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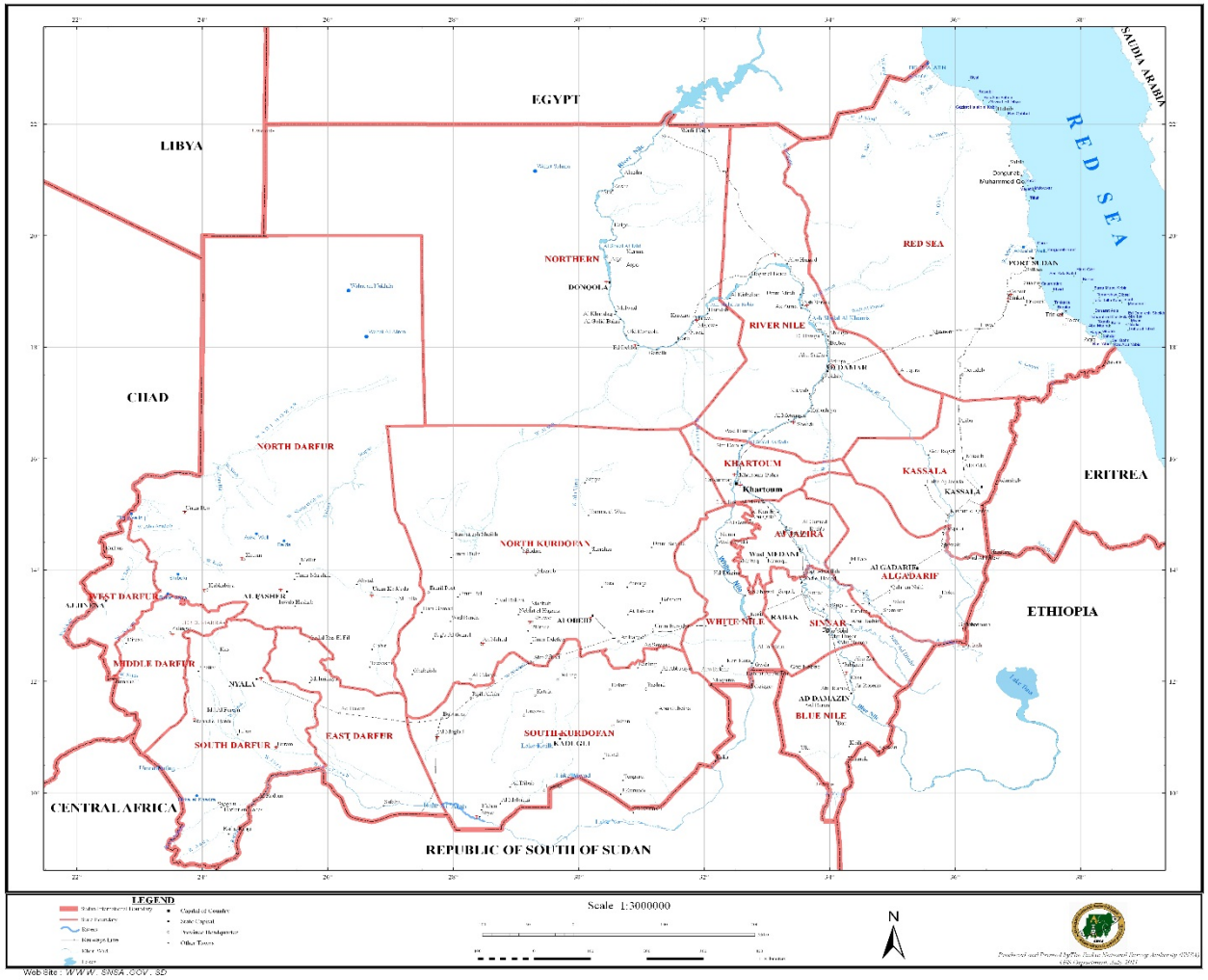
GEOINFORMATION TECHNOLOGY APPLICATIONS AND PRACTICE IN SUDAN

Contents

- About Sudan.
- Geoinformation , Remote sensing and GIS for natural resources management, and environmental monitoring.
- Geoinformation in hazard and disaster mapping.
- Marin Information System of Sudan (MISS).
- Geoinformation in Border demarcation.

ABOUT SUDAN

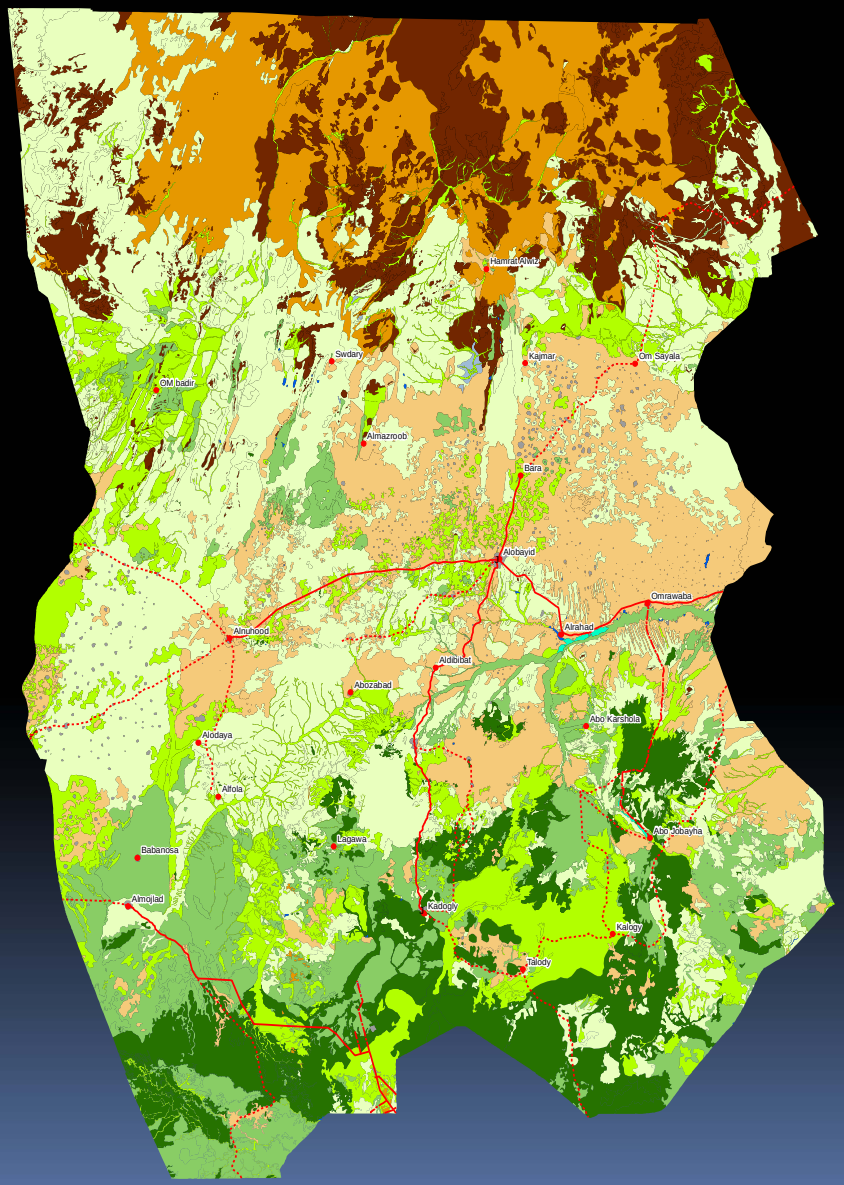
Sudan

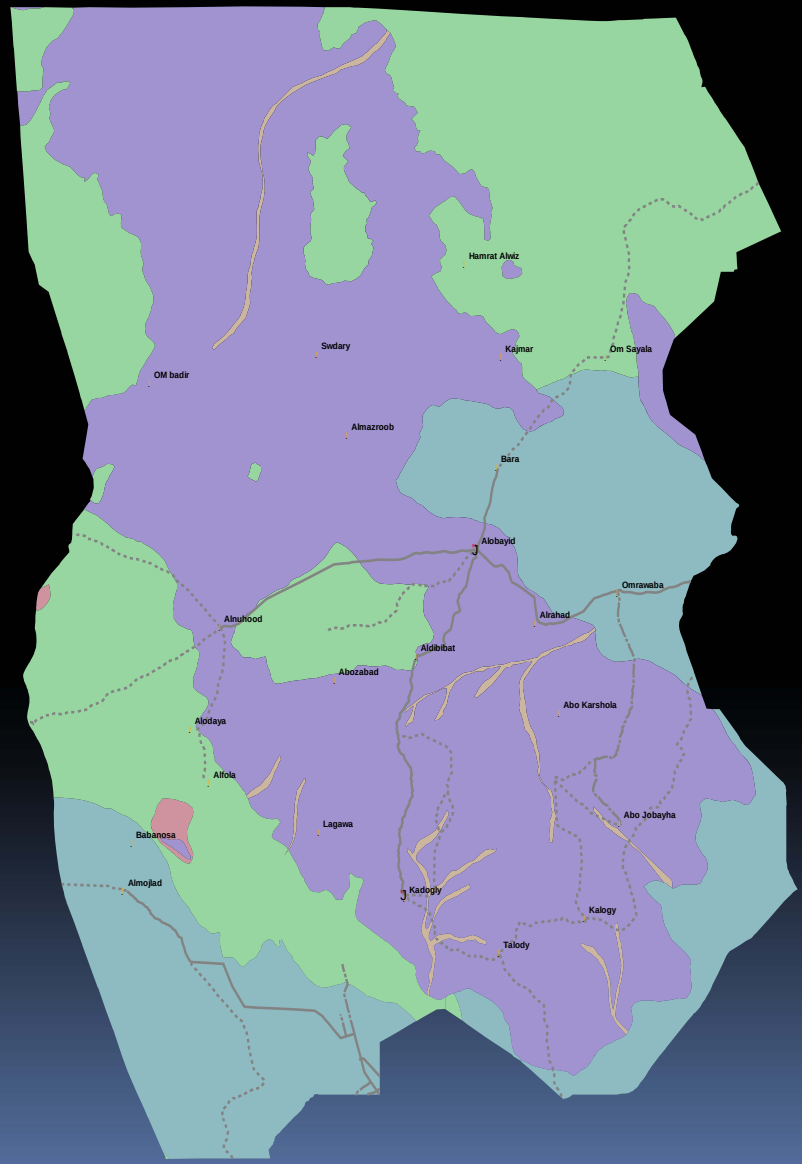

EGYPT
LIBYA
CHAD
CENTRAL AFRICA
REPUBLIC OF SOUTH OF SUDAN
ERITREA
ETHIOPIA
SAUDIA ARABIA
RED SEA
NORTHERN
DONQOLA
RIVER NILE
RED SEA
PORT SUDAN
KHARTOUM
Khartoum
KASSALA
KASSALA
AL JAZIRA
NORTH KURDOFAN
NORTH DARFUR
WEST DARFUR
AL FASHER
MIDDLE DARFUR
NYALA
SOUTH DARFUR
EAST DARFER
SOUTH KURDOFAN
KADUGLI
WHITE NILE
SINNAR
BLUE NILE
AD DAMAZIN
ALGADARIF
LEGEND
Scale 1:3000000
N
Web Site : WWW.SNSA.GOV.SD

- lies in the north east part of Africa.
- Area 1.9 million square kilometres.
- Population 28 million.
- One of the oldest civilization an the surface of the Earth (7000 years).
- Main physical features : Sahara desert, River Nile, Red Sea.

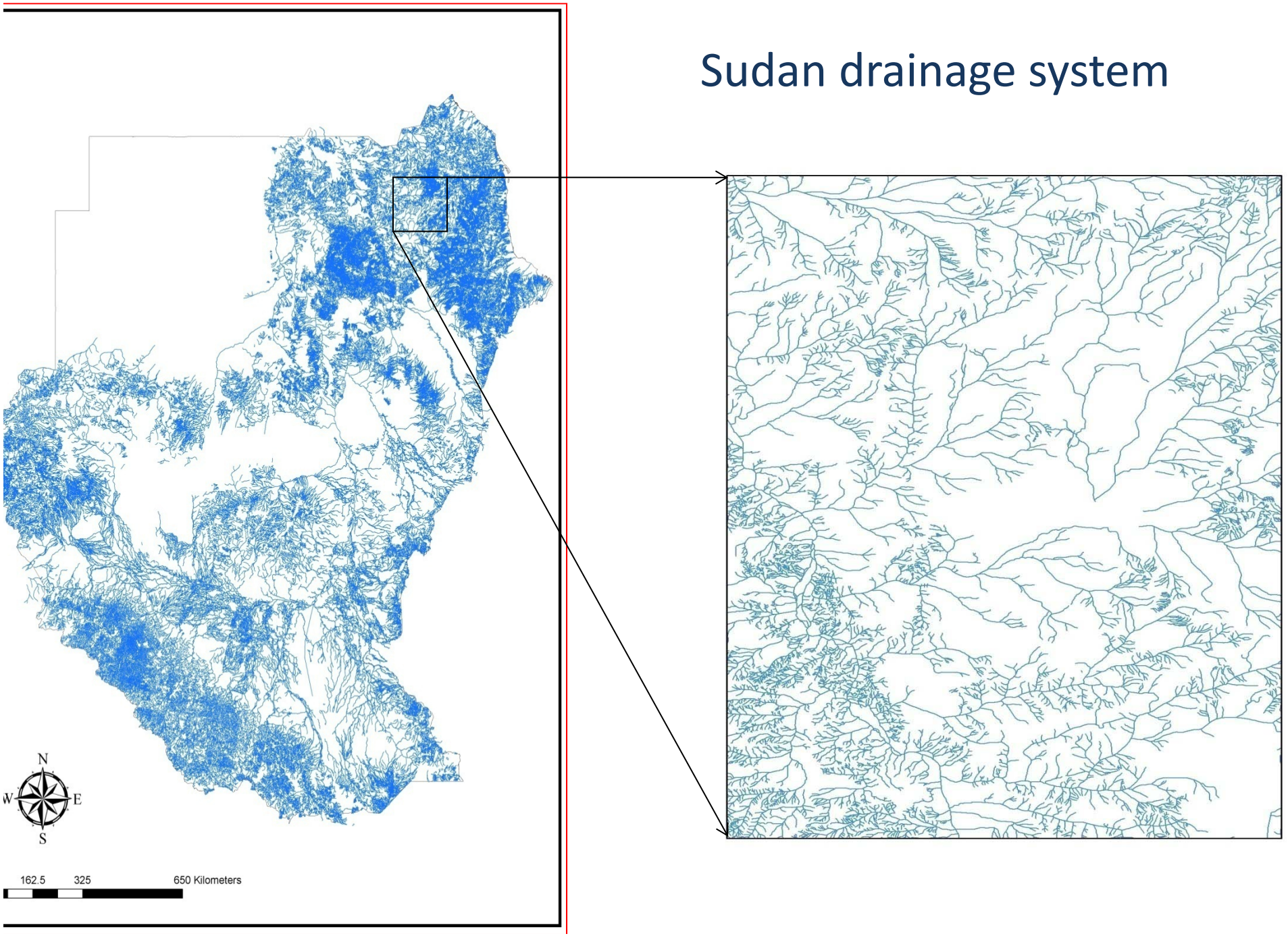
GEOINFORMATION , REMOTE SENSING AND GIS FOR NATURAL RESOURCES MANAGEMENT,AND ENVIRONMENTAL MONITORING.

Assessment and Mapping of Natural Resources

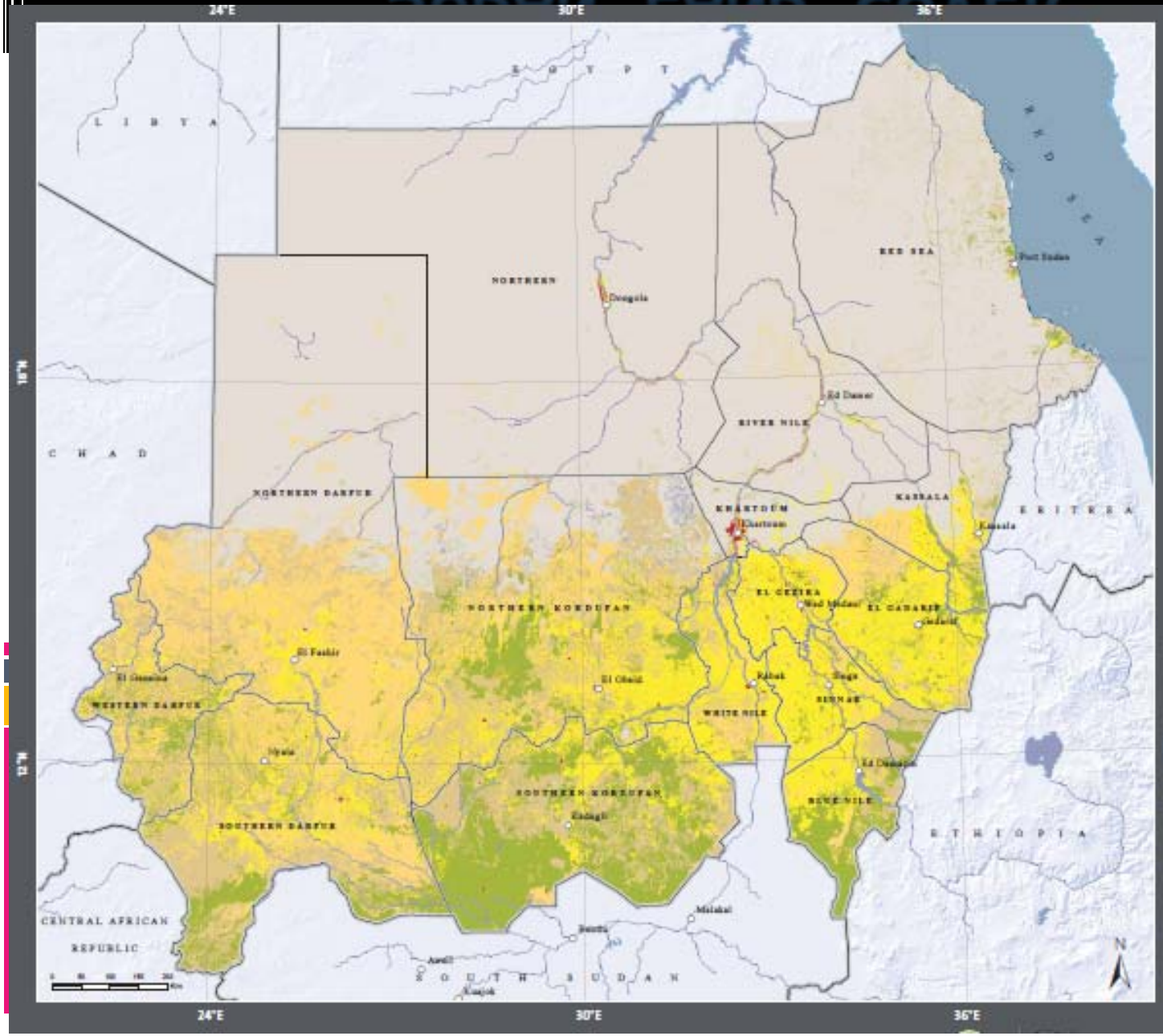




Sudan drainage system



SUDAN LAND COVER



Agriculture in terrestrial and aquatic/regularly flooded land

Trees closed-to-sparse in terrestrial and aquatic/ regularly flooded land

Shrubs closed-to-sparse in terrestrial and aquatic/ regularly flooded land

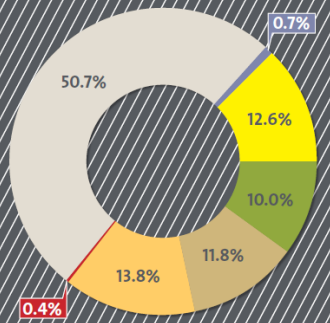
Herbaceous closed-to-sparse in terrestrial and aquatic/ regularly flooded land

Urban areas

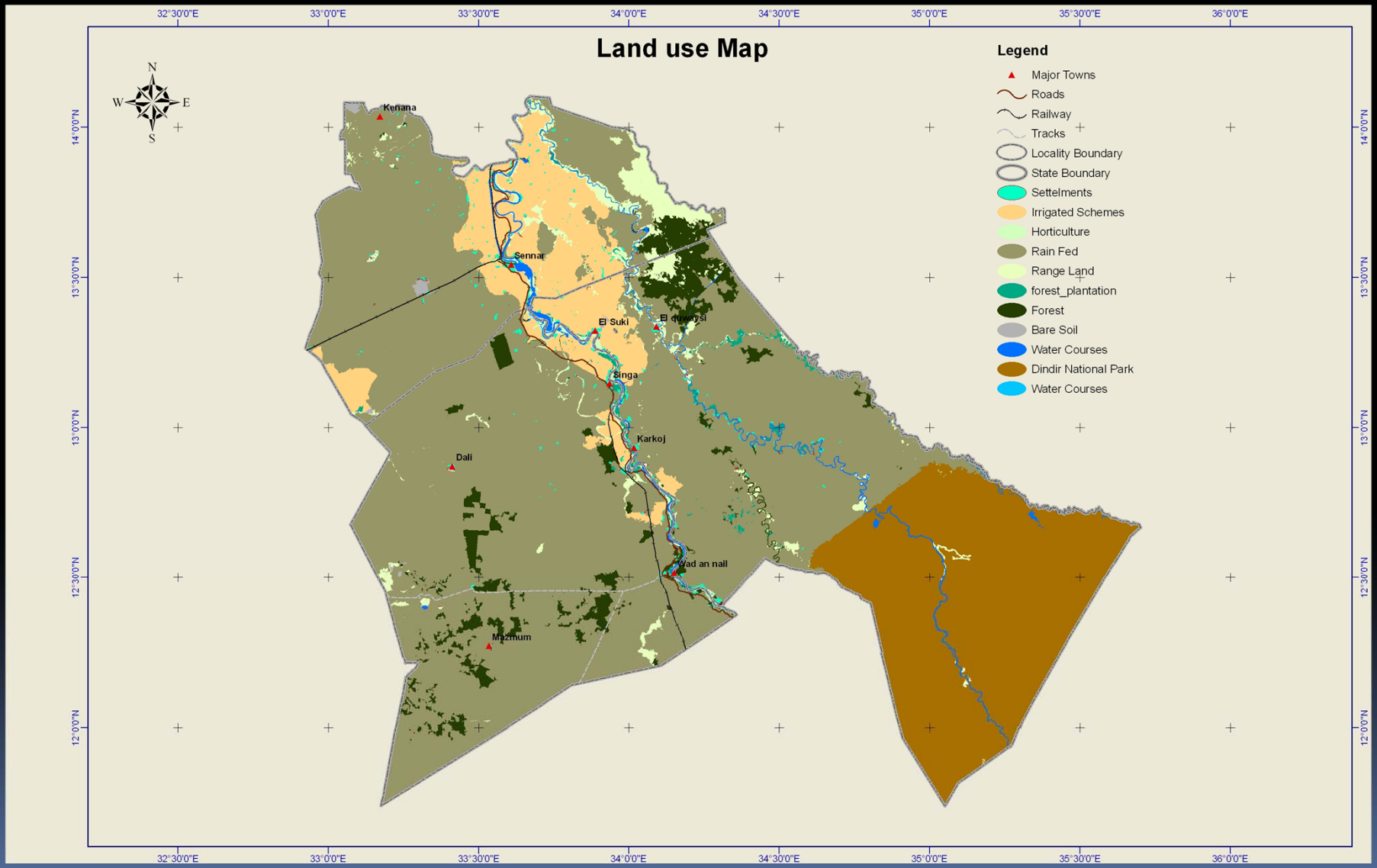
Bare Rocks and Soil and/ or Other Unconsolidated Material(s)

Seasonal/perennial, natural/artificial **waterbodies**

LAND COVER PERCENTAGE

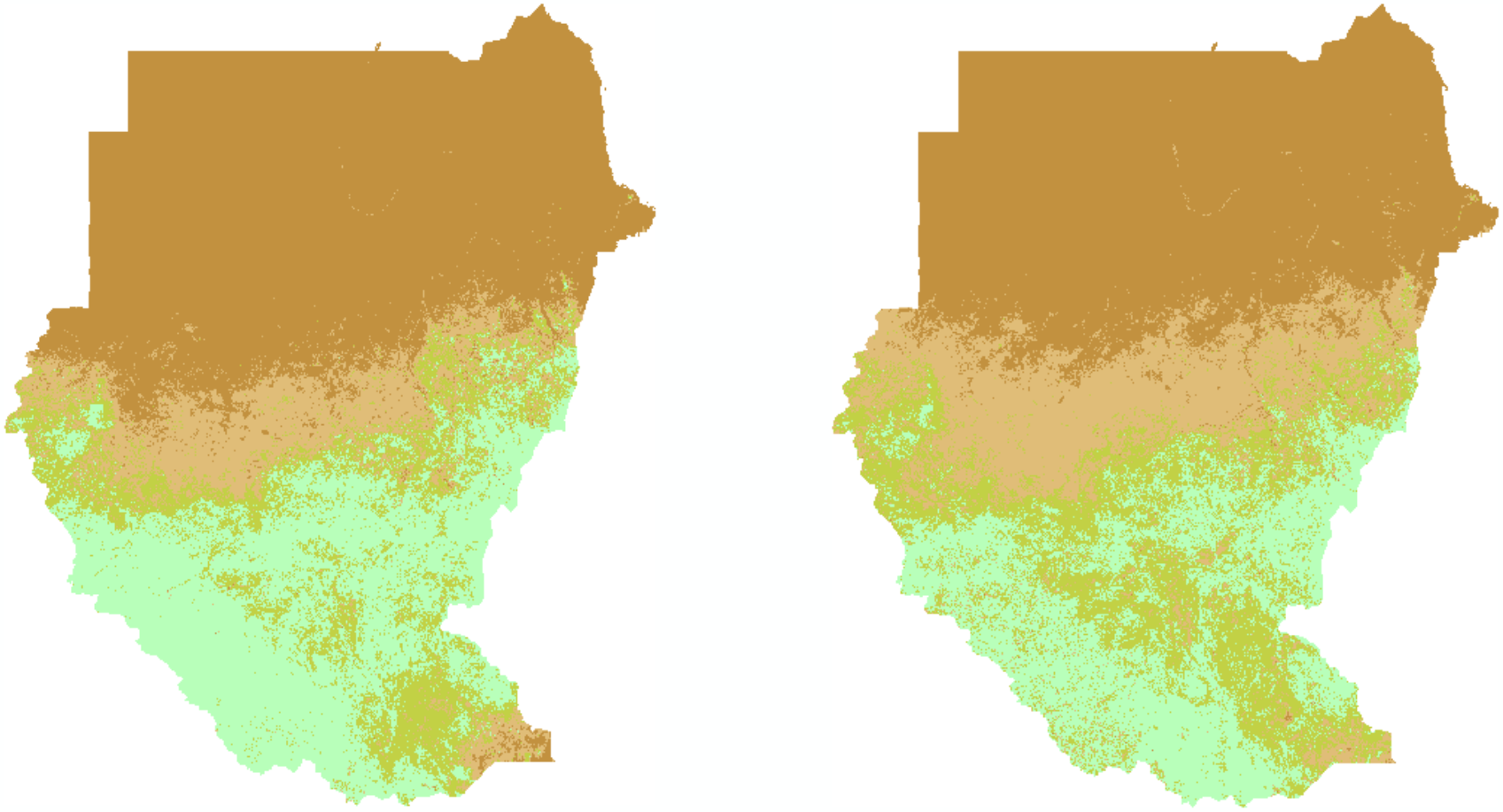


Land use Mapping



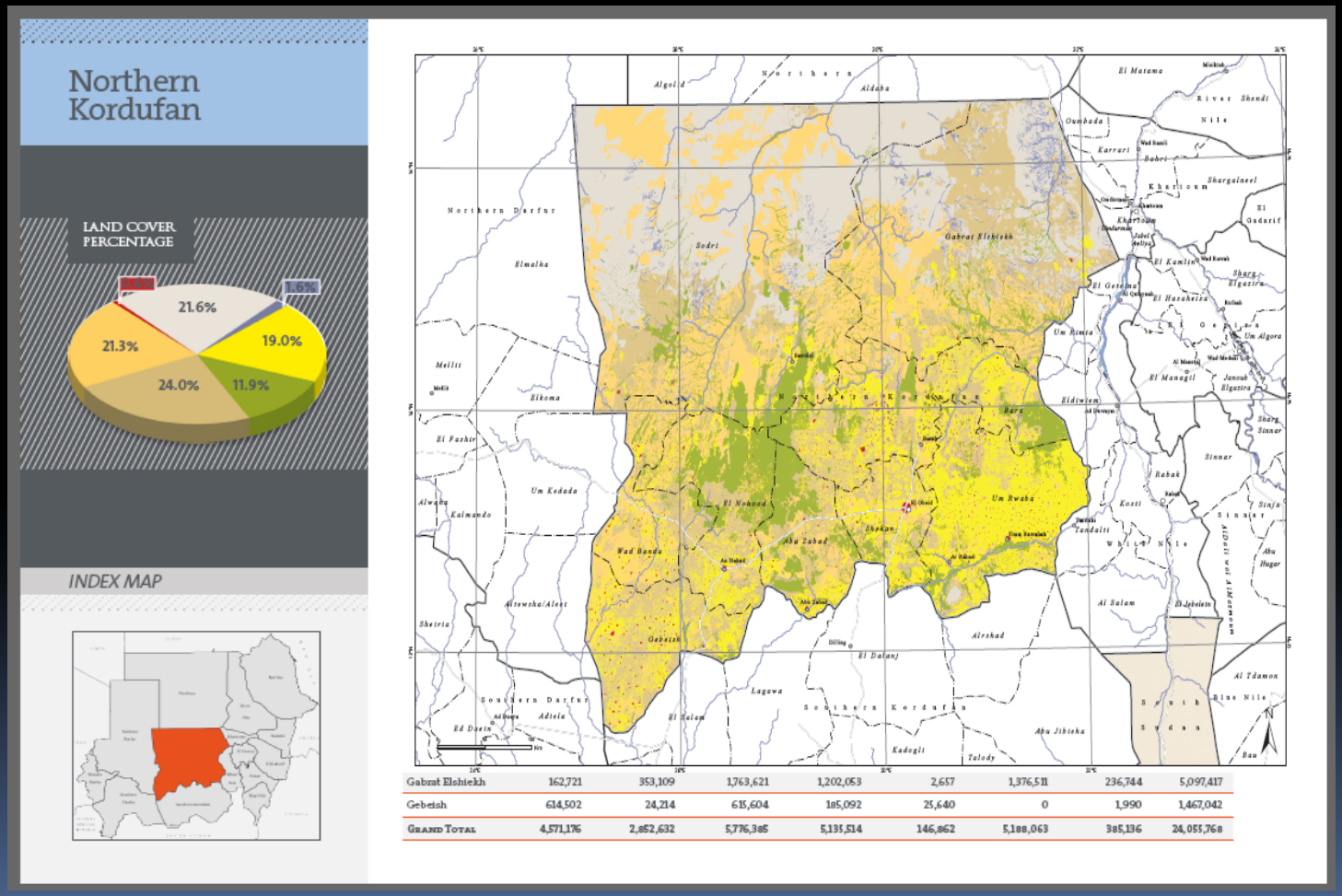
Vegetation cover monitoring

2003-2007



Kordofan State where traditional agriculture is practised in small areas in form of isolated or cultured fields (field size equals to 5 hectares). Demarcation of crop area, location and distribution of the small fields, was achieved through the land cover mapping,

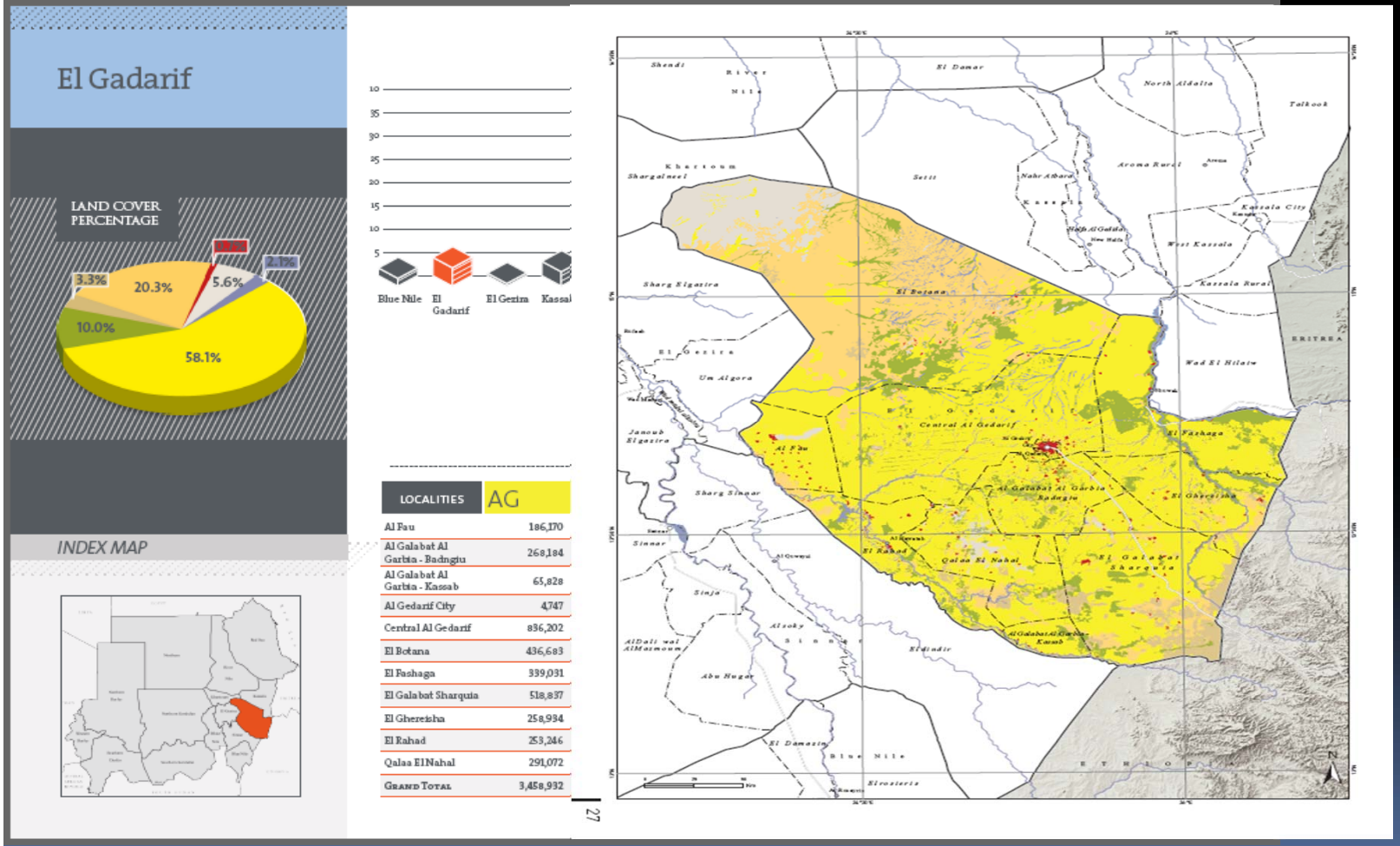
Agricultural land is 4.500000 Ha (12.5%)And rangeland is 45.3% of the State area



Gabrat Elshiekh	162,721	353,109	1,763,621	1,202,053	2,657	1,376,511	236,744	5,097,417
Gebeish	614,502	24,214	615,604	185,092	25,640	0	1,990	1,467,042
Grand Total	4,571,176	2,852,632	5,776,385	5,135,514	146,862	5,188,063	385,136	24,055,768

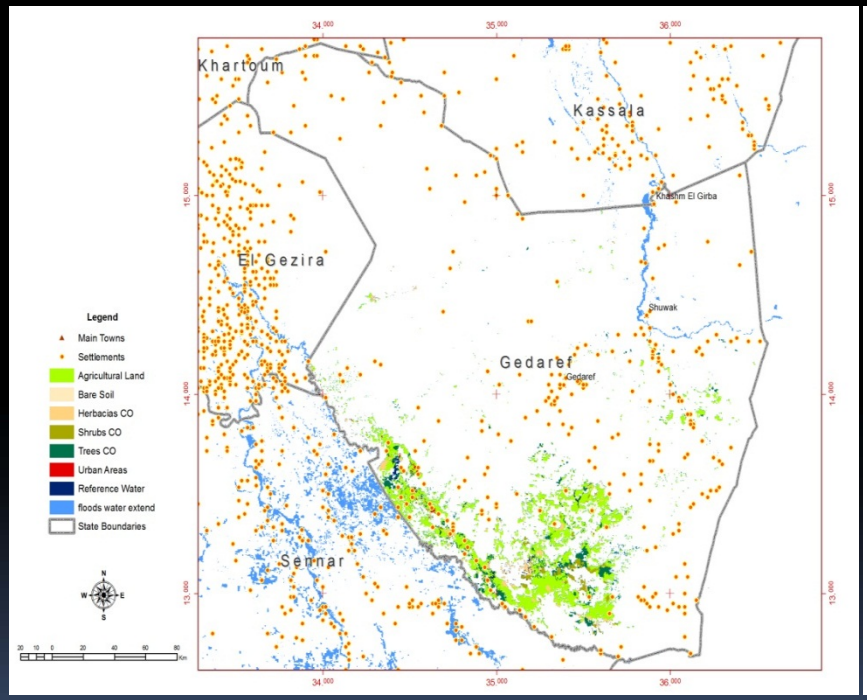
North Kordufan Land Cover

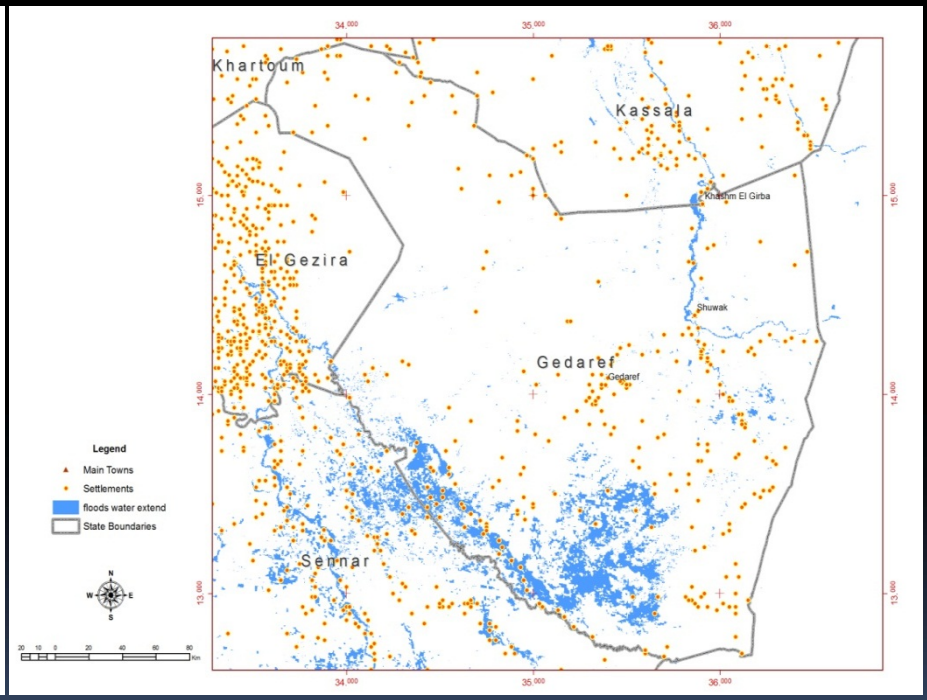
Gadarif State is one of the key states in crop production under the mechanized rain fed system. Through land cover mapping, a reasonable level of crop area measurement and stratification for statistical crop production estimation was easily achieved. **The total area under agriculture is 3,450,932 hectares**



El Gadarif Land Cover

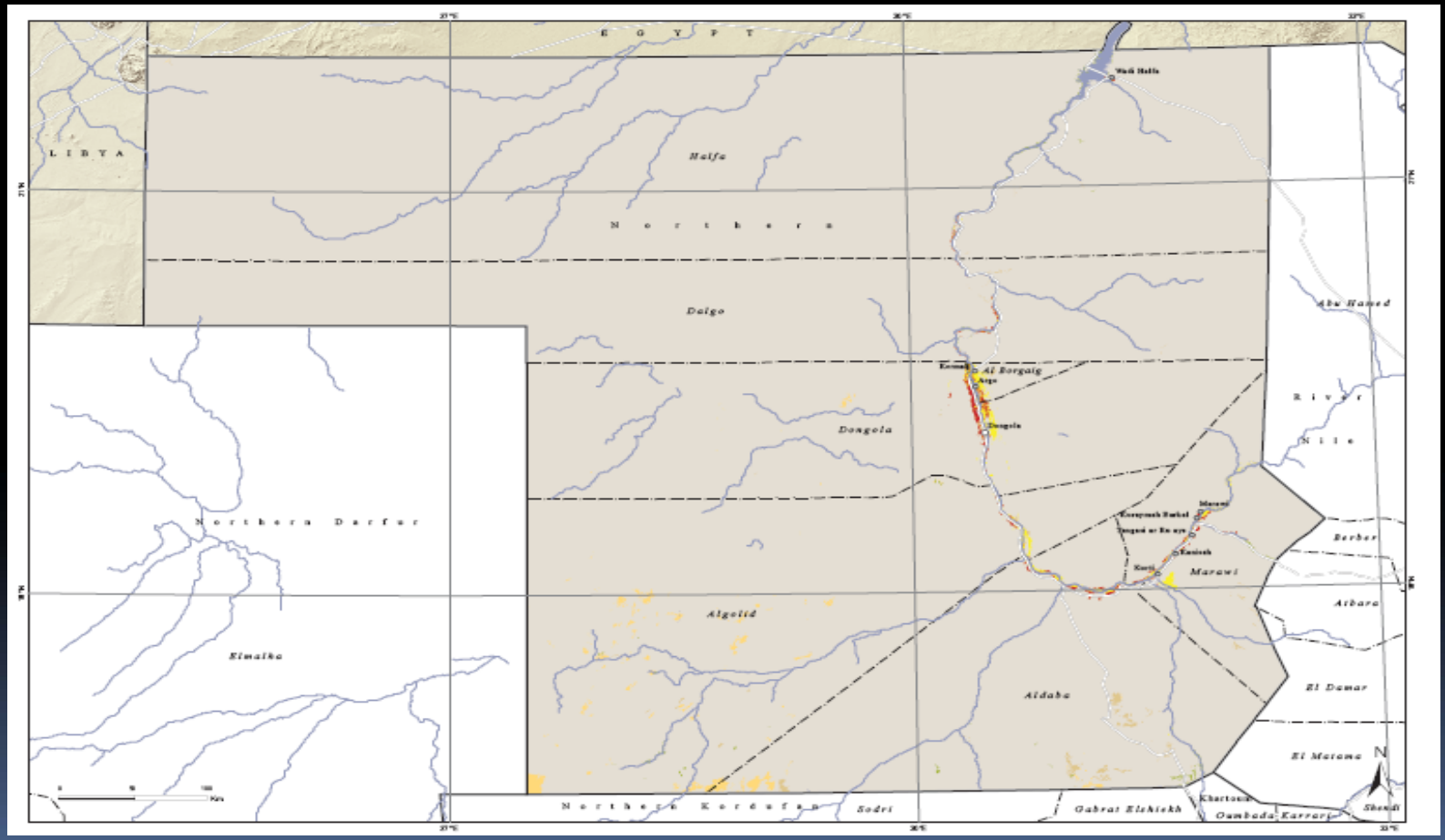
MODIS data When overlaying the layer of rainfall extent on the land cover map of the same area , the affected crops (which were classified as a loss) were identified and their adverse effect on the harvest could be estimated.
Sound measures and actions can be easily taken based on such information.





El Gadarif Rainfall and Land Cover

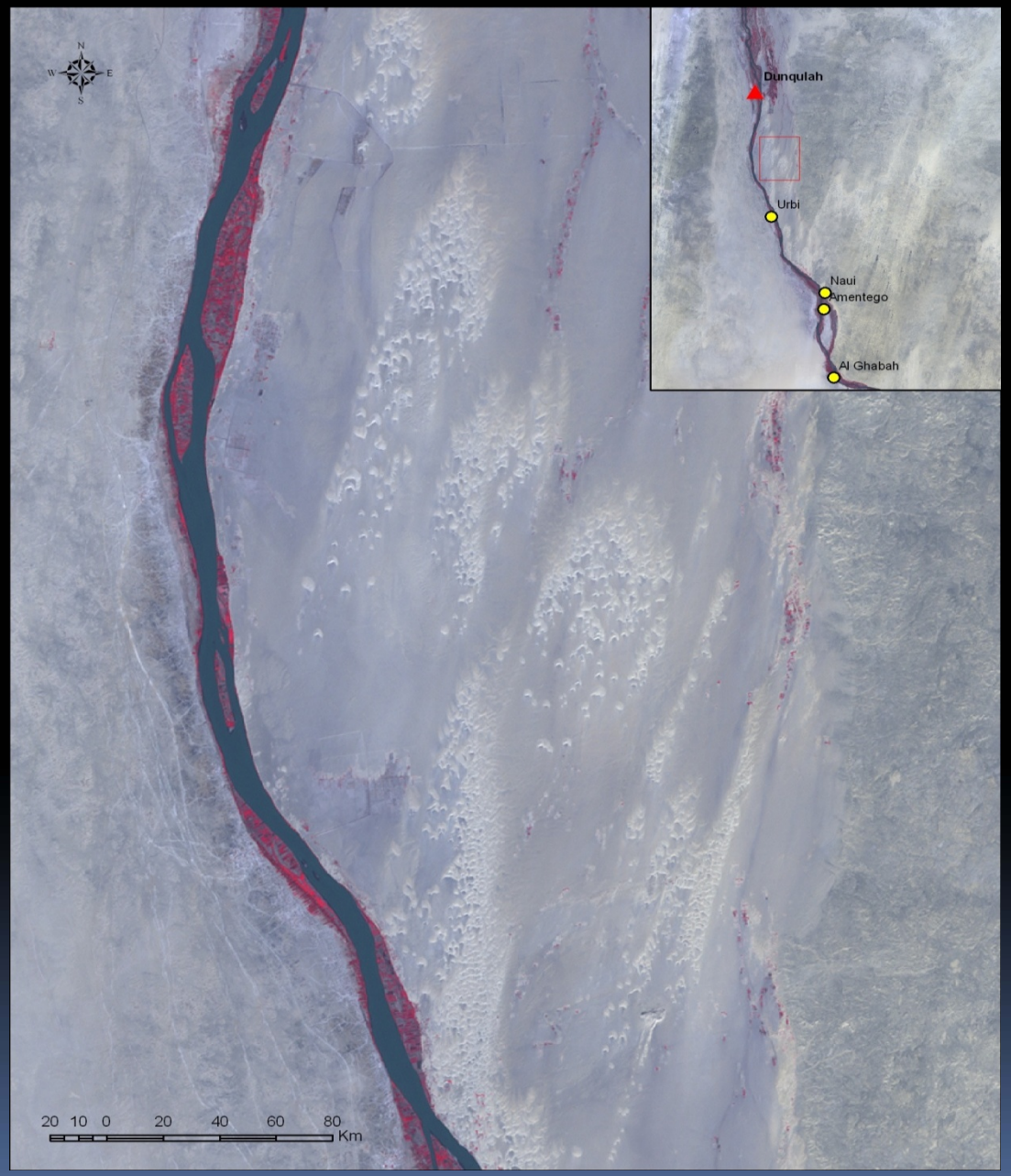
For the irrigated sector; The Northern State, according to its geographic location in the northern part of Sudan, is threatened by desertification, mainly sand encroachment whereby sand covers some of the potential land and agricultural schemes. 92% of the area of the state is under the LC class "Bare rocks and soils and other unconsolidated materials“



Northern State land cover

A study, carried out in 2009, indicated that the range of the rate of sand dune advance was 6-23 m/year in Dongola area, Northern State.

The LC change analysis mainly in wadi Elseliem revealed that a large area (estimated at 86% of the total project's area), which was once under cultivation due to sand encroach- ment, is now abandoned, hence food shortage is likely to appear.

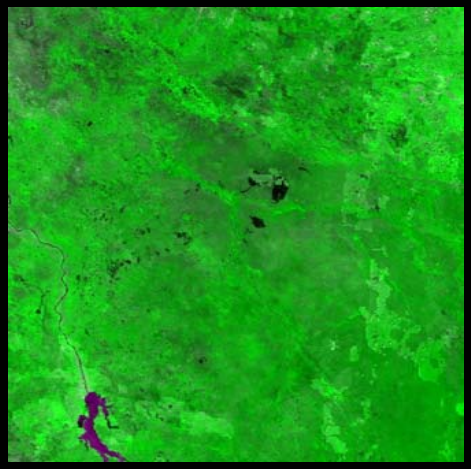


Sand dunes advance in Northern State

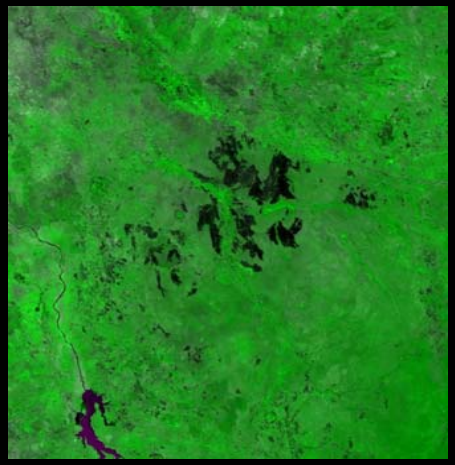
GEOINFORMATION IN HAZARD AND DISASTER MAPPING

Monitoring and mapping land fire

15/10/2008

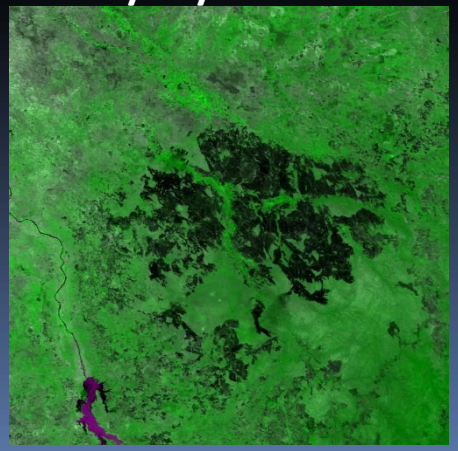


23/10/2008

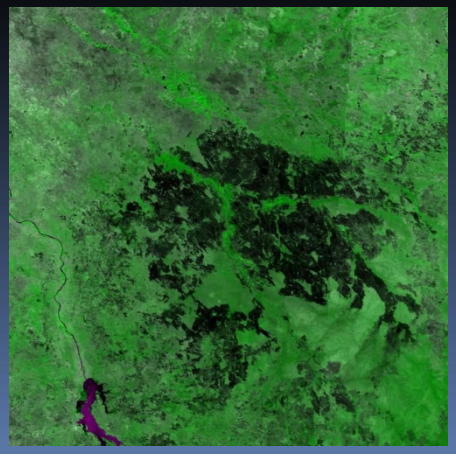


31/10/2008

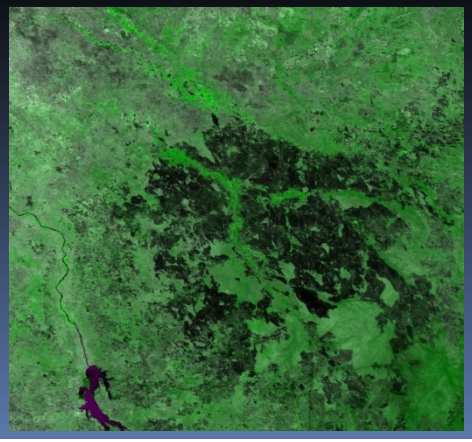
08/11/2008



16/11/2008

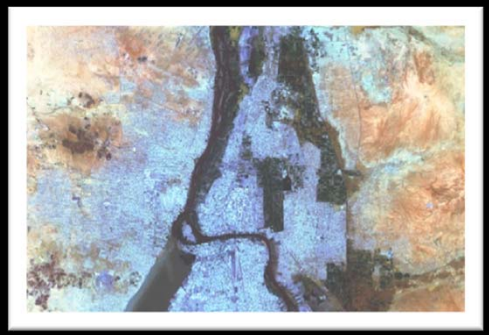


24/11/2008

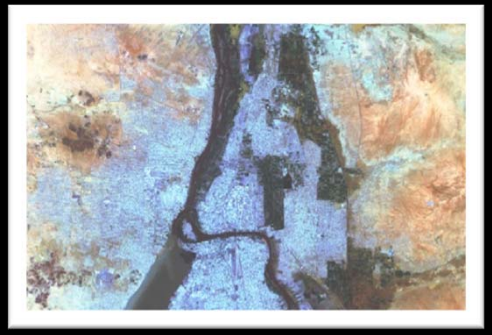


Different satellites provide recent and up-to-date information on flood status

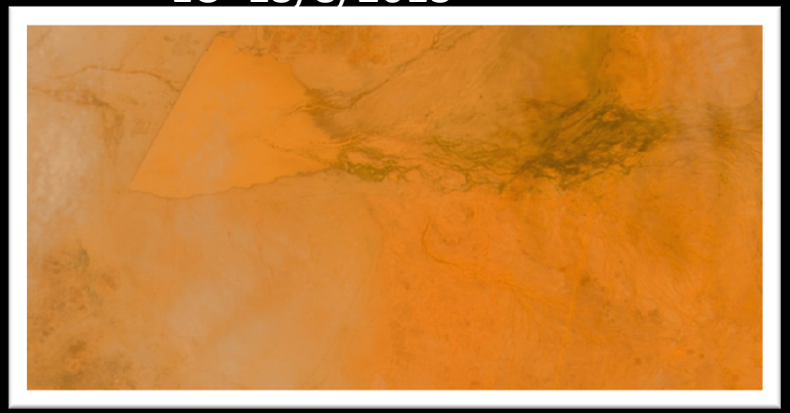
Formosat 8/8/2013



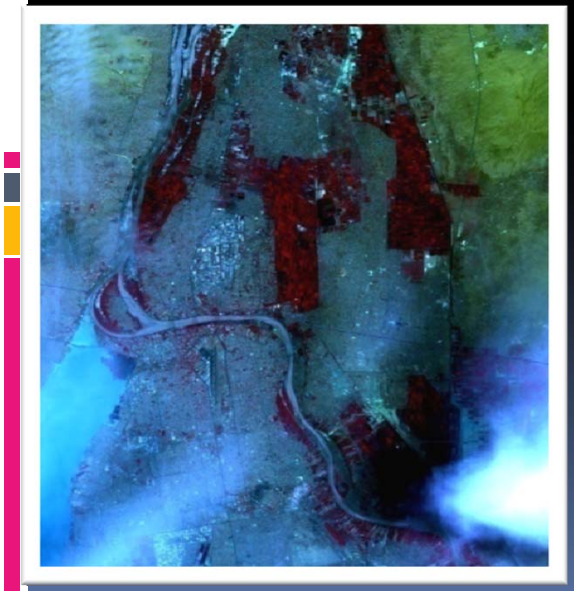
Formosat 9/8/2013



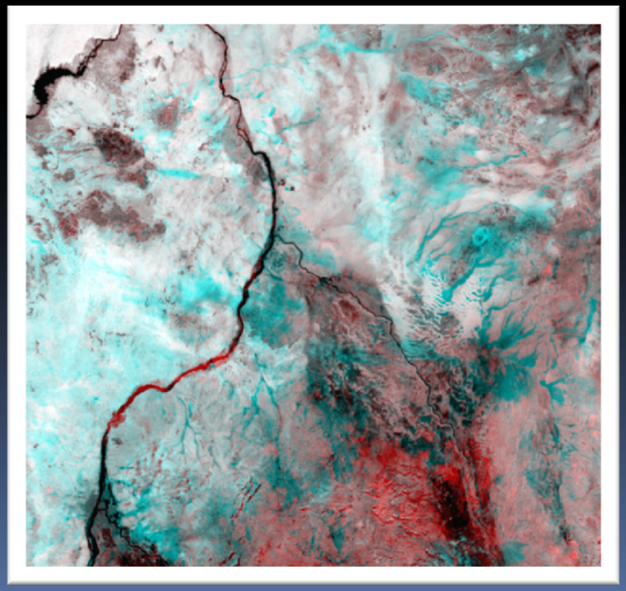
EO 13/8/2013



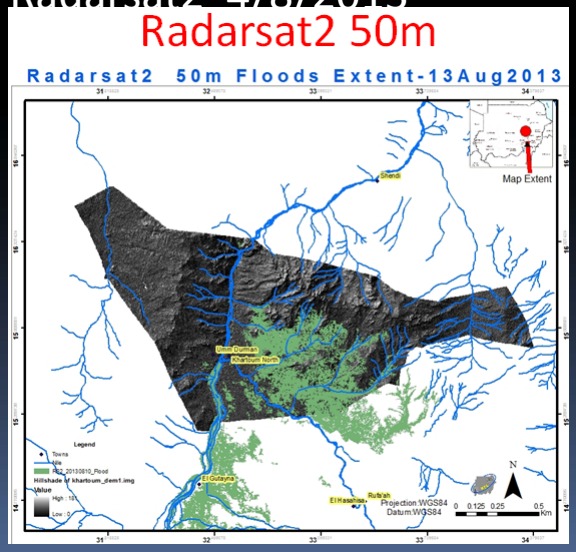
ASTER 13/8/2013



MODIS 4/8/2013

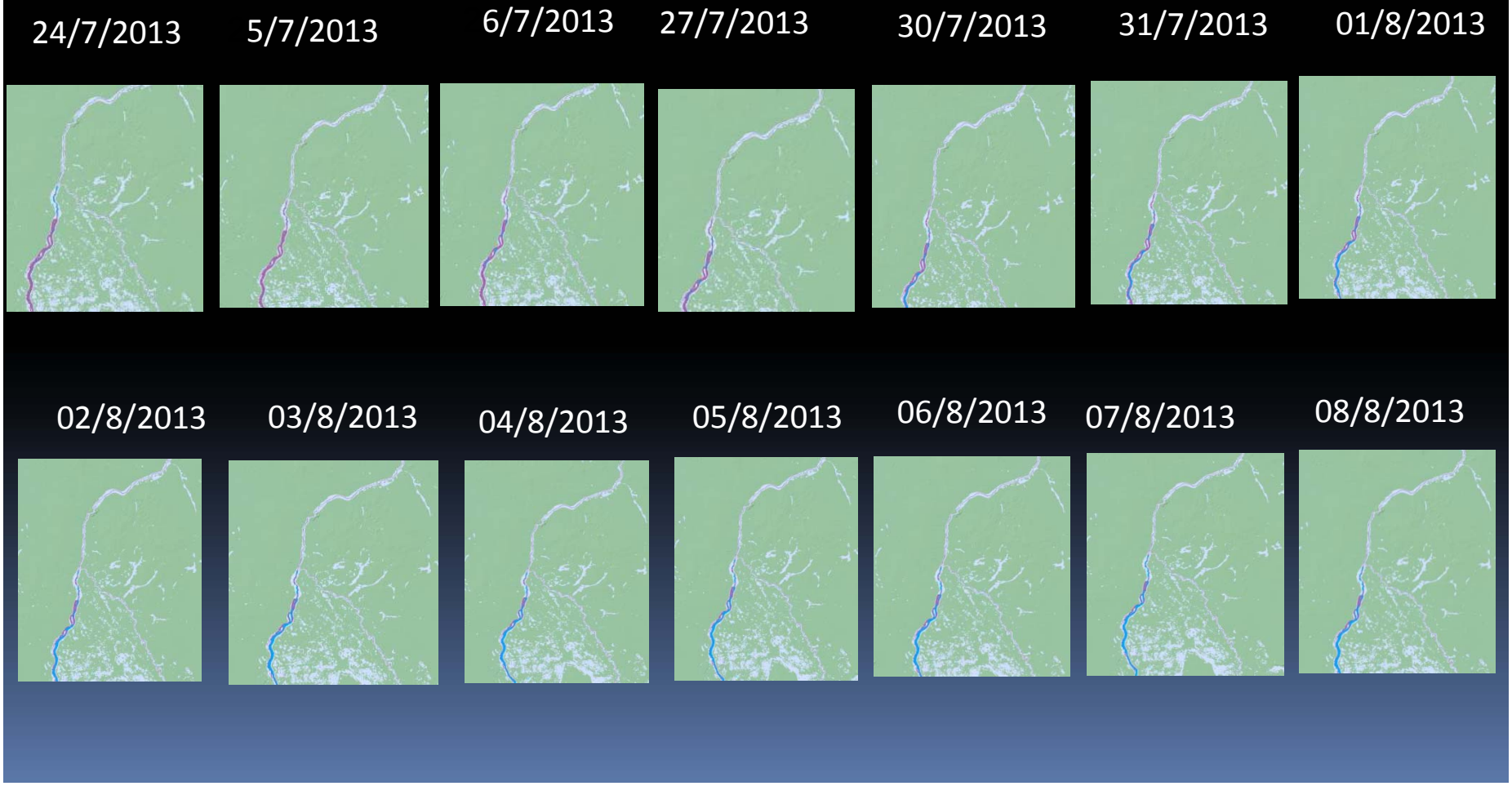


Radarsat2 4/8/2013



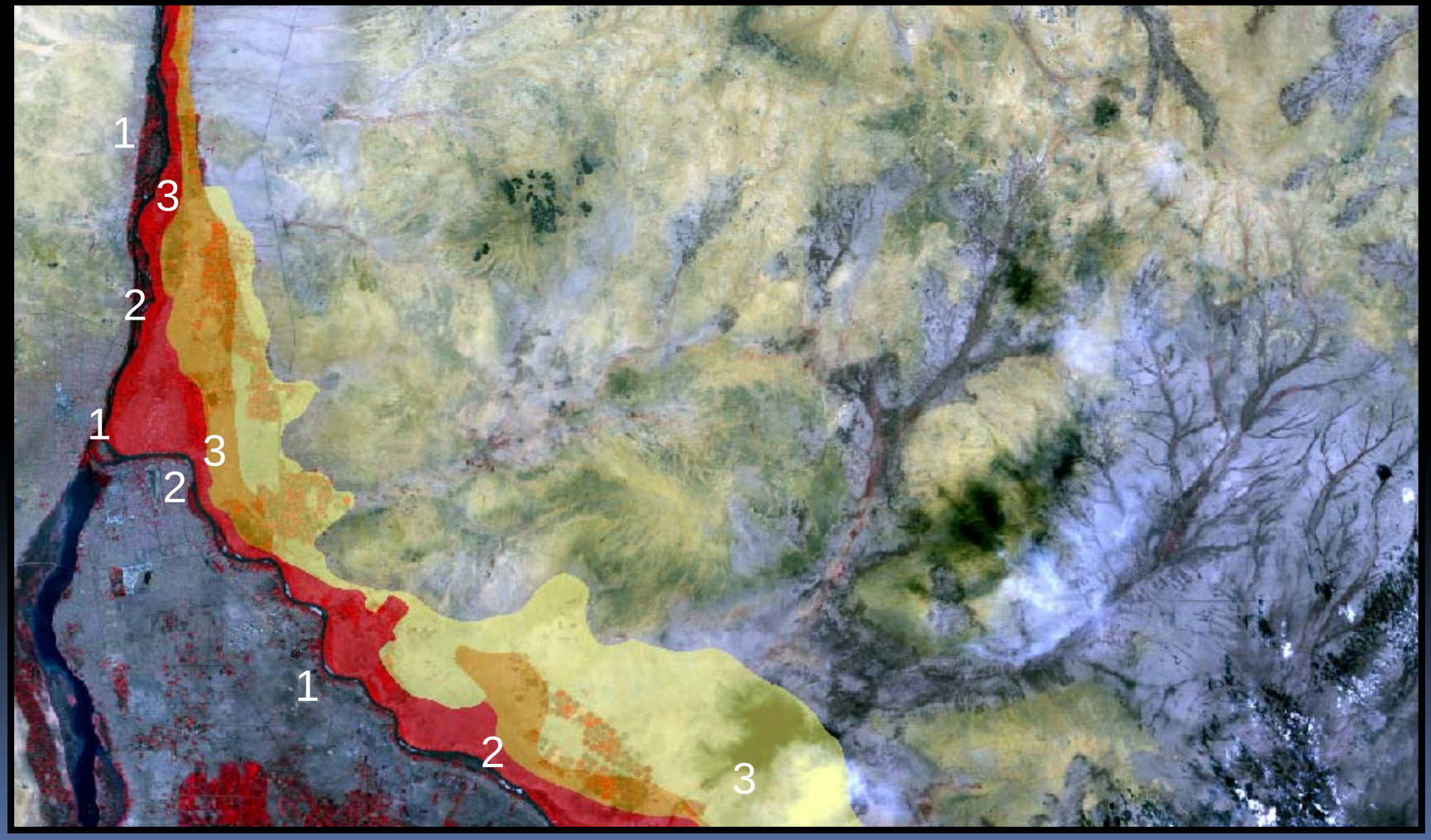
Green color is the
Data produced from Radarsat2

Temporal coverage to provide data daily by MODIS

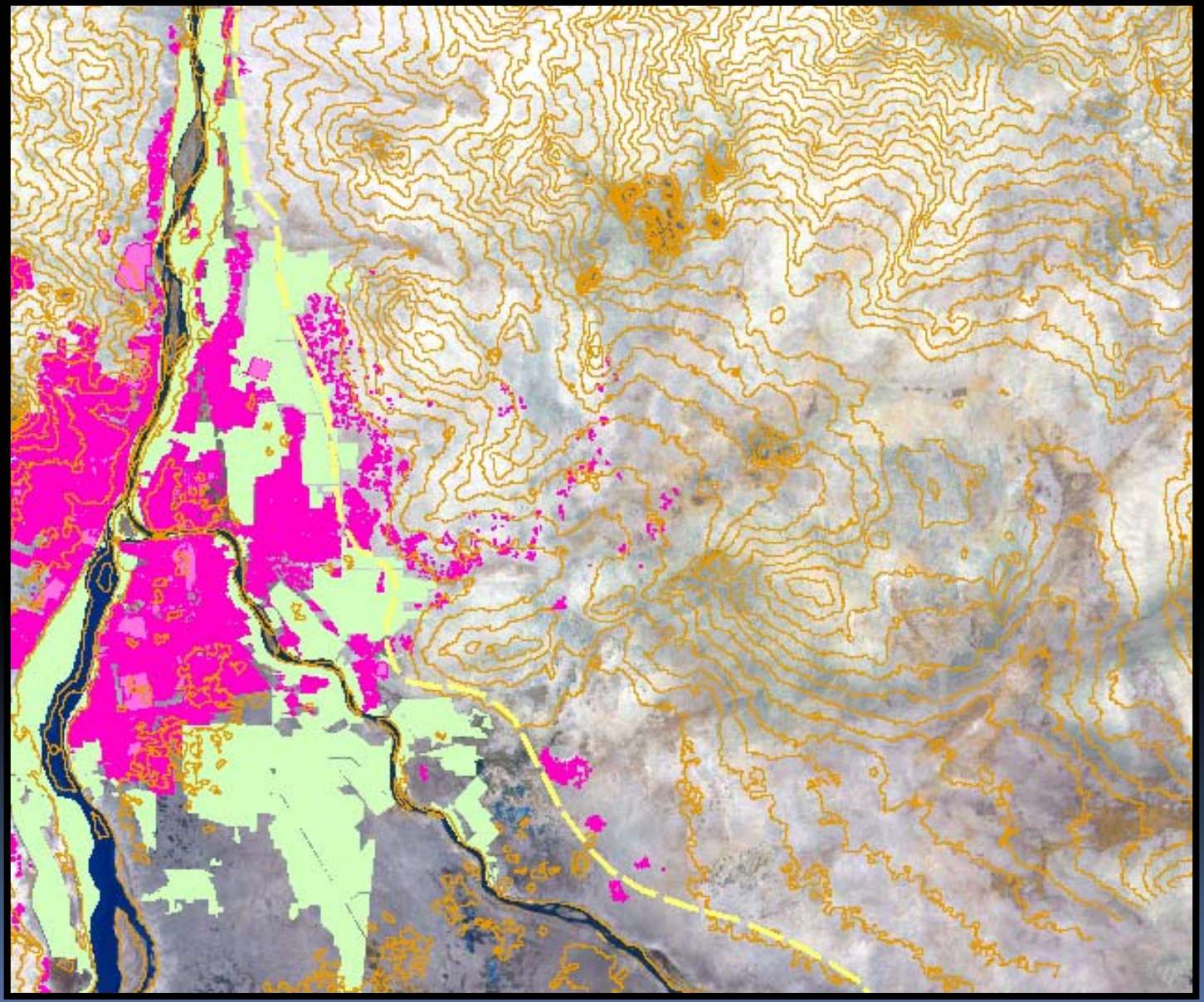


Flood zone levels and the related risk

1st level, high risk, mainly from the river Nile.
2nd level, high risk, mainly from the Valleys,
3rd level, rarely it is affected by the Valleys



Approximately 80% of the residential and agricultural parcels of the eastern bank of the Nile locality are located within the flood zone



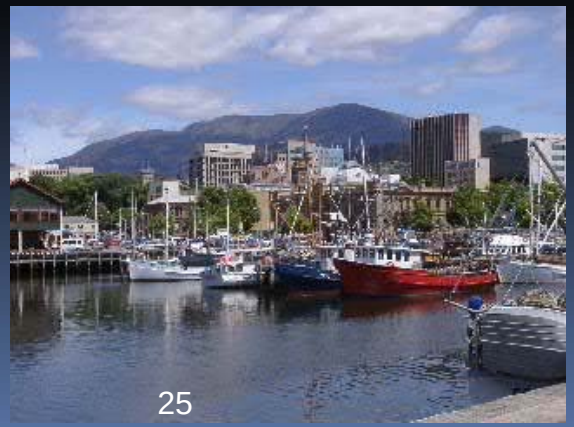
MARINE INFORMATION SYSTEM OF SUDAN (MISS).

Stop

hydrographic Survey in figures

- 75% of the earth is covered with water
- Only 10% is charted
- 80% of the world population live on coast of sea and rivers
- 96% of International trade go through the sea by ships

(والفلك التى تجرى فى البحر بما ينفع الناس) سورة البقرة ، آية 164



Objective

- Provide Hydrographic data to consumers , all Hydrographic Communities and all departments in Sudan (Government and Private) with access to spatial Marine data where, when, and how they need
- Creation of Marine Data base for seas and in land water (Rivers and lakes)

Current Situation

- Absence of marine data resulted in bad management of water resources
- Sudan is not a member of IHO and IMO
- No co-ordination body responsible of Producing marine Chart or marine data base
- Poor and inaccurate navigation charts
- No marine data for in land water (water quality and quantity)
- Duplication, conflicts of responsibilities ,no future foreseeing

Current activities

- *Many* hydrographic Private companies, dredging, offshore engineering, coastal engineering (Reclamation and construction)
- Every company works on its own datun,refencence
- No coordination body
- No regulations or law to govern marine activities

Consequences:

1. Mismanagement, lack of co-ordinationation
2. Responsibilities overlap, conflict
3. Money and time consumption
4. Absent of future foreseeing

Why do we need hydrographic services in Sudan?

- Sudan is one of the richest countries in water resources (Seas and Rivers)
- Sudan has a long coast line (about 700km) rich in minerals and marine live
- Unique marine environment (Biodiversity)of the Red Sea
- Red sea is most strategic water in the word
- Red sea is the busiest and important navigation area in the world

Hydrographic data users

- Service and involve the following institutions or ministries according to their responsibilities.
- Ministry of Defense (Sudan Navy Force)
- Ministry of Interior (coast guard)
- Ministry of transport/ communication (navigational charts, Notice to mariners, Aids to navigation)
- Ministry of foreign affairs (international Boundary)
- Ministry of Agriculture (Fishing Department)
- Ministry of irrigation (In-land water)
- Ministry of Environment (Sea/ river/ mariner pollution monitoring and control/ coastal zone development)
- Ministry of Industry and mining (Marine resource exploitation)
- Ministry of Tourism (Good charting of beautiful marine Spots)
- Ministry of Education and Universities (Marine research/ hydrographic training)

In Rivers and lakes

- River basin Authorities.
- Government agencies.
- Industry and other responsible for water supply
- Power generation
- Agricuture
- Waterway Transport
- Waste Disposal
- Public Health and water quality

River data base

- Pollution control
- Flood early warning
- Irregation schedule and operations
- river navigation
- water allocation and drought management
- Integrated river basin management
- reseach and numerical models for variouus applications(new dams construction)

River watch

- RIVERWATCH is an integrated, real-time, monitoring and information system providing forecasting, warning and decision support which can improve the resource/emergency management capabilities of river basin authorities, government agencies, industry and others responsible for water supply, power generation, agriculture, waterway transport, waste disposal, public health and water quality.

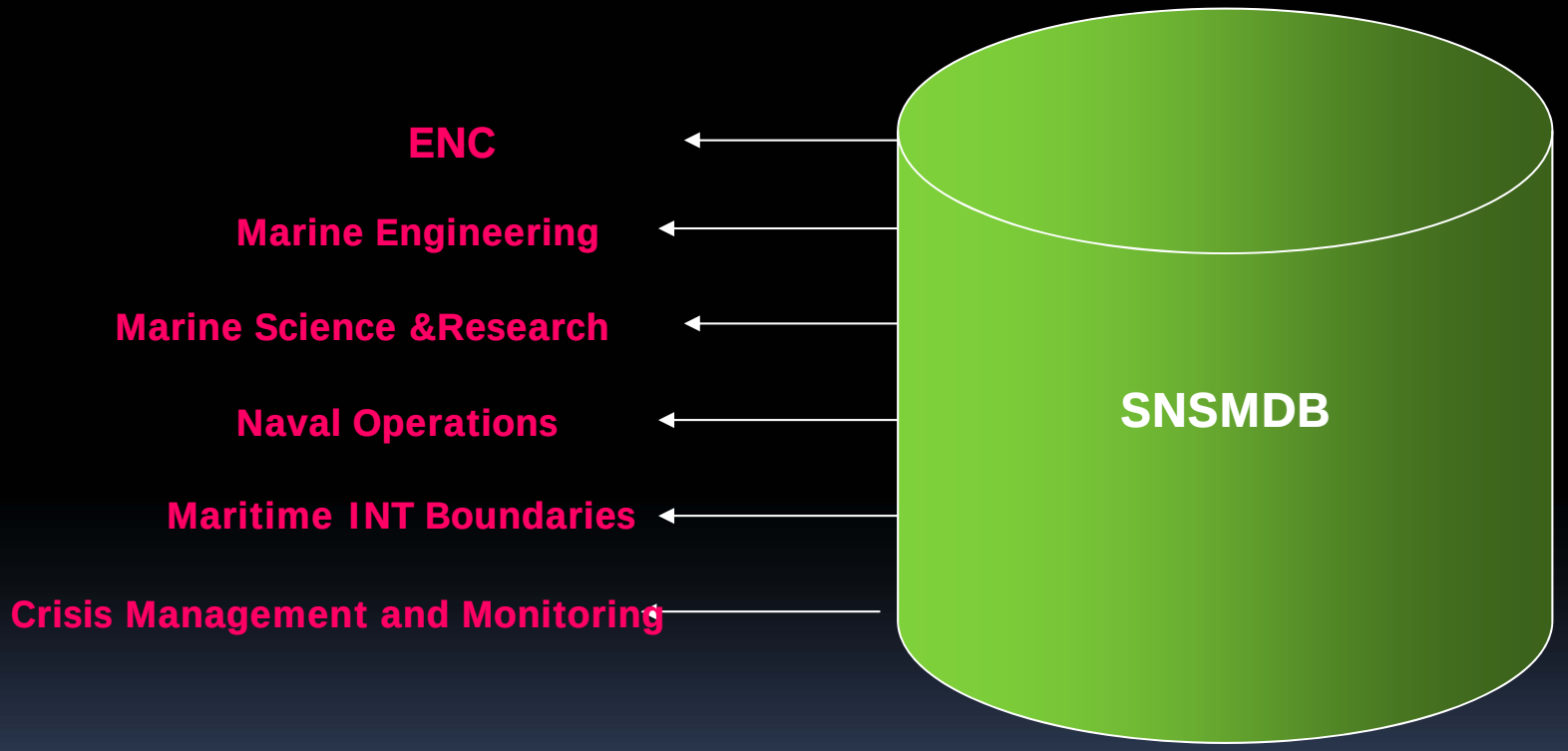
Hydrographic services – National Marine Data base

- save time, money and effort by
- reducing redundant data collection
- Avoid duplication
- To make Survey Department, the dominant body (National Co-ordinates System)
- Provide manageable , accessible Data to all decision makers anytime
- to ensure greater accuracy when sharing spatial data.

How?

- Make data shareable
- Make data multi- purposes
- Make use of the redundant data
- Convert large volumes of spatial data to the National coordinate system
- Consistency of accuracy

Database outputs (MIS)



- Naval operations and Production

Production of Combat and amphibious Chart and special productions

- International Maritime Boundaries

To meet (UNCLOS 82)

- Environmental and Academic Research

MIS application and Outputs

- Electronic Navigation Chart (ENC)

1. Safety of Navigation
2. Safety of Marine Environment (Fauna and Flora)
3. Conformal to IMO regulation (SOLAS) requirements

GEOINFORMATION IN BORDER DEMARCATION

PART (1)

1.1 Introduction:

- A boundary is a single planimetric dimension that needs precise orientation to the landscape to promote stability of alignment. Yet nothing offered by nature or man that represents a sharp line void of at least some probability of change.
- Cartography itself, especially at large scales, not infrequently reflects our in-adequacies in locating points and lines definitively.

1.2 Some Legal Issues of Boundaries:

- Other problems which beset the determination of boundaries are the legal complications which can arise. First, of course, for accord on any given boundary, the two factions affected must approve the procedure used to determine the boundary as well as the final results.
- For example, for boundary designated to "follow the crest of a mountain range."
- Does the boundary follow the highest elevations or the watershed divide.

- The terms "boundary," "border" and "frontier" are in fact not synonyms although infrequently, used interchangeably.
- A frontier, is the international boundary into our out of a country.
- A border is the area embedding the boundary line on both sides.
- An international boundary is that line which marks the limits of the geographic area within which the legitimacy of the operations of the state must be determined.
- **A) Boundary Marker**: Device placed on the ground as a means of indicating the limit of sovereignty, also called "Monument, Pillar" and "Boundary Stone".

- **B) Median Line**: A line bisecting an area (in the case of boundaries, the area is usually a river or lake) drawn in such a way that every point along it is equidistant from the nearest point on either side of the area.

Markers

Thalweg: Deepest part of the main channel of a stream.

- **Coordinated Points:** Points on the surface of the Earth precisely located by Survey techniques.

- **Astronomical Points:** Points determined by an astronomical reading
- **Boundary Junction:** A point on the ground where States meet.
- B**oundary Turning Point:** A point on the boundary denoting the junction of

.

- **Boundary Point:** one on which formal markers or pillars have been erected.
- **Delimitation:** choice of a boundary site and its definition in a treaty or other formal document.
- **Delineation:** Occasionally the term serves as a synonym for demarcation

PART (2)

- **About Sudan:** the second largest country in Africa.
- as far as land area is concerned (1,900,000 square kilometers).
- (8˚ N to 23 ˚ 30´ N and from 22˚ E to 38´ E).
- population is approximately 32 Million.
- Sudan traverses five types of climate.
- equatorial.
- rich savanna.
- poor savanna
- desert
- meditrean

- neighbours seven countries, the only African country possessing this characteristic.

Neighbouring Country	Boundary line Length Approx.(km)
Ethiopia	725
Eritrea	605
Central African Republic	428
Chad	1,300
Libya	380
Egypt	1,280
South Sudan	2,100
Total	7,445

- This is in addition to its 800 km long sea border across the Red Sea with the Kingdom of Saudi Arabia thus totaling 7520 kms i:e approximately one and a third the radius of the Earth , a unique situation in Africa.

2.2 <u>Boundaries Between African Countries</u>:

- no clear boundaries between African countries before the colonial era exist.
- Recommendations of OAU (Addis Ababa, 1963) and the Cairo Convention (1964) agreed upon the adoption of boundaries inherited from the colonial era.

2.3 Current Status of Boundary Delimitation / Demarcation Between Sudan and Its Neighbours:

2-3-1 Sudan – Ethiopia Border Line (725 kms):

- In July 1972, an agreement was signed between the two countries, based on earlier protocols (1902, 1903, 1907, 1909).
- Two committees were formed.
- "special" (the issues of agriculture across the boundary line); and
- The "technical" (demarcation and re-demarcation of the boundary).
- Several meetings were held in Addis Ababa and Khartoum to resolve these problems.

- **2-3-2 Sudan – Eritrea Border Line (605 kms**
  - Used to be part of the Sudan – Ethiopia line.
  - In general, there are no problems between the two countries in this respect .
- **2-3-3 Sudan – Chad Border Line (1300 km):**
  - Borders are governed by the January, 10th 1924 protocol. In 1961,
  - the border line had been fully delimited and partially demarcated.
  - delay of full demarcation pertains to some weak description points in the 1924 protocol.
  - The two countries agreed to resume the process of demarcation, which started in 1994 and in fact made ready all preparations. However, due to the political and security conditions in the region, the work had not been started.

2-3-4 Sudan – Central African Republic Border Line (428 kms):

- The position of the border line is governed by January the 10th, 1924 protocol between the British Sudan and the French Equatorial Africa.
- This protocol contained full description of the border line compiled by a committee from both countries.
- This committee did not establish any border marks along the line.
- Instead, heaps of stones were positioned at regular intervals.
- Again, the 1924 protocol contains some weak points especially as regards the description of the village of "Um Dafouk" area extent.

2-3-5 Sudan – Libya Border Line (380 km):

- The border line between Sudan and Libya is very clearly defined being depending on junctions of latitudes and longitudes.
- The present border line was delimited in accordance with the 1934 agreement between Britain, Egypt and Italy.
- Therefore, the border line between Sudan and Libya is fully delimited and partially demarcated since 1934, except that part of the line crossing Auwainat Mountain.

2-3-6 Sudan – Egypt Border Line (1280 kms):

- The definition of the border line between Sudan and Egypt was made according to the 19/1/1899 concordat between Britain and Egypt.
- The latter defined Sudan as the land lying south of the 22^{o} N parallel without defining the eastern or western ends of this line.
- No pillars or border marks were ever erected on this line except the two points at Adindan and Faras on the west end of the line.

PART (3)

- **Demarcation of the Interior Boundaries Between the Sudanese States:**
  - In 1994, the Sudanese government declared the "Federal Government Law" in which Sudan was divided into 26 states (16 in the North and 10 in the South before separation of the latter).
  - each state would have its own parliament and government.
  - neighbouring states delimit and demarcate their borders with other states.
  - necessity of huge investments.
  - SSA thus formed administrative and technical committees to perform the delimitation and demarcation of state boundaries using:
    - small scale maps;
    - medium scale maps where appropriate;
    - aerial photos where available;
    - satellite imagery;
    - GPS and other ground survey methods;
    - state border juridistic records; and
    - Google Earth images as collateral information.

- Sudan will definitely benefit a great deal from this undertaking and will be one of the first African countries to do so.
- The following pictures demonstrate some activities of SSA in demarcation of boundaries.

reconnaissance

Two party officials to attend

Finding local markers

The two parties

Pre-marking

On trees

Pre-marking

Community ……

Community leaders to participate

Preparation FOR A meeting

Leaders from each party

Tribal CHIEFS Talk to their people

Mission preparation

SUDAN SURVEY AUTHORITY CONVOY MOVES TO BOUNDARY AREA

Affordable logistics

Well- equipped

Finding locations AND BOUNDARY POINTS

Through MAPS AND/OR GPS

forests: OFTEN A CHALLENGE

swamps: BEWILDERING DETERENTS

Rivers: SOMETIMES VERY USEFUL IN BOUNDARY- Making OPERATIONs

Wetland: A NEGATIVE CONTRIBUTER IN BOUNDARY DEMARCATION OPERATIONS

WETLANDS: TIME-LOSS FACTOR

Dry land: USUALLY A FRIENDLY FACTOR

People’s properties

LOCAL PEOPLE SOMETIMES CONSULTED

Then establishing markers

CAST IN-SITU BOUNDARY MARKERS

PROTECTION AND Security OF THE SURVEY TEAM is important

CASTING PILLARS

CASTING BOUNDARY PILLARS

CASTING BOUNDARY PILLARS IN-SITU

IN-SITU CASTING OF BOUNDARY PILLARS

Re-observing BOUNDARY pointS

Again with community attendance

USE OF High accuracy GPS IS NECESSARY IN MOST CASES

Final agreement

For sustainable DEVELOPMANT

Boundary-making should not be a cause of conflict but a cause of integration

Boundary guard

is a usual scene

Sudan Boundary survey group

together with an Ethiopian one

END SHOW

THANK YOU