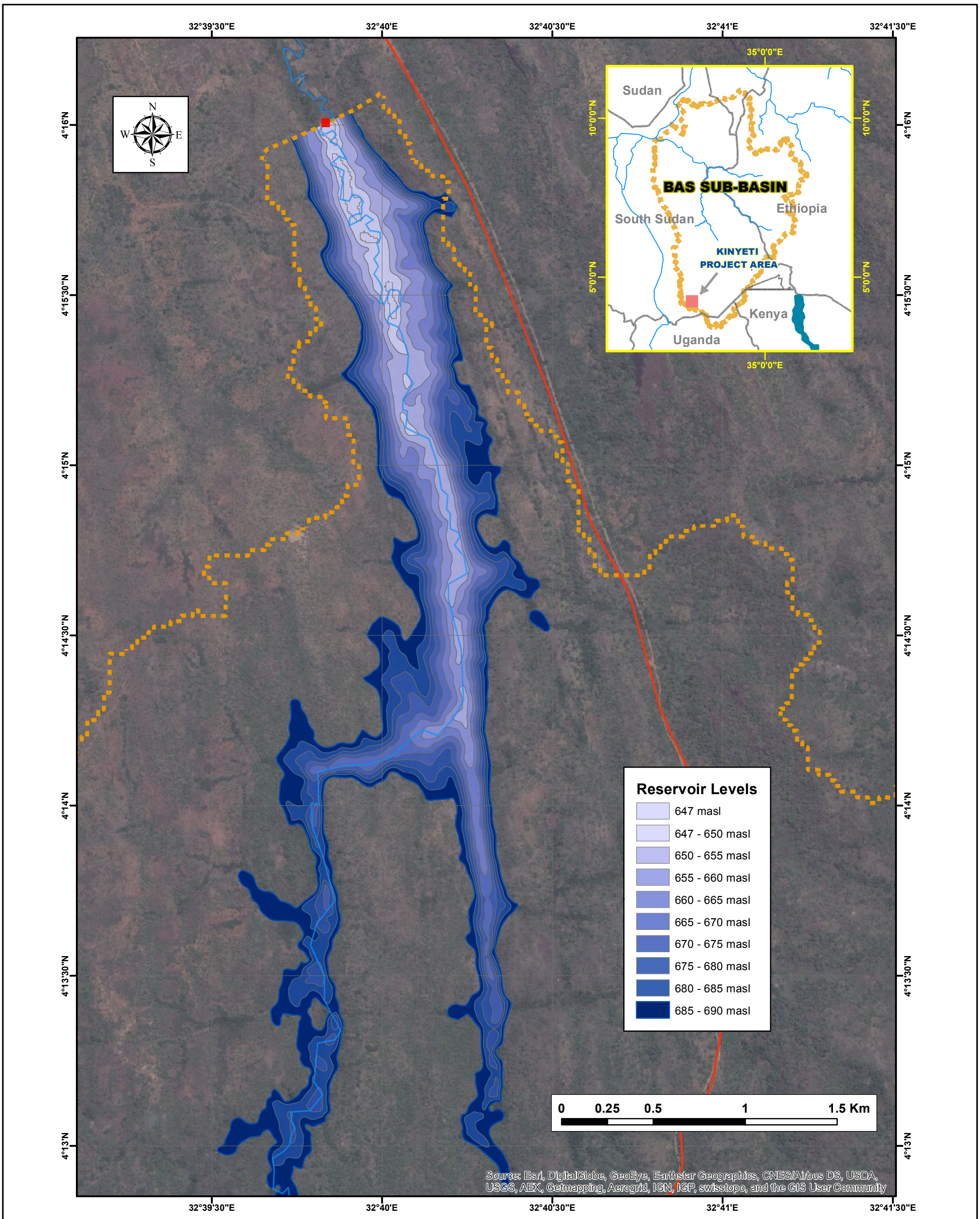
aurecon BRL Ingénierie

Title: Kinyeti Dam Regional Geology & Earthquakes

Date: February 2017 | **Draft Final Map**

Prepared by: GTS Services (gtshsig@gmail.com)

KINYETI MULTI-PURPOSE DAM NEAR TORIT TOWN: RESERVOIR PLANFORM



Legend

- Kinyeti Dam near Torit
- Mainstream Kinyeti
- Kinyeti Dam Sub-catchment

Reservoir Levels:
DTM-DEM and contours derived from ALOS PRISM stereoscopic satelitte images).

Background Map:
World Imagery from ArcGIS Online (ESRI/Environmental Systems Research)

Note: Boundaries of countries are not authoritative.

Coordinate System: GCS_WGS84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

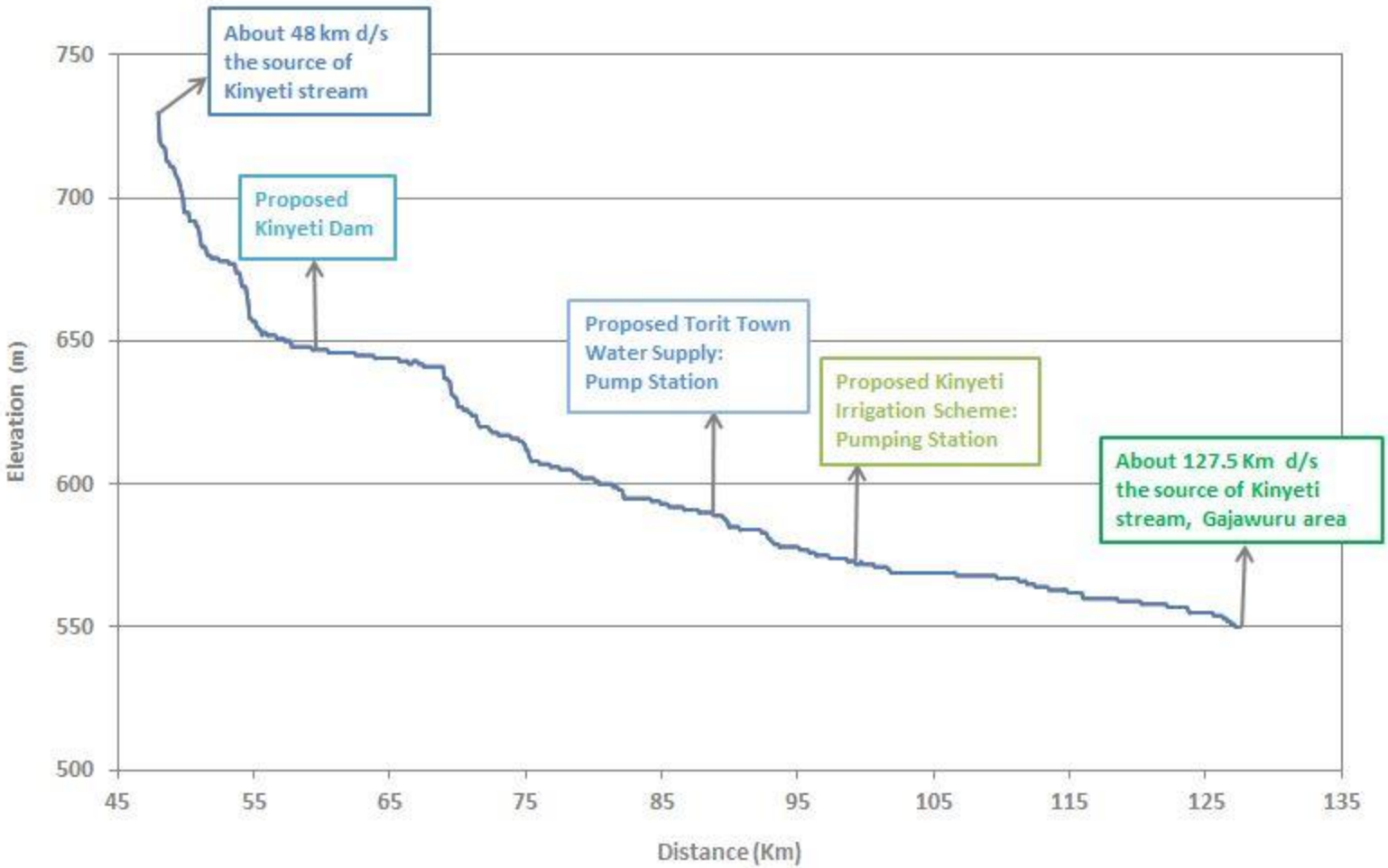
aurecon BRL Ingénierie

Title: Kinyeti Dam near Torit - Reservoir Planform

Date: October 2016 | **Draft Final Map**

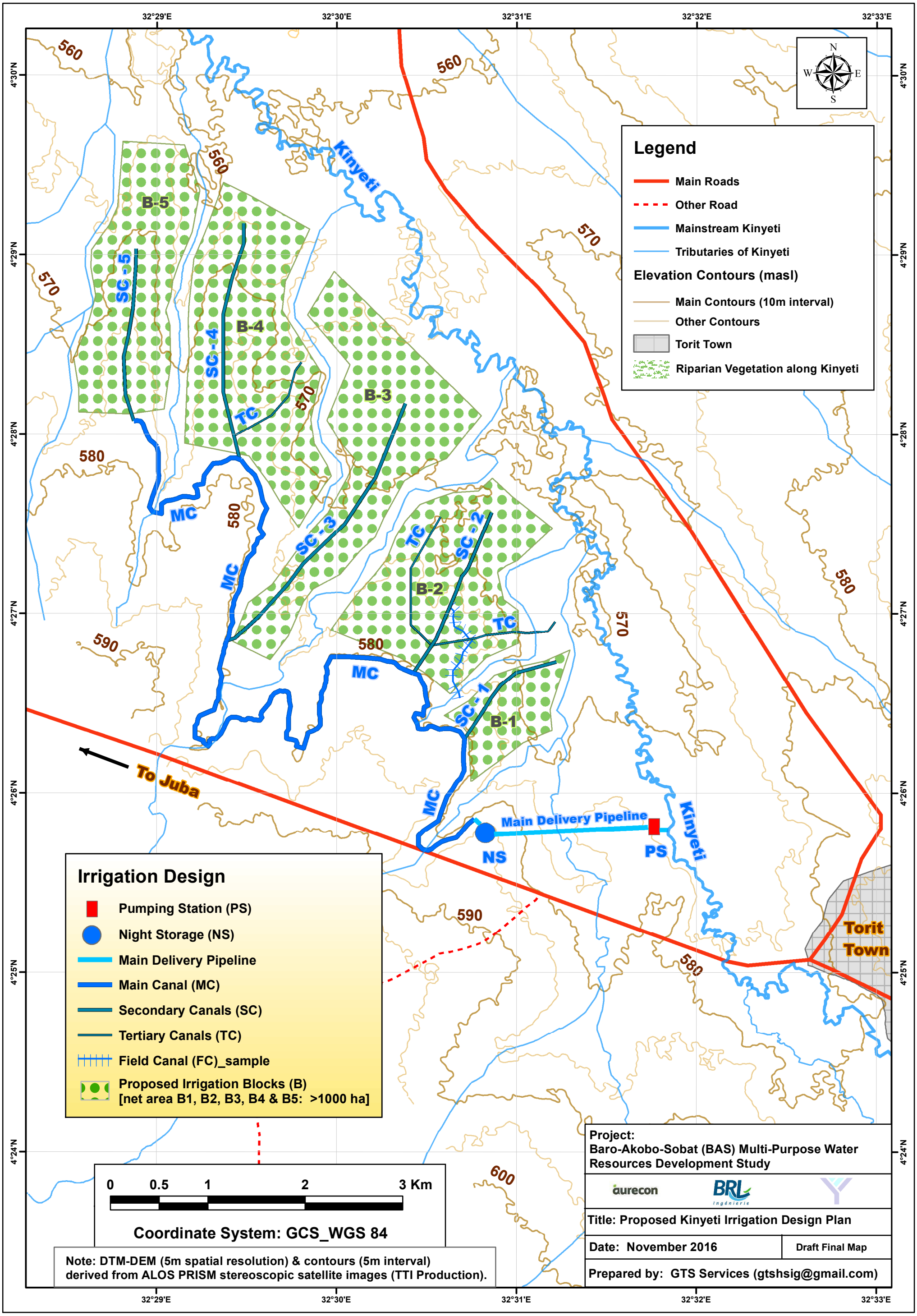
Prepared by: GTS Services (gtshsig@gmail.com)

Longitudinal Profile of Kinyeti River

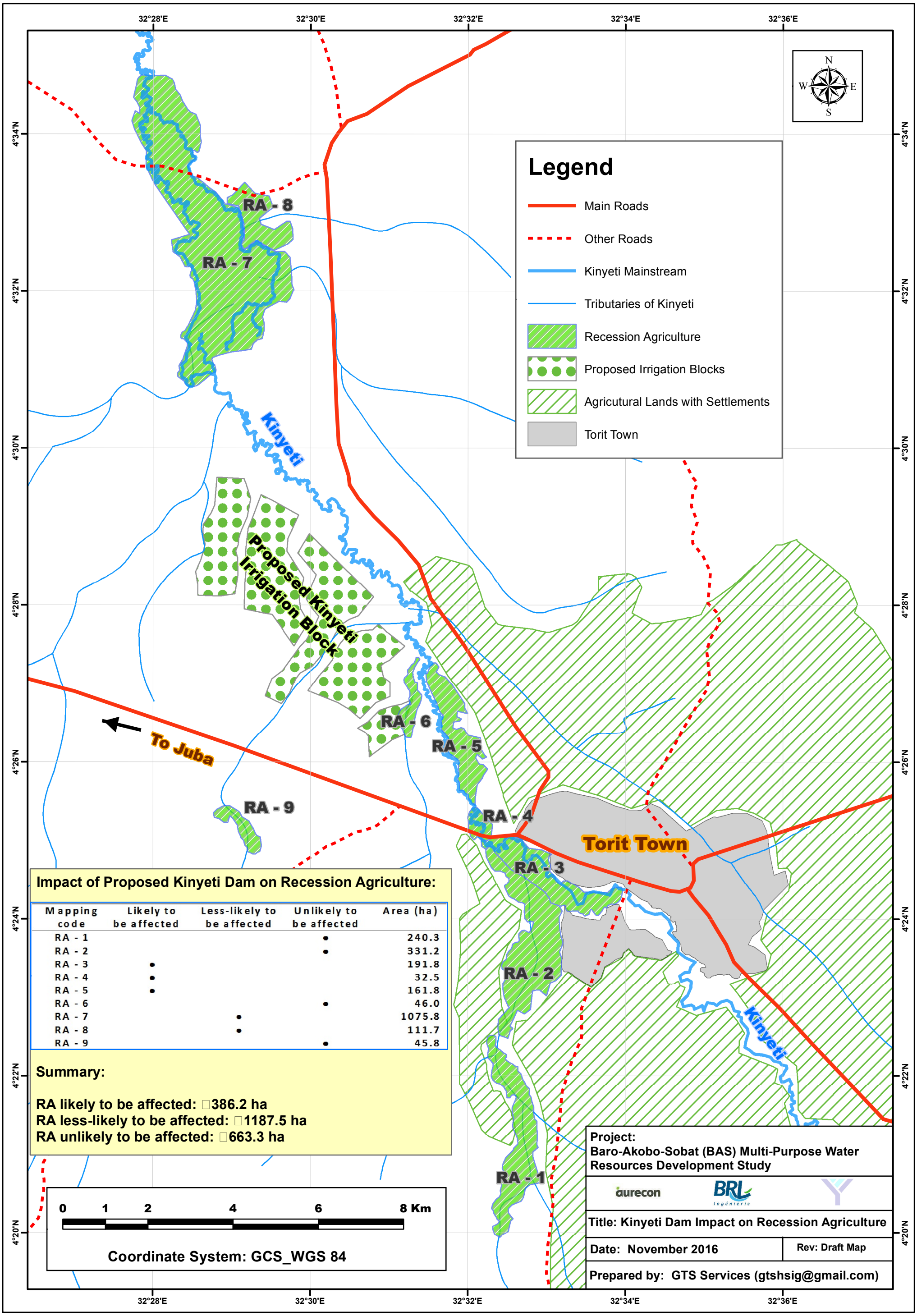


Source of Elevation Data: DTM - DEM derived from ALOS PRSIM stereoscopic high resolution satellite images

PROPOSED KINYETI IRRIGATION DESIGN PLAN



EIA: KINYETI DAM IMPACT ON RECESSION AGRICULTURE



Impact of Proposed Kinyeti Dam on Recession Agriculture:

Mapping code	Likely to be affected	Less-likely to be affected	Unlikely to be affected	Area (ha)
RA - 1			•	240.3
RA - 2			•	331.2
RA - 3	•			191.8
RA - 4	•			32.5
RA - 5	•			161.8
RA - 6			•	46.0
RA - 7		•		1075.8
RA - 8		•		111.7
RA - 9			•	45.8

Summary:

RA likely to be affected: □386.2 ha
RA less-likely to be affected: □1187.5 ha
RA unlikely to be affected: □663.3 ha

0 1 2 4 6 8 Km

Coordinate System: GCS_WGS 84

Project:
Baro-Akobo-Sobat (BAS) Multi-Purpose Water Resources Development Study

aurecon BRL Ingénierie

Title: Kinyeti Dam Impact on Recession Agriculture

Date: November 2016 | **Rev: Draft Map**

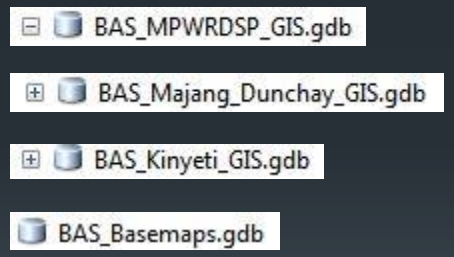
Prepared by: GTS Services (gtshsig@gmail.com)

10. GEO-DATABASE (SPATIAL DATABASE)

BAS MPWRDSP Spatial Database

Introduction

- BAS MPWRDSP spatial database include the following Geodatabases:
  - BAS_MPWRDSP_GIS.gdb
  - BAS_Majang-Dunchay_GIS.gdb
  - BAS_Kinyeti_GIS.gdb
  - BAS_Basemaps.gdb



Main BAS Geo-database

BAS_MPWRDSP_GIS.gdb

Comprises:

- 4 raster catalogs
- 16 feature datasets

Feature Datasets

- Administration
- Climate
- EcoTourism
- Education
- Geology
- Groundwater
- Hydrography
- Hydropower
- Irrigation
- Landuse_Landcover
- Livelihoods_Poverty
- Livestock_Fishery
- Protected Areas
- Transportation
- Water Supply
- Wetlands_Floodplains

Raster Catalogs

- Climate_rc
- Demography_rc
- Elevation_Relief_rc
- Groundwater_rc

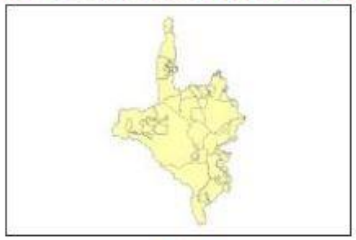
Metadata

Under development

ISO 19139 Metadata Implementation Specification

BAS_ETH_livelihood_zones

File Geodatabase Feature Class



Tags

Livelihood, Livelihood Zones, Socio-Economic, Baro-Akobo-Sobat, BAS, Ethiopia, Eastern Nile

Summary

Livelihood zones of the Ethiopian (ETH) part of Baro-Akobo-Sobat (BAS) sub-basin; data extracted for BAS MPWRDSP (Multi-Purpose Water Resources Development Study Project)

Description

Note: Livelihood zone map illustrates the country by zone, showing areas where people generally have the same options for obtaining food and income and engaging in trade.

Online spatial data source: Livelihood zones of Ethiopia (November 2009), FEWS NET (Famine Early Warning Systems Network)-USAID (US Agency for International Development); Data source: Livelihood Integration Unit, Ministry of Agriculture and Rural Development (MoARD) of Ethiopia.

Credits

FEWS NET-USAID, MoARD, BRL Ing, Aurecon, Yerer Consultants, GTS Services, ENTRO

Use limitations

Detailed zoning may be required for certain subspaces if presented at relatively larger-scale; (appreciate the comprehensive and generalized nature of livelihood zonings carried out at country level).