Sudan 2013 floods, From satellite images perspective, Case study: Eastern Nile Locality, Khartoum State

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Introduction

- Sudan area is 1.949 million square kilometers.
- Sudan population is about 32 millions.
- Annual rainfall amount exceeds 800 mm in the South and below 100 mm in the extreme north.

The major environmental problems that cause disasters in Sudan are floods, droughts and desertification.

Floods:

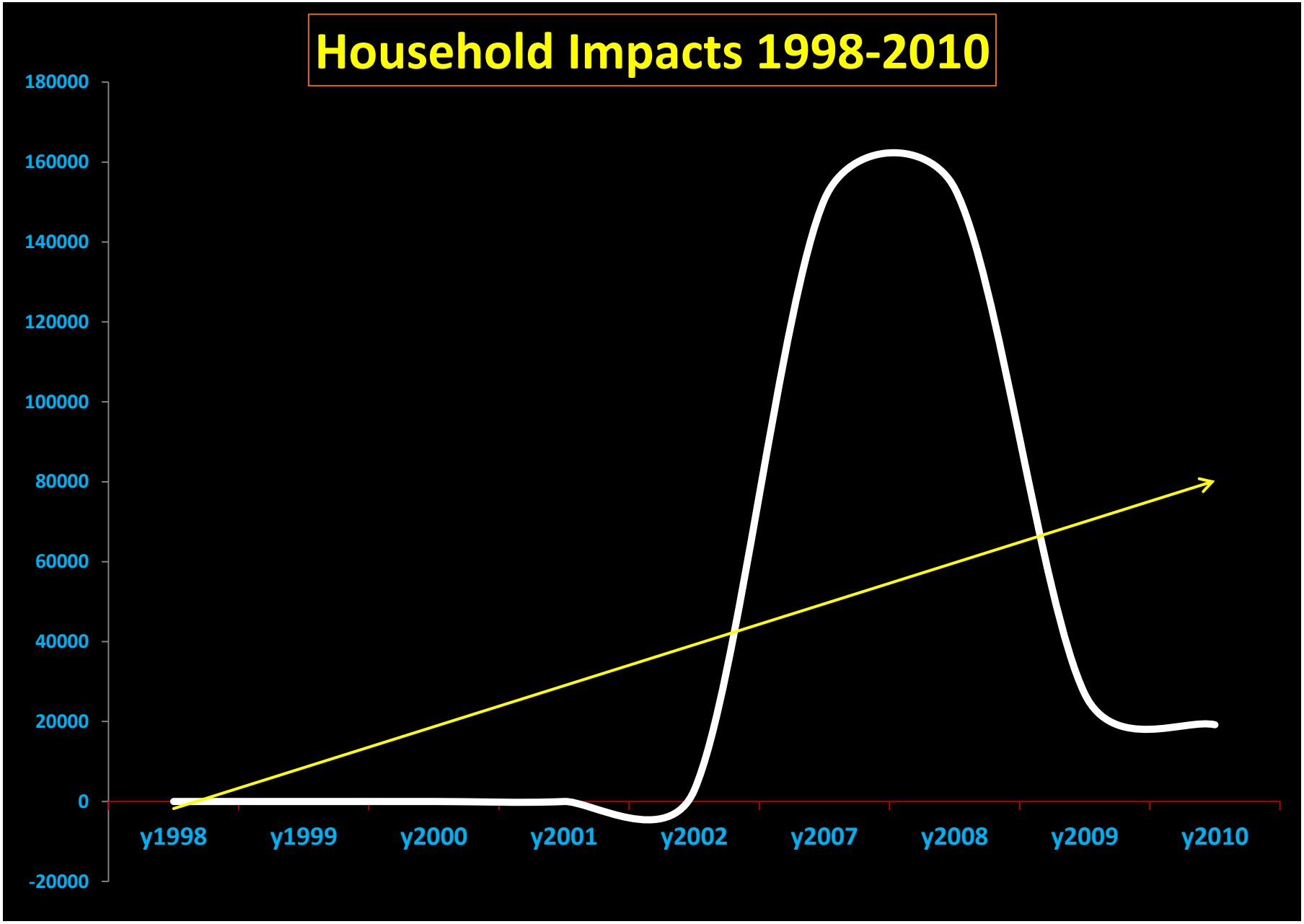
Both river flood and flash floods, their impacts include loss of lives and properties. They cause damage to natural resources, especially to soils and vegetation along the Nile bank and its tributaries, deterioration of health situation with increasing incidences of malaria and water-borne diseases as well as disruption of social services.

Sudan Location Map

Flood Impacts Records 1998-2010

	HH.	T.Damage	P.DAMAGE	Fatalities	Injuries	Ruminants	Poultry
y1998	59 433	20 000	23 884	55	28	10896	132671
y1999	292 429	73 291	43 753	125	76	8547	5220
y2000	7 850	873	6 985	53	13	8750	12545
y2001	21 217	9 390	8 978	4	0	250	0
y2002	2817	2950	5950	37	9	4527	0
y2007	150655	76597	80272	157	302	20064	4241
y2008	153472	5876	14817	20	73	5665	3000
y2009	26922	16048	10874	42	31	5709	0
y2010	19198	7912	11286	80	51	5135	2500
Total	353064	110256	123199	573	583	69543	160177

Household Impacts 1998-2010



Khartoum 2013 flash floods
Eastern Nile Locality

Some photos showing part of the damage

Some photos showing part of the damage, cont'd

Some photos showing part of the damage, cont'd

Data and information used

Through UN- SPIDER and UNDP Khartoum – Sudan efforts and charter activation, different sets of information from satellite data interpretation were available to all actors of disaster management in Sudan within relatively short period (August first to August 13).

Satellite data and GIS information was used during the first stage of disaster (emergency response) effectively.

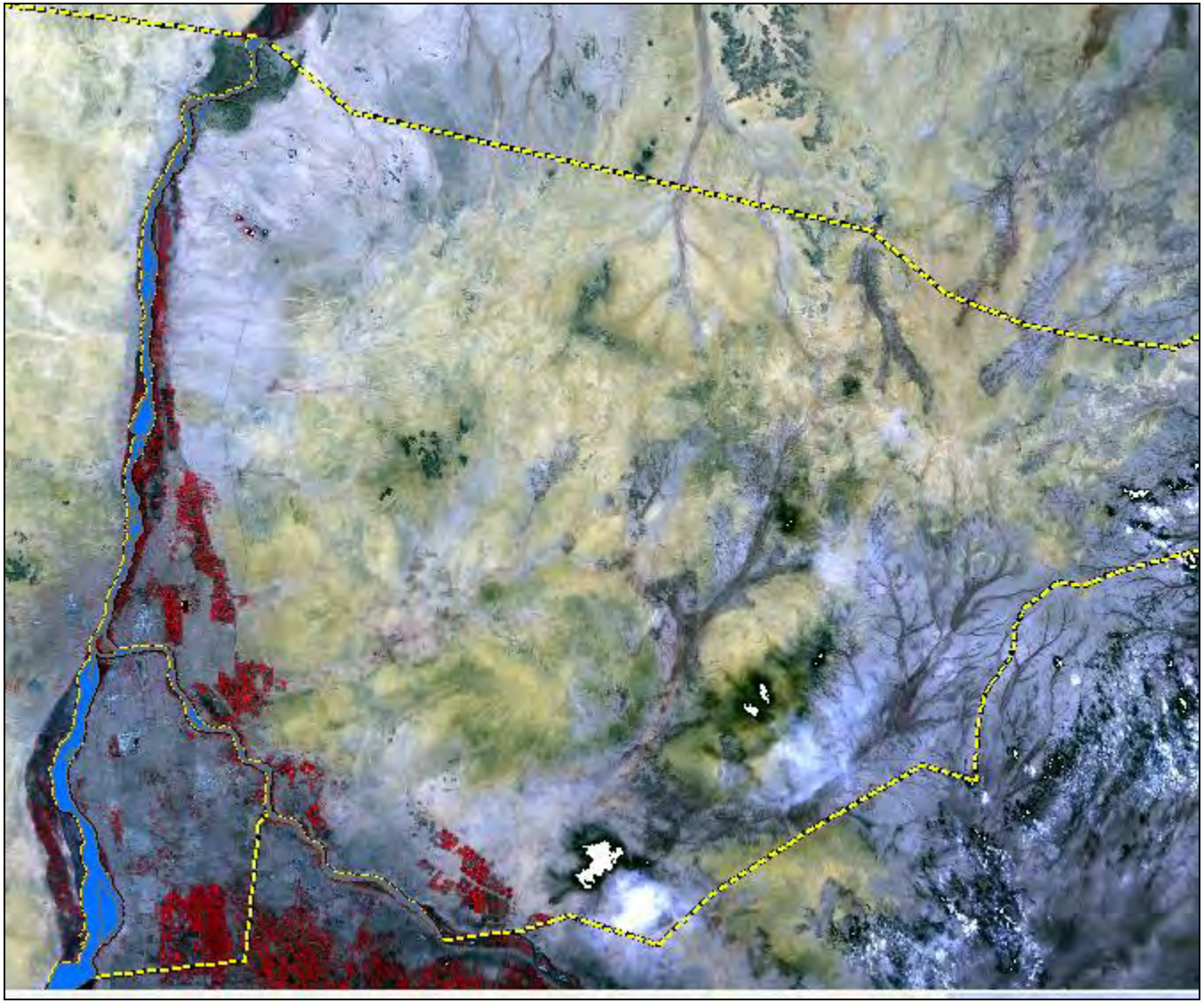
The provided information will be used also for flood damage assessment

Why Satellite Images?

Satellite images provide:

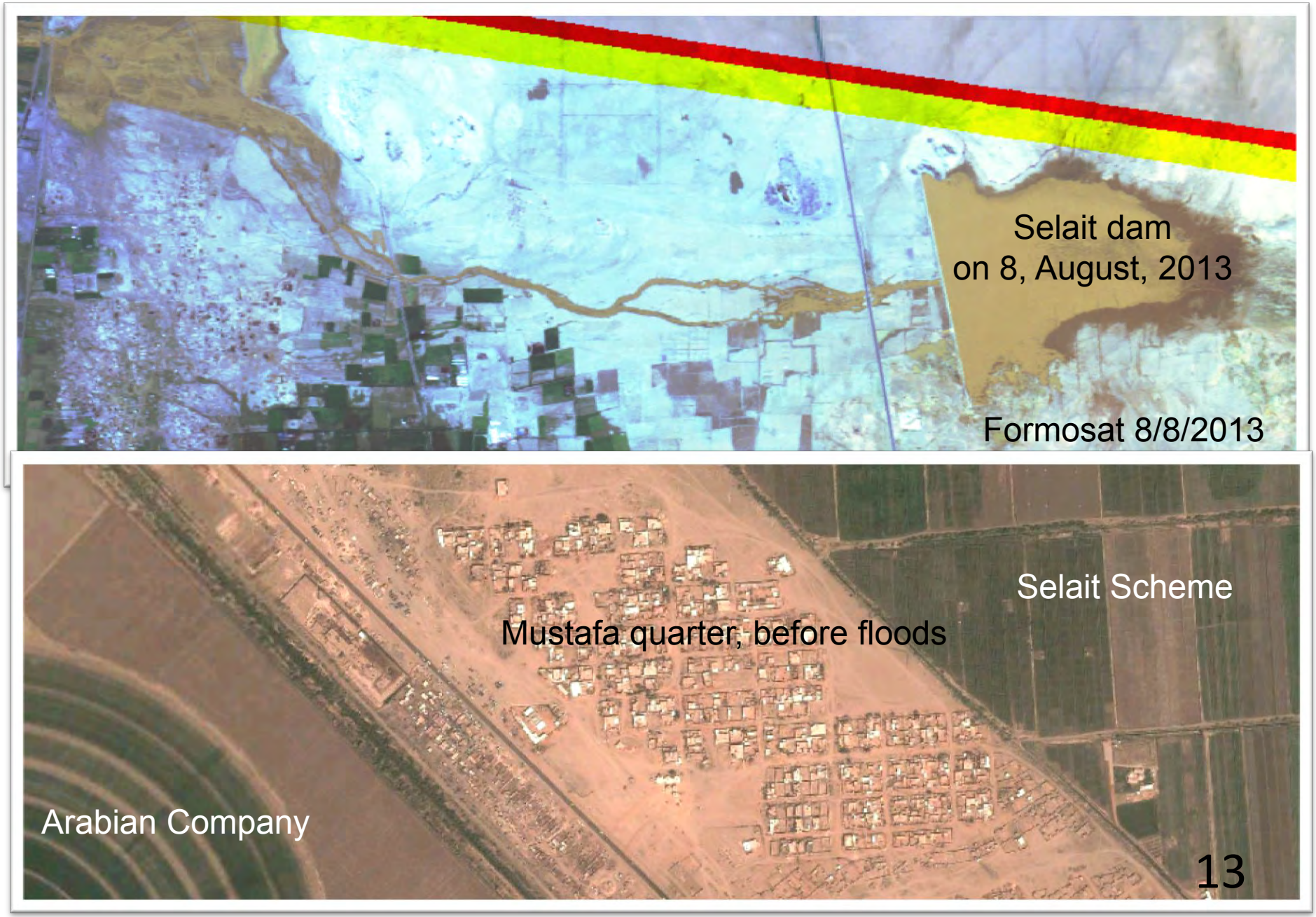
1. Wide area coverage to give a general overview
2. High resolution data to give details and helps in immediate interventions
3. Recent coverage to assess the current situation
4. Temporal coverage to provide data regularly
5. Easy to draw information from satellite data
6. Archives and Live data (image) for future uses

Synoptic view provided by satellite Images



Landsat Image covering the eastern part of Khartoum State

Detailed information provided by high resolution data



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

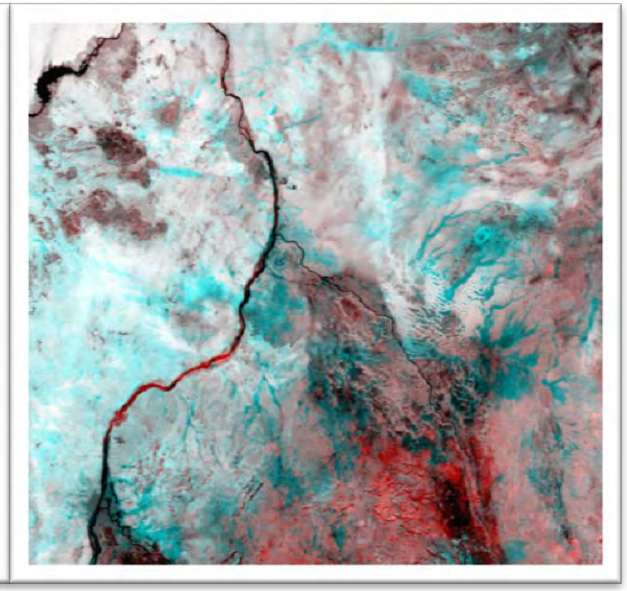
Formosat 8/8/2013

Formosat 9/8/2013

EO 13/8/2013

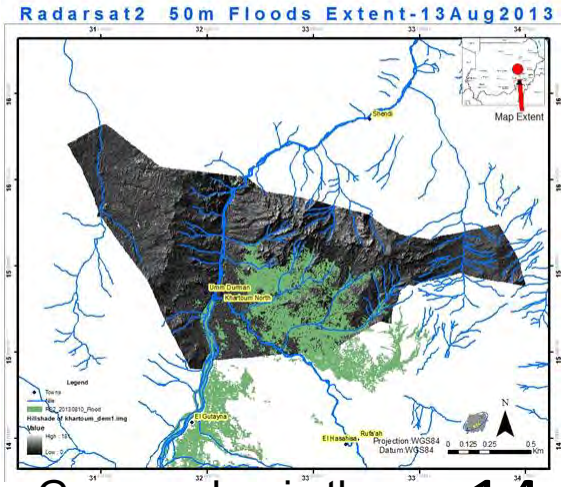
ASTER 13/8/2013

MODIS 4/8/2013



Radarsat2 4/8/2013

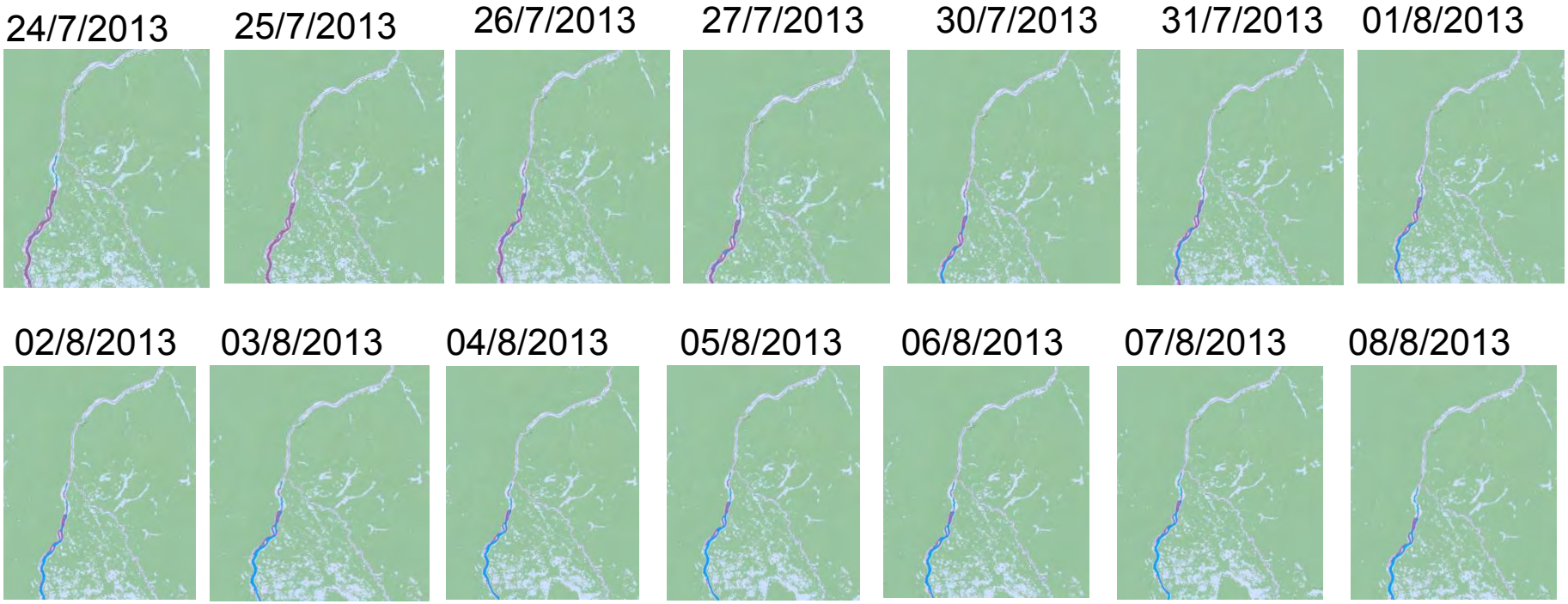
Radarsat2 50m



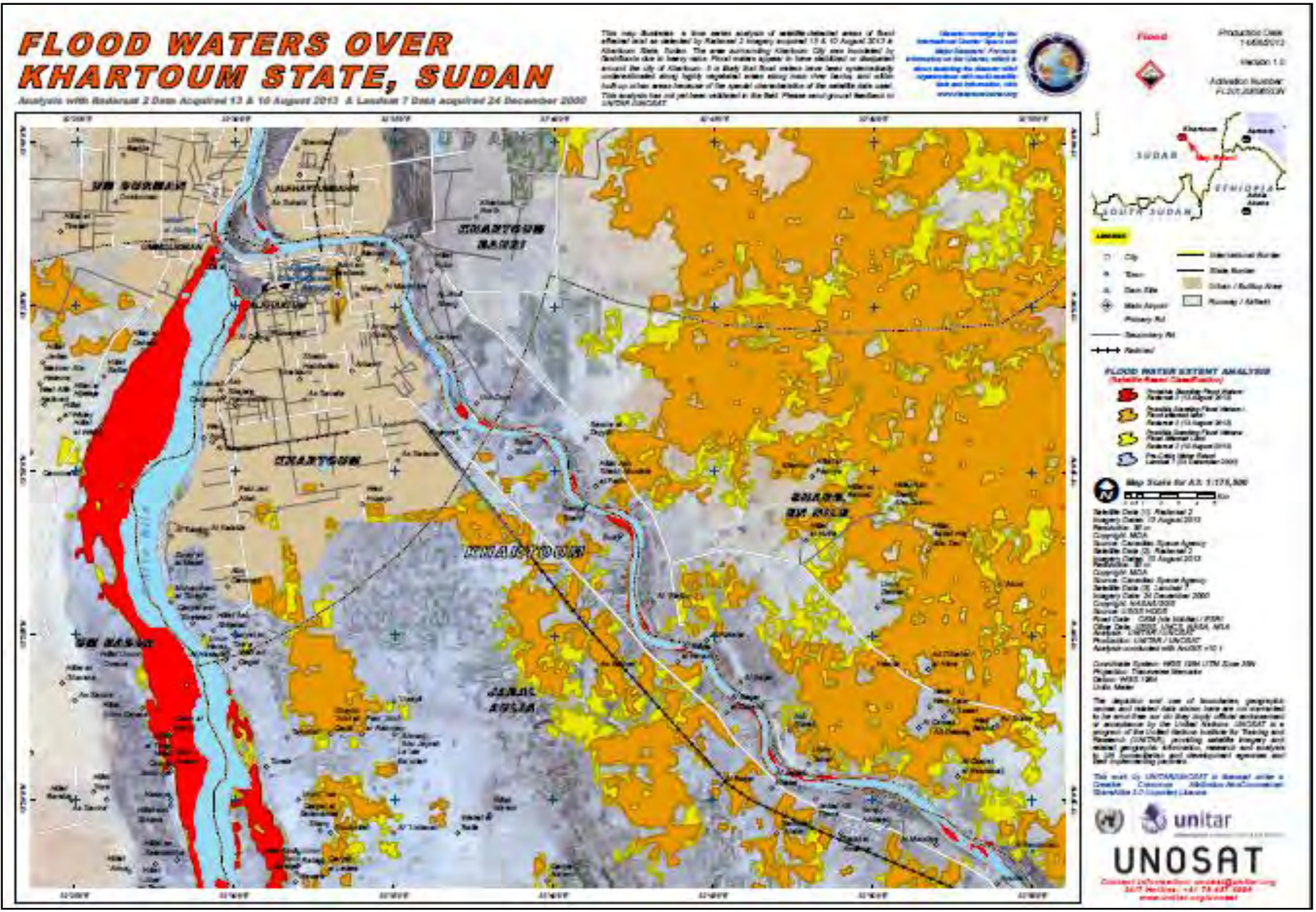
Green color is the

Data produced from Radarsat2

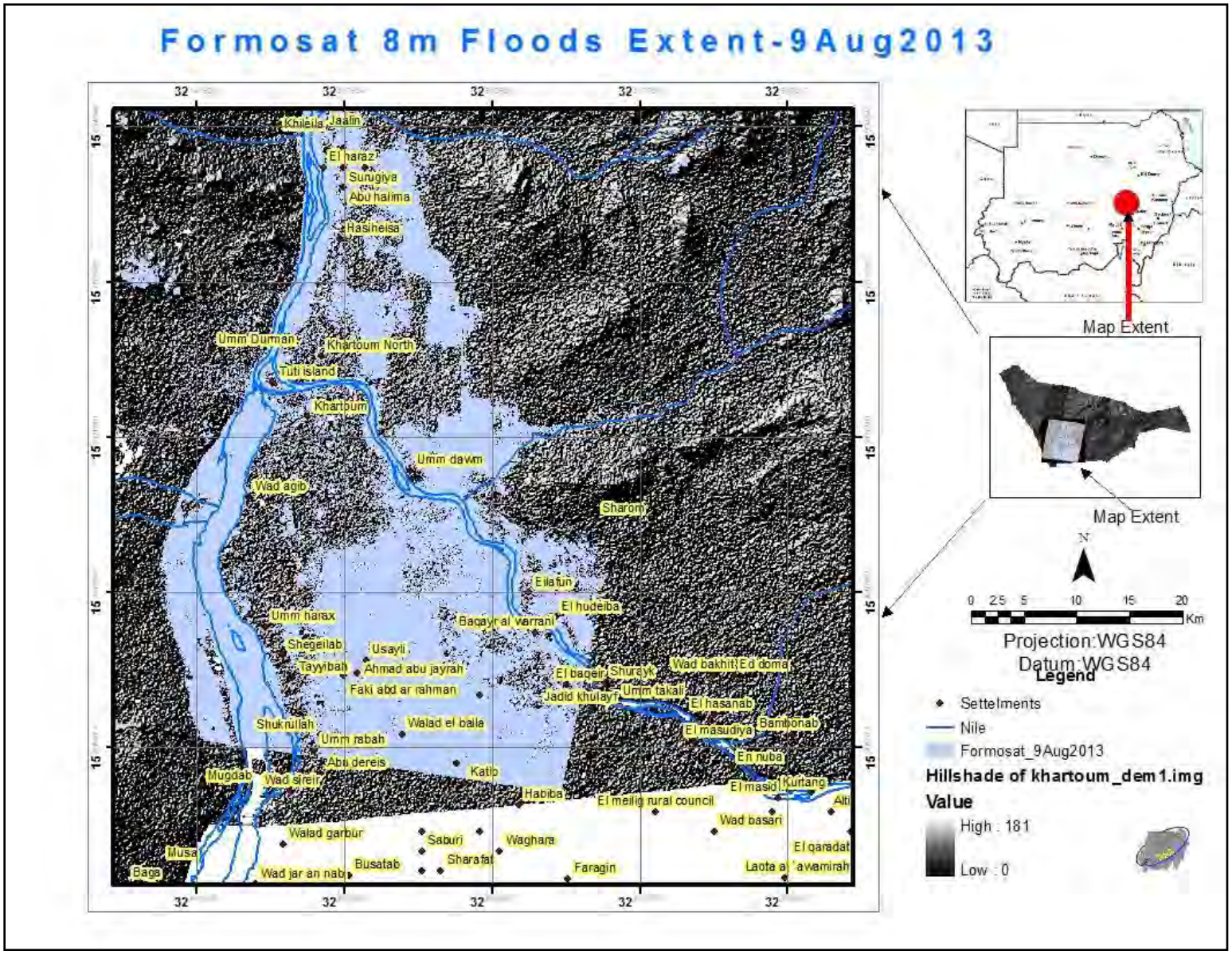
Temporal coverage to provide data regularly
Daily acquisition by MODIS



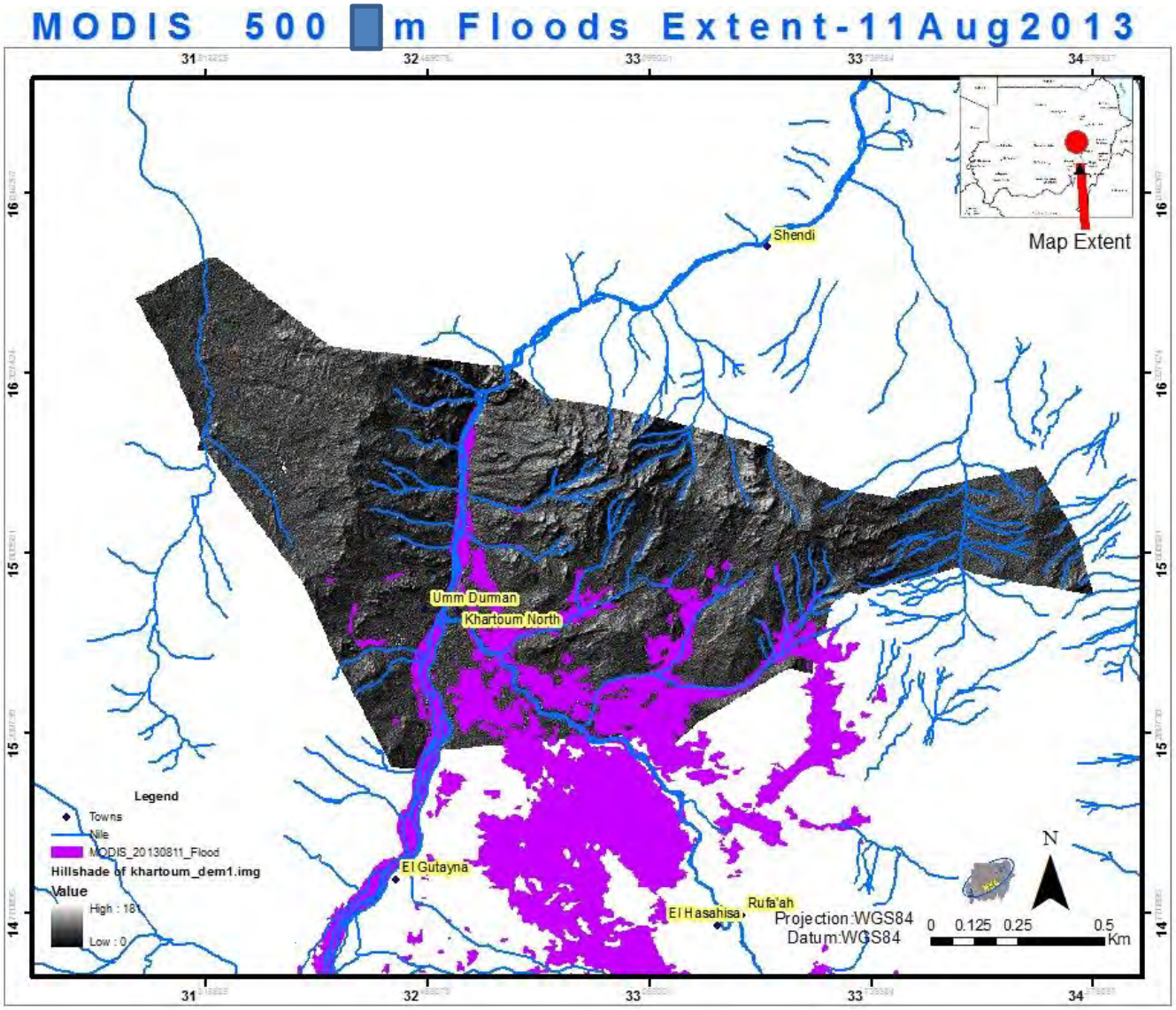
Maps of Khartoum floods based on Satellite Image interpretation through UN-SPIDER and International Support


FLOOD WATERS OVER KHARTOUM STATE, SUDAN
Analysis with Radarsat 2 Data Acquired 13 & 10 August 2013 & Landsat 7 Data acquired 24 December 2000
UNOSAT
unitar
SUDAN
SOUTH SUDAN
ETHIOPIA
KHARTOUM
KHARTOUM NORTH
OMDURMAN
UM BADDAR
UM BADA
JEBEL AULIA
FLOOD WATER EXTENT ANALYSIS

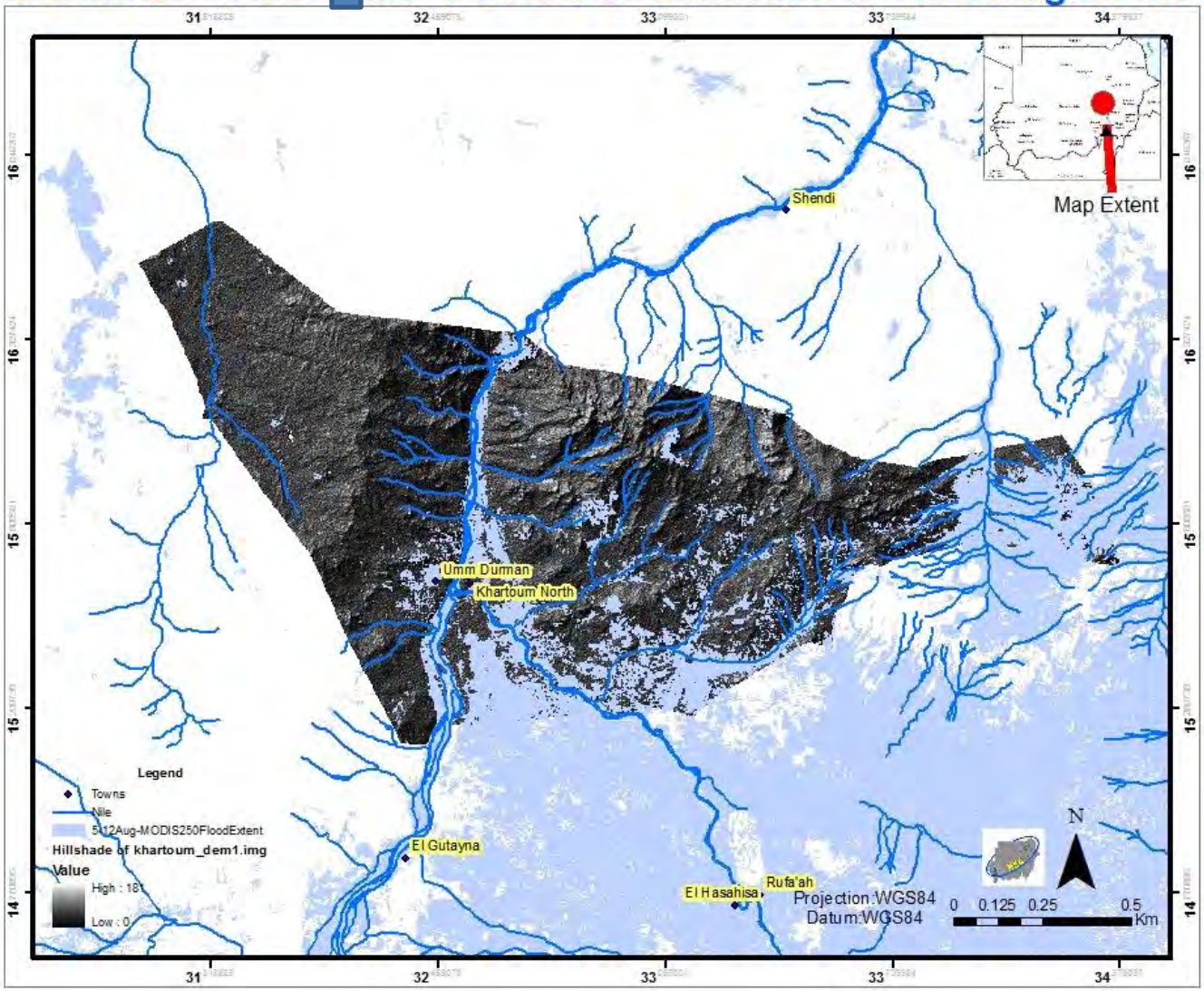
Formosat 8m


Formosat 8m Floods Extent-9Aug2013
Khileila
Jaalin
El haraz
Sunugiya
Abu halima
Hasiheisa
Umm Durman
Khartoum North
Tuti island
Khartoum
Umm dawm
Wad agib
Sharon
Eilafun
El hudeiba
Umm harax
Baqayr al warrani
Shegeilab
Usayli
Tayyibah
Ahmad abu jayrah
Faki abd ar rahman
El baqeir
Shureyk
Wad bakhit
Ed doma
Jadid khulayf
Umm takali
El hasanab
Shuk rullah
Walad el balla
El masudiya
Bambonab
Umm rabah
En nuba
Abu dereis
Katib
Mugdab
Wad sireir
Habiba
El masid
Kurtang
El meilig rural council
Alti
Wad basari
Walad garbur
Saburi
Waghara
El qaradat
Musa
Sharafat
Busatab
Faragin
Laota al 'awamirah
Baga
Wad jar an nab
Map Extent
Map Extent
N
0 2.5 5 10 15 20
Km
Projection:WGS84
Datum:WGS84
Legend
Settelments
Nile
Formosat_9Aug2013
Hillshade of khartoum_dem1.img
Value
High : 181
Low : 0

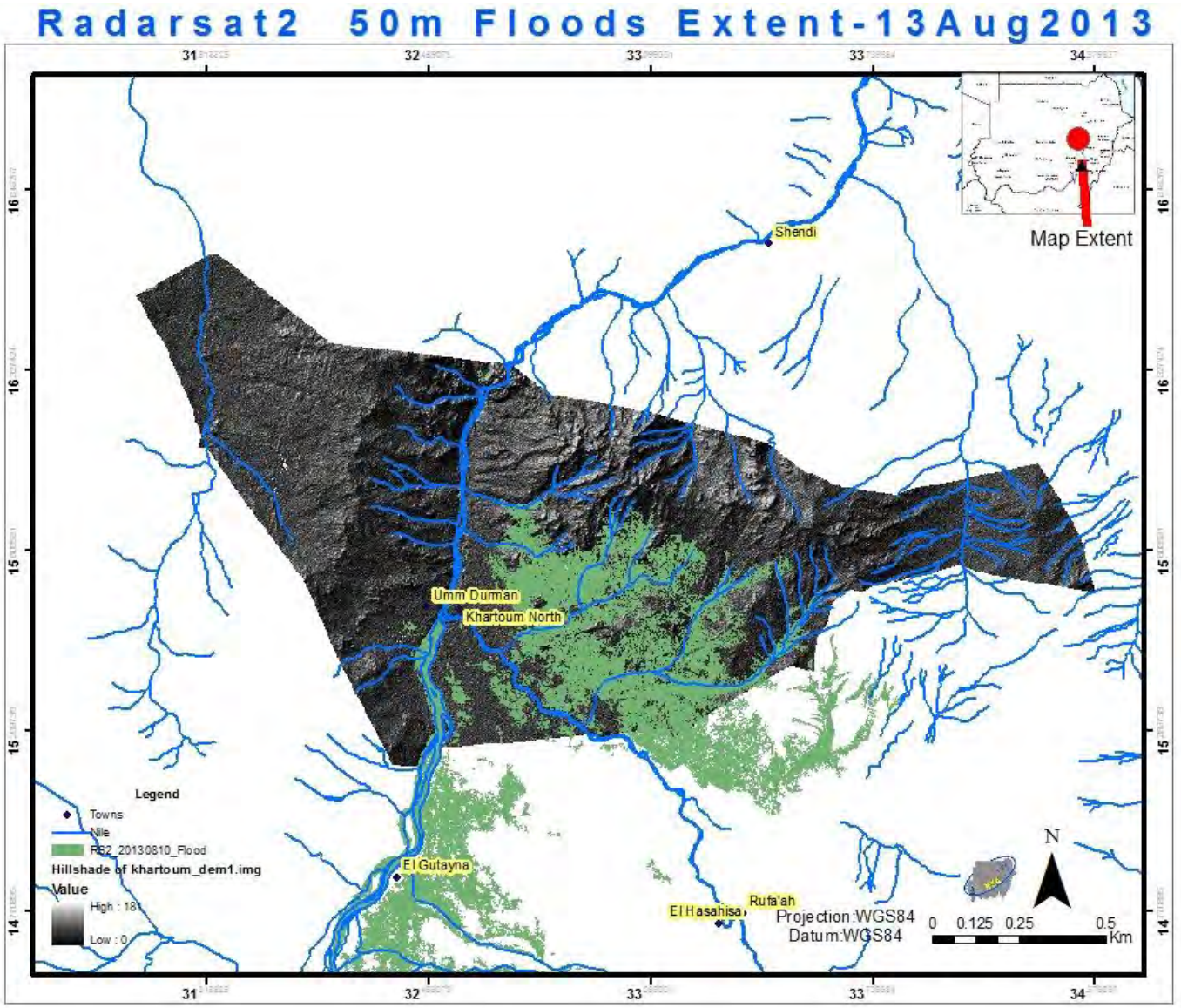
MODIS 500 m


MODIS 500 m Floods Extent-11Aug2013
Shendi
Map Extent
Umm Durman
Khartoum North
El Gutayna
El Hasahisa
Rufa'ah
Legend
Towns
Nile
MODIS_20130811_Flood
Hillshade of khartoum_dem1.img
Value
High : 181
Low : 0
N
Projection:WGS84
Datum:WGS84
0 0.125 0.25 0.5
Km

MODIS 250 m


MODIS 250 m Floods Extent-5-12Aug2013
Shendi
Map Extent
Umm Durman
Khartoum North
El Gutayna
El Hasahisa
Rufa'ah
Legend
Towns
Nile
5-12Aug-MODIS250FloodExtent
Hillshade of khartoum_dem1.img
Value
High : 18
Low : 0
N
Projection:WGS84
Datum:WGS84
0 0.125 0.25 0.5
Km

Radarsat2 50m



WHO Benefits from the available images and information

Disaster Management Actors

1. Civil Defense,
2. Emergency and Humanitarian Action Department of the Ministry of Health,
3. Ministry of Agriculture,
4. Humanitarian Aid Commission,
5. Physical Planning - Khartoum State.

The mentioned organizations were able to use the satellite data and the information provided by UN-SPIDER through Remote Sensing Authority support. Besides their utilization of knowledge gained from UN-SPIDER training course in Khartoum in May 2013.

Flood risk assessment from satellite image perspective

RSA intended to identify factors that contribute to high risk of Khartoum floods based on image interpretation

Proposed measures for risk reduction based on RSA findings

Recommendations

Factors that contribute to high risk of Khartoum floods

1- Topography

2- Flood prone areas

3- Land use

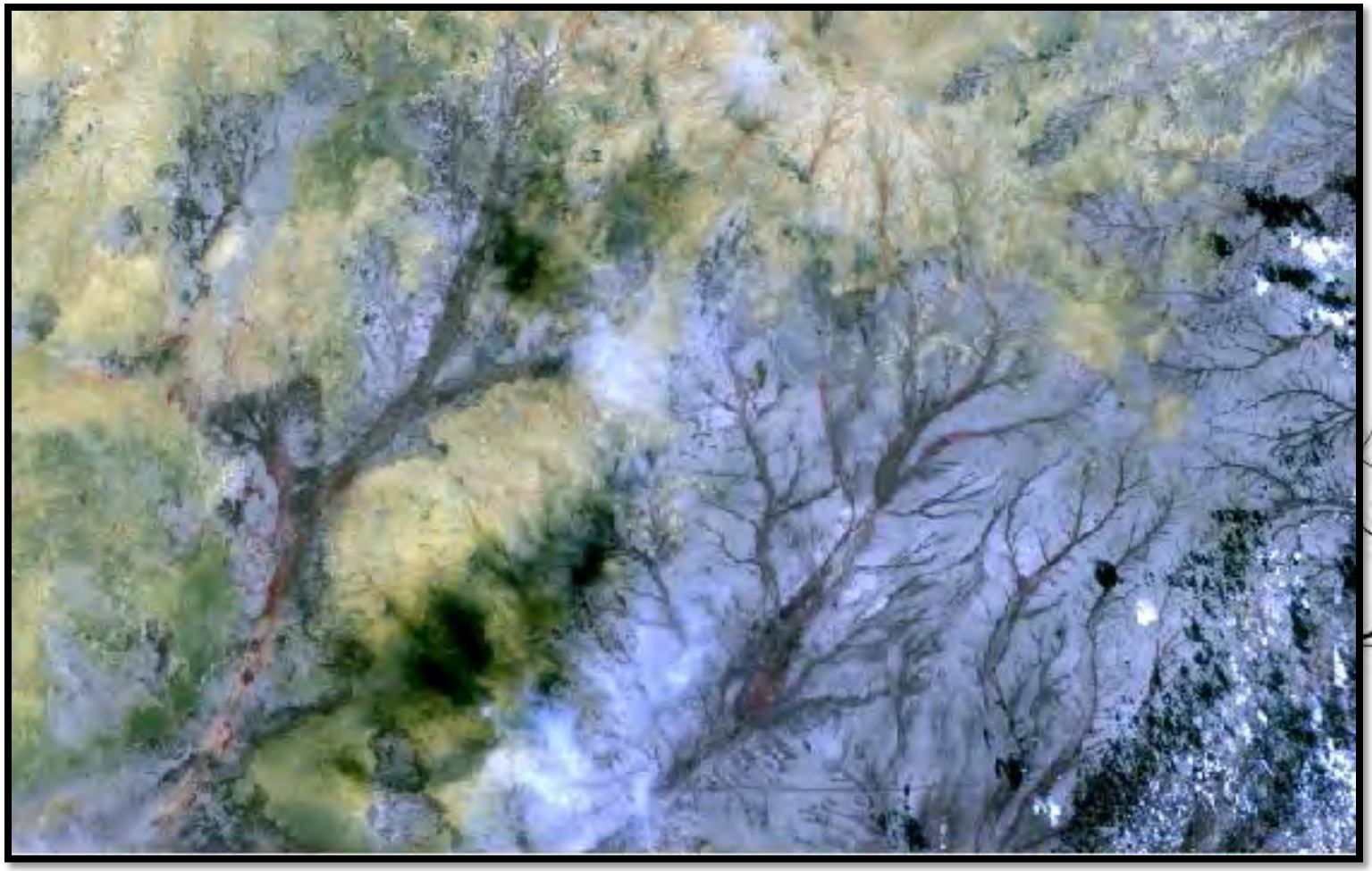
1- **Topography of the area and flood risk**

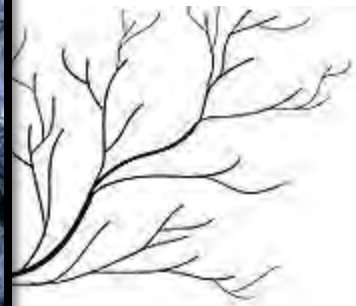
The land form of the eastern side of Khartoum State is characterized by having Dendritic drainage pattern, which is a well- integrated pattern formed by a main stream with its tributaries branching and re-branching freely in all directions .

This type of drainage system results from the erosion of the land surface.

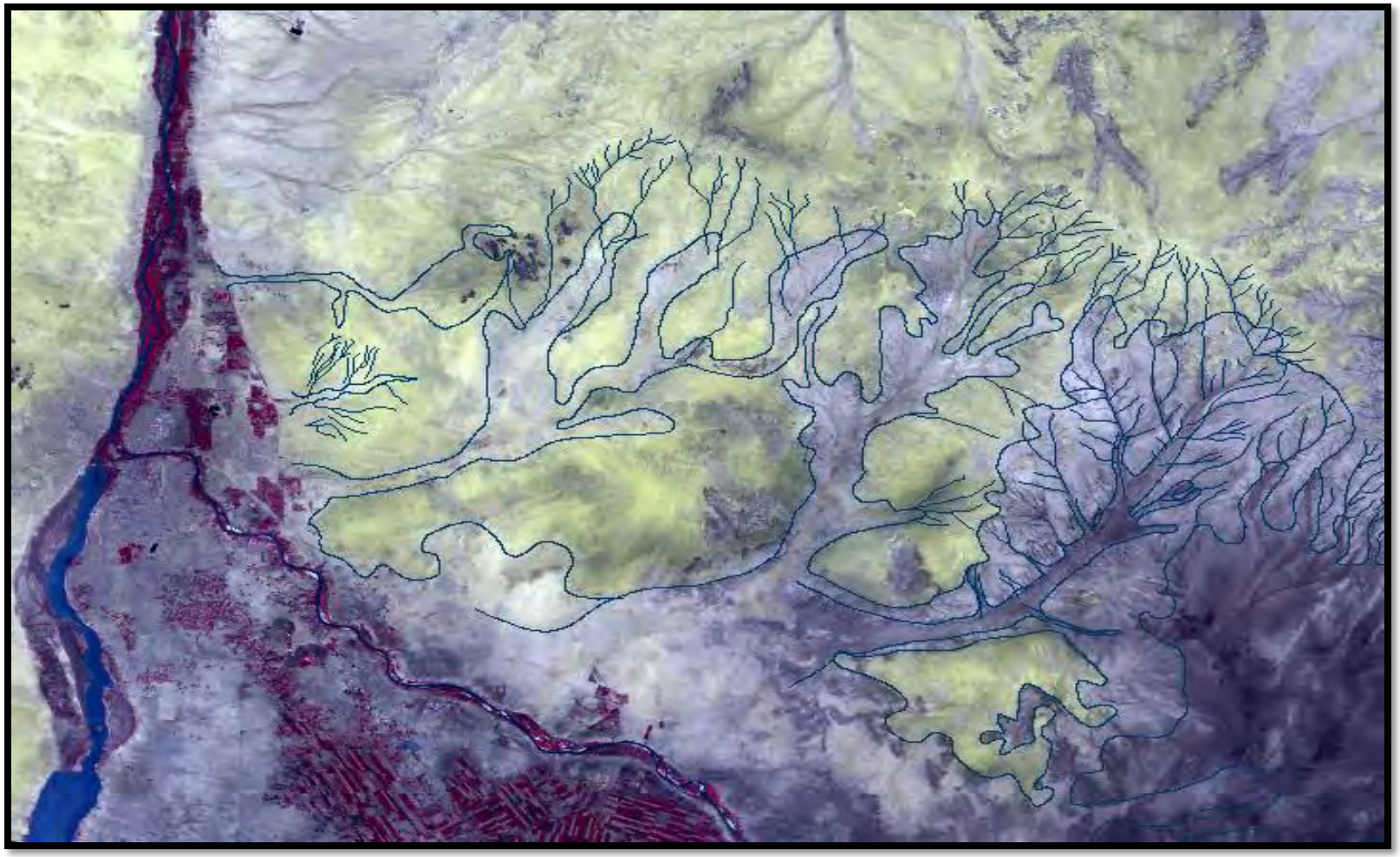
Drainage pattern of the eastern region

Fine- textured dendritic pattern, the system induces and accelerates floods



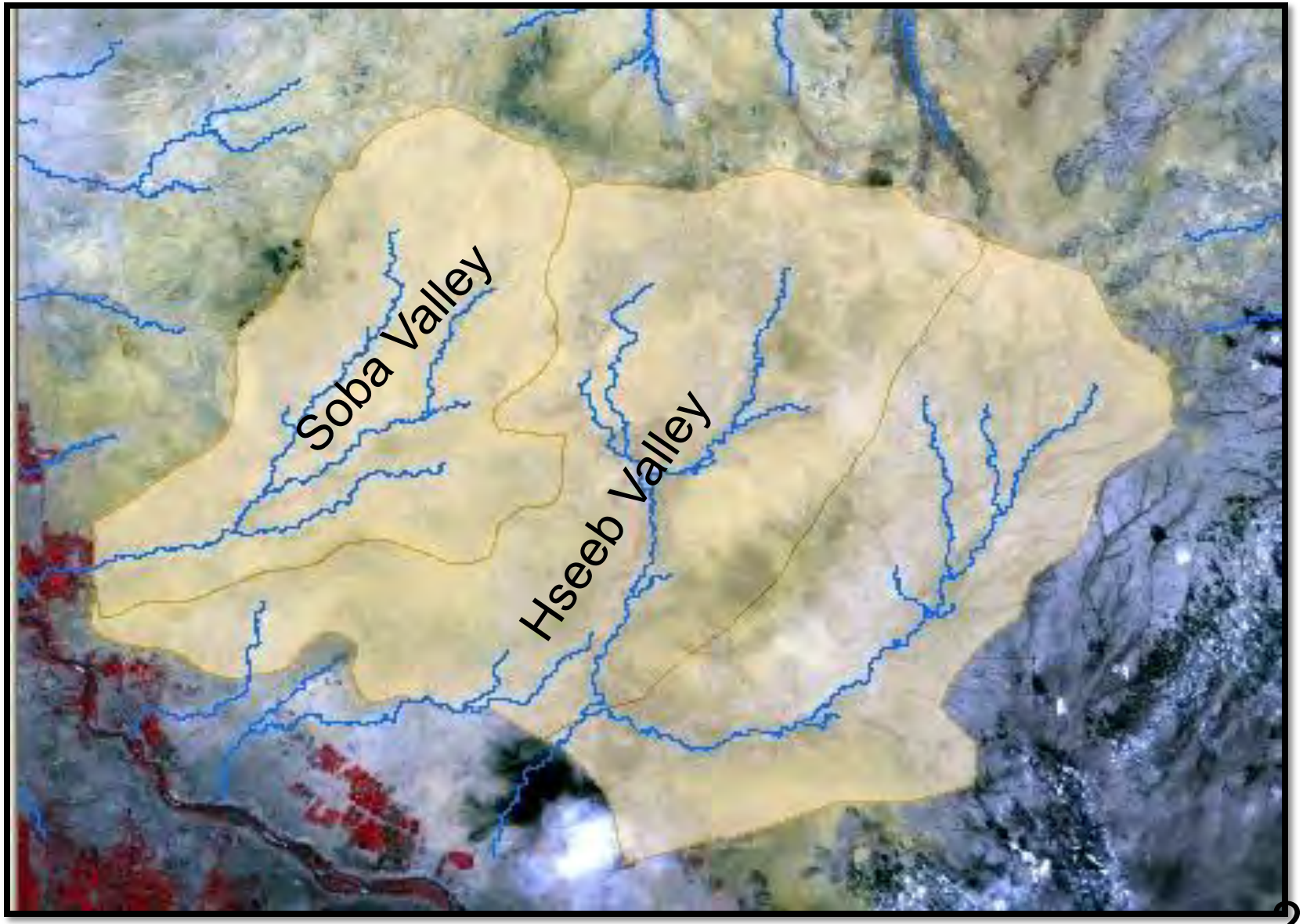


Areas and lengths of the Valleys

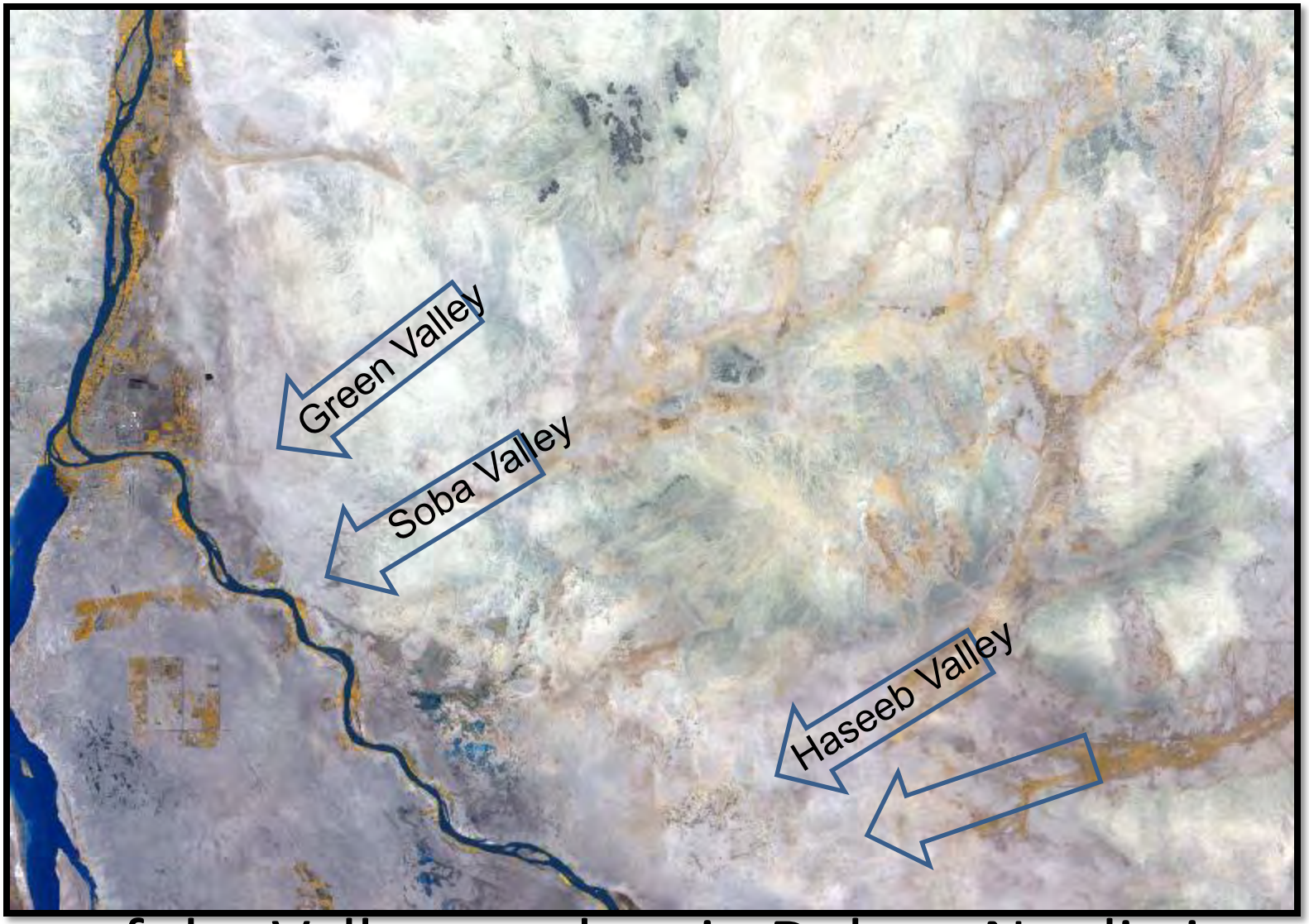


Lengths of some valleys exceed 70 km, therefore, such valleys are expected to carry huge amount of water in a destructive manner

Large Catchments

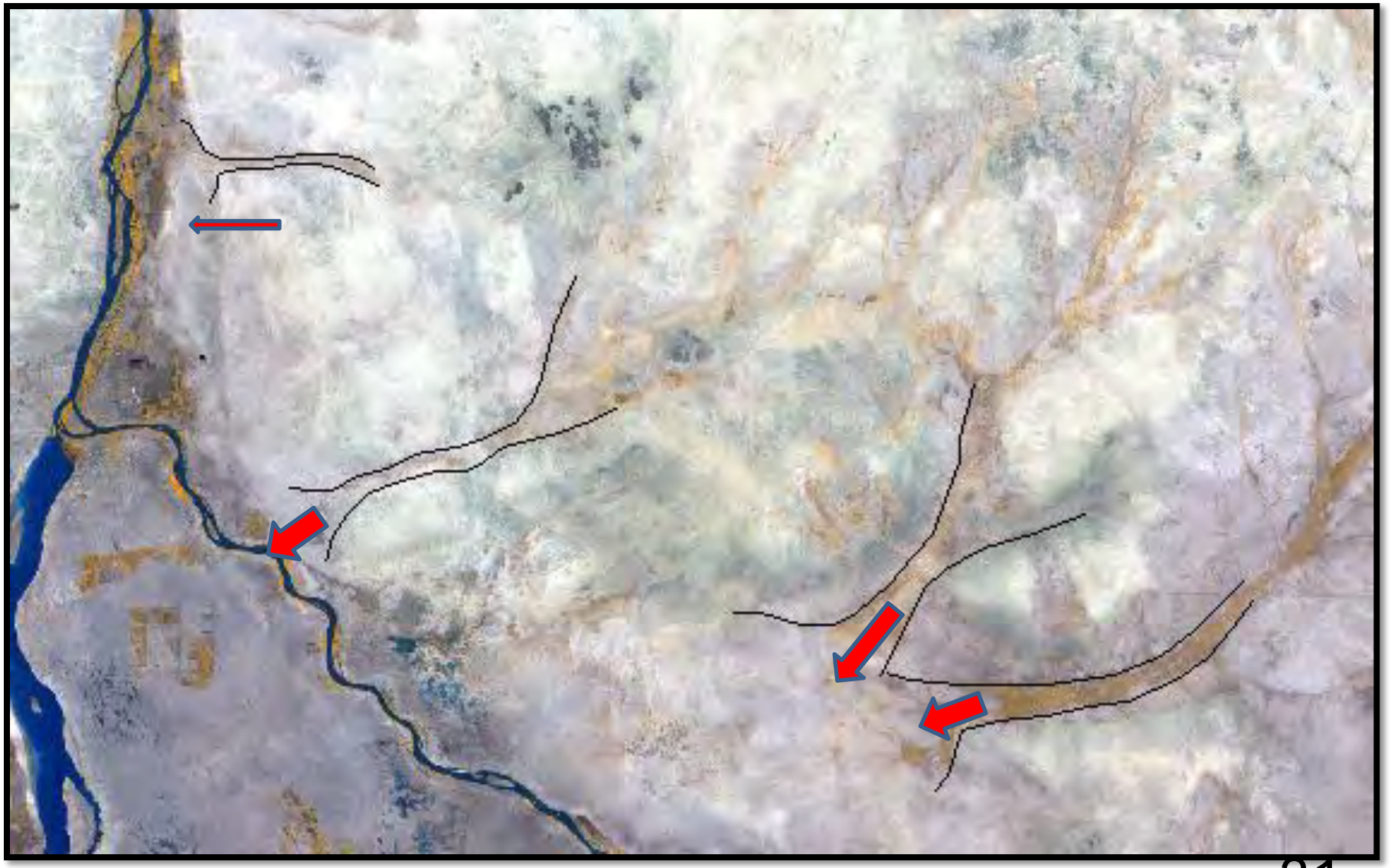


1972 Landsat image of the region



Most of the Valleys end up in Deltas. No distinct water courses reach the Nile

Delta (Flood prone area)

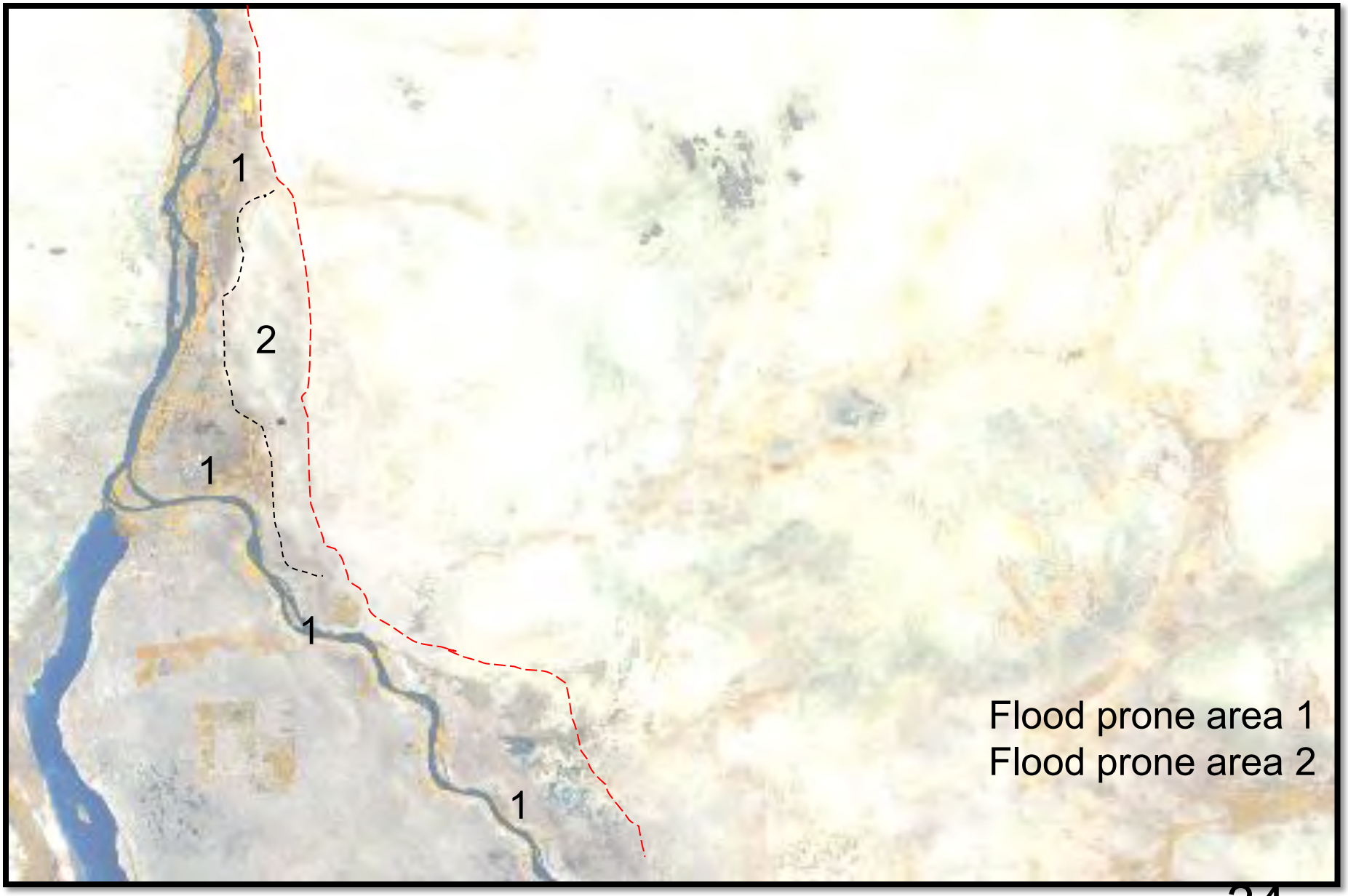


Delta

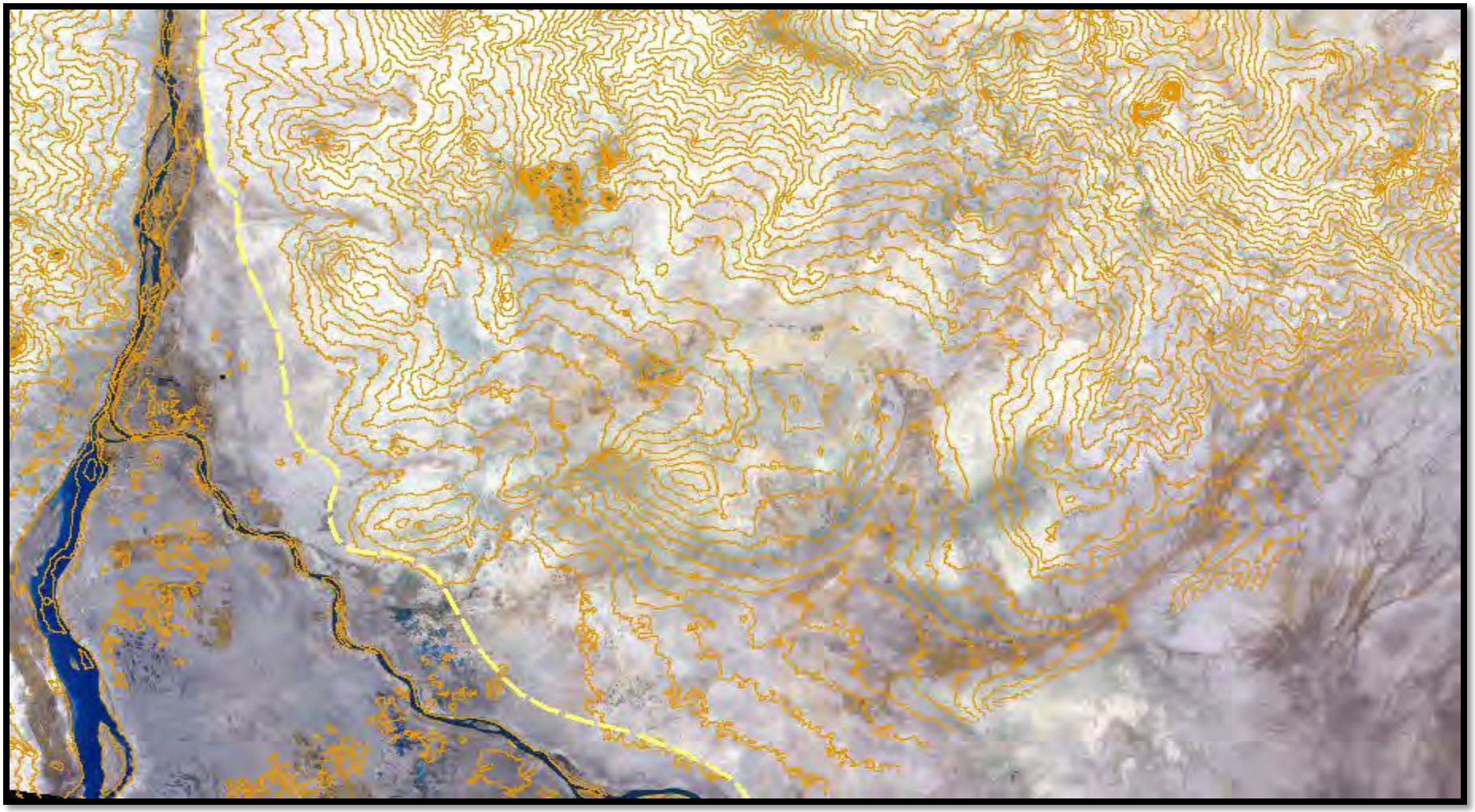
No distinct drainage course ends up at the Nile. Water flows freely in different directions along the Flood Prone Area

2- Flood – prone areas

Landsat Image in 1972

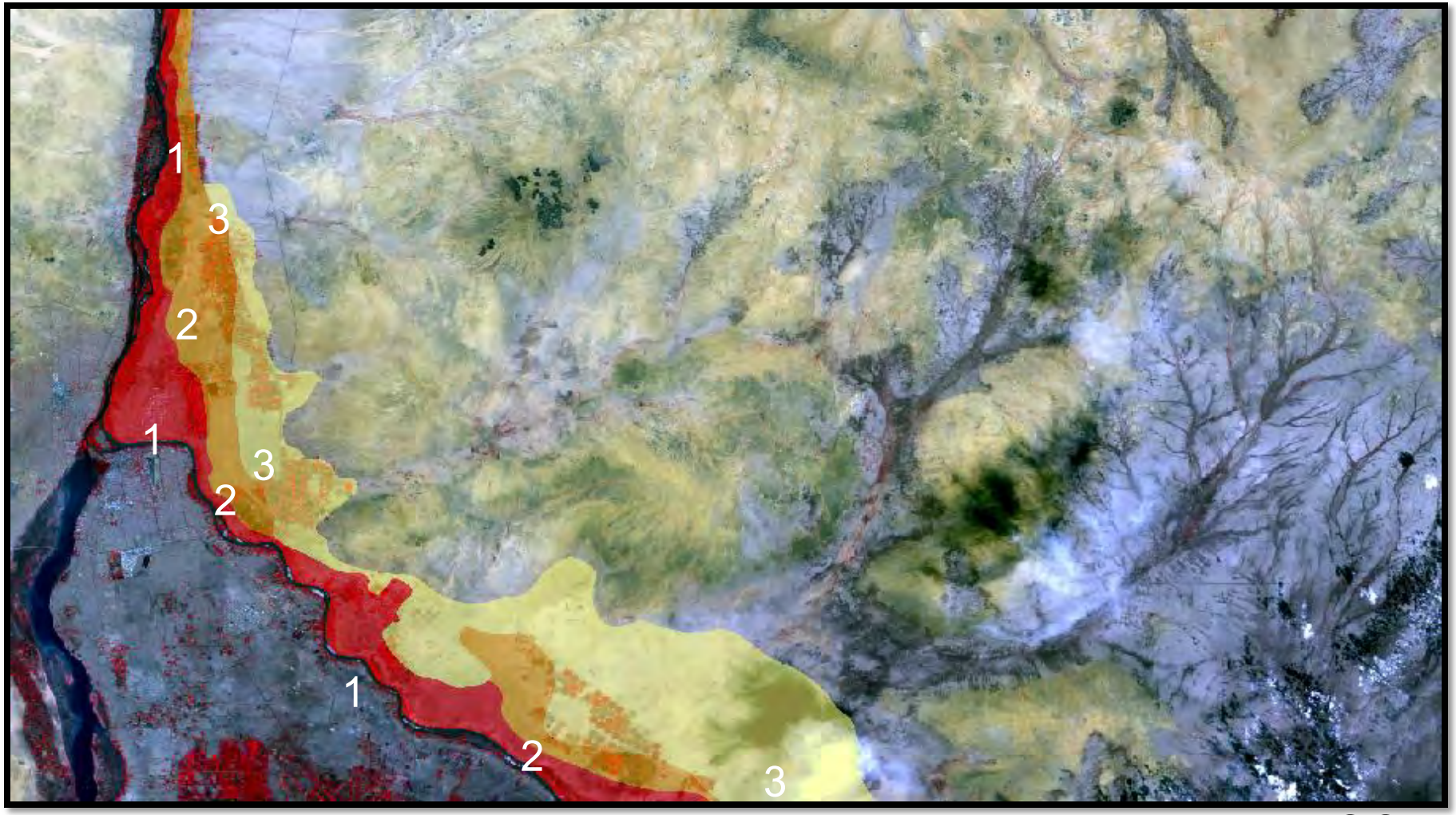


Contour lines and Flood prone zone



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.

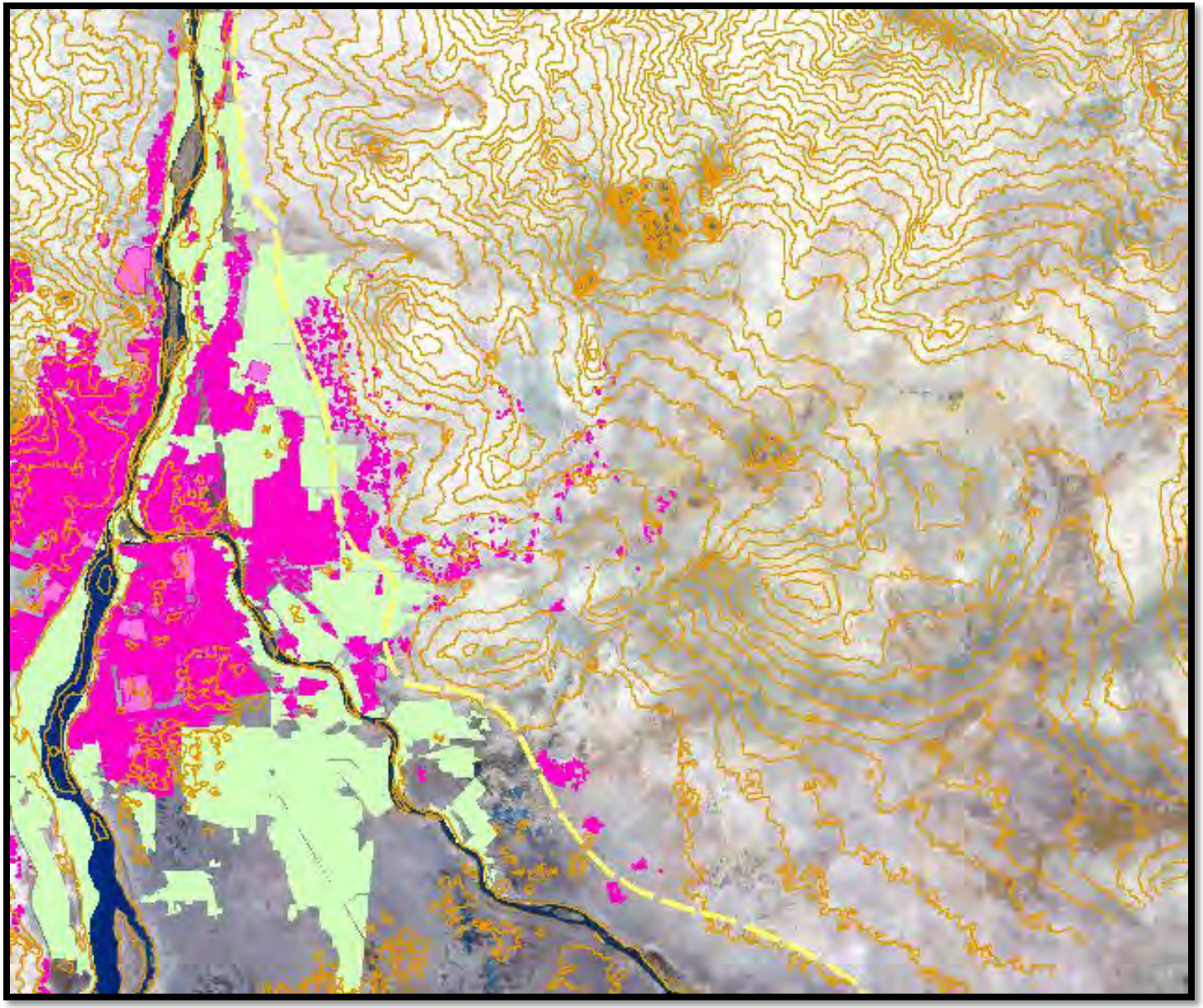


3- Land use

A- Urban Planning

B- Agricultural Schemes

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



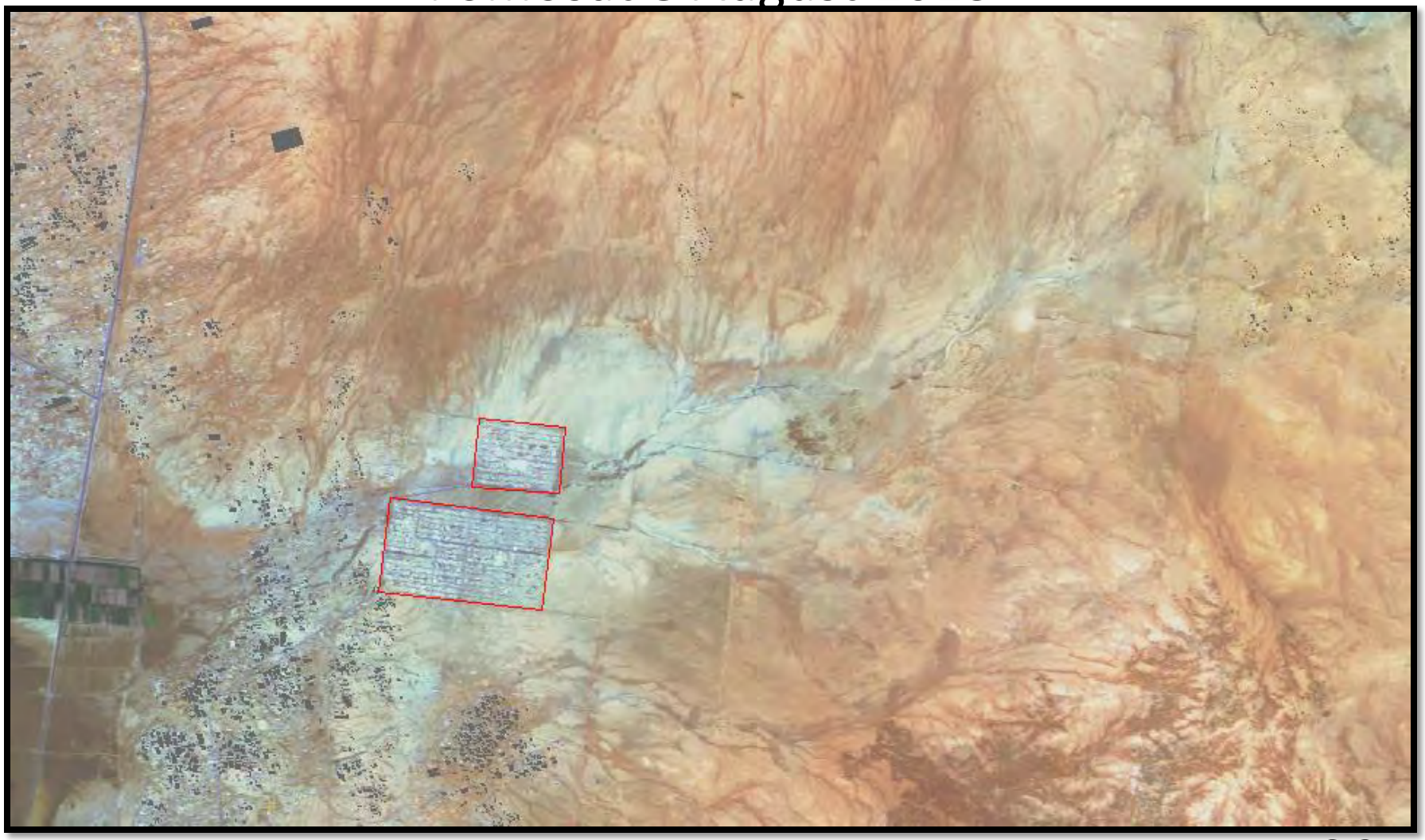
Residential

Agricultural

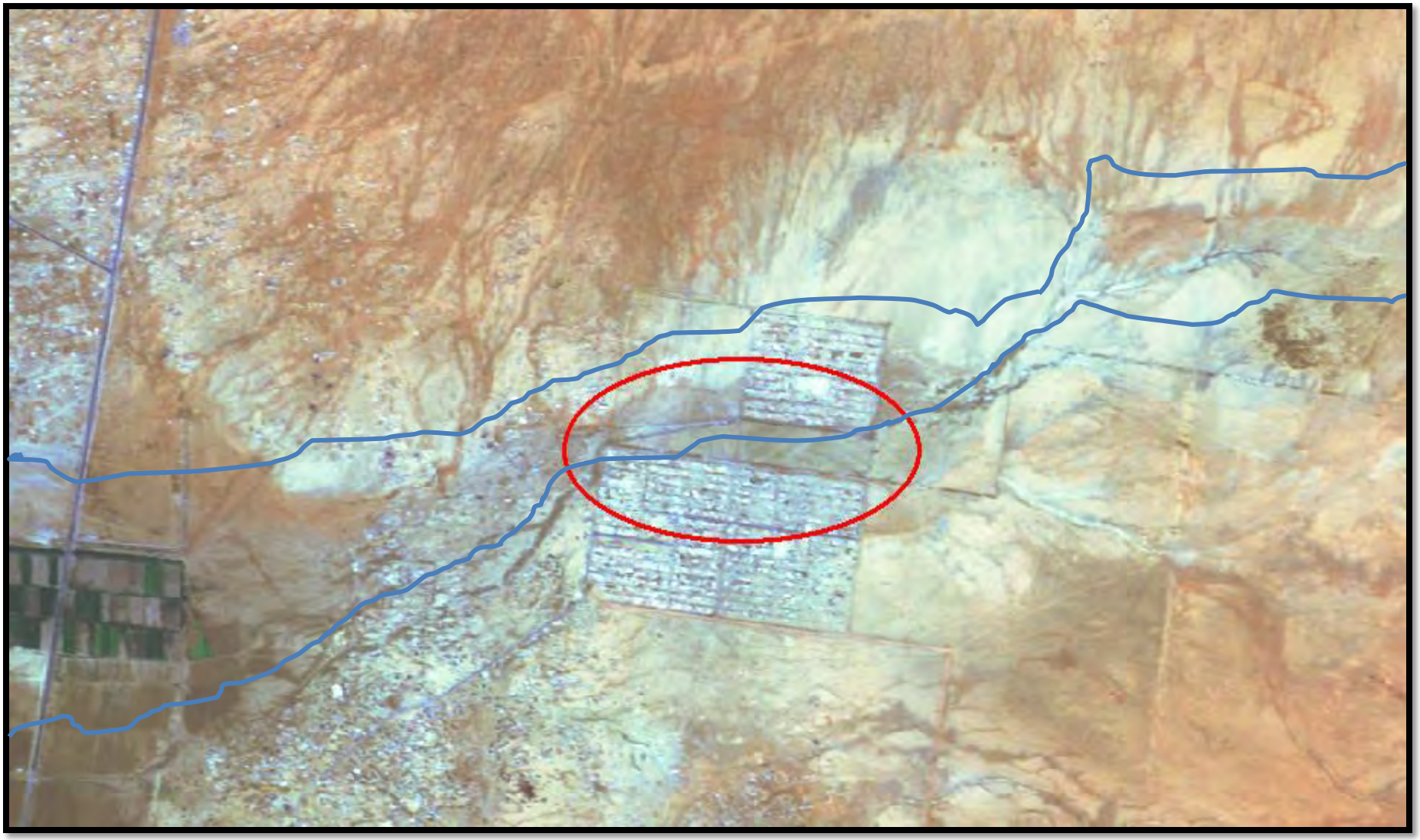
A- Urban Planning

construction of houses on the drainage lines

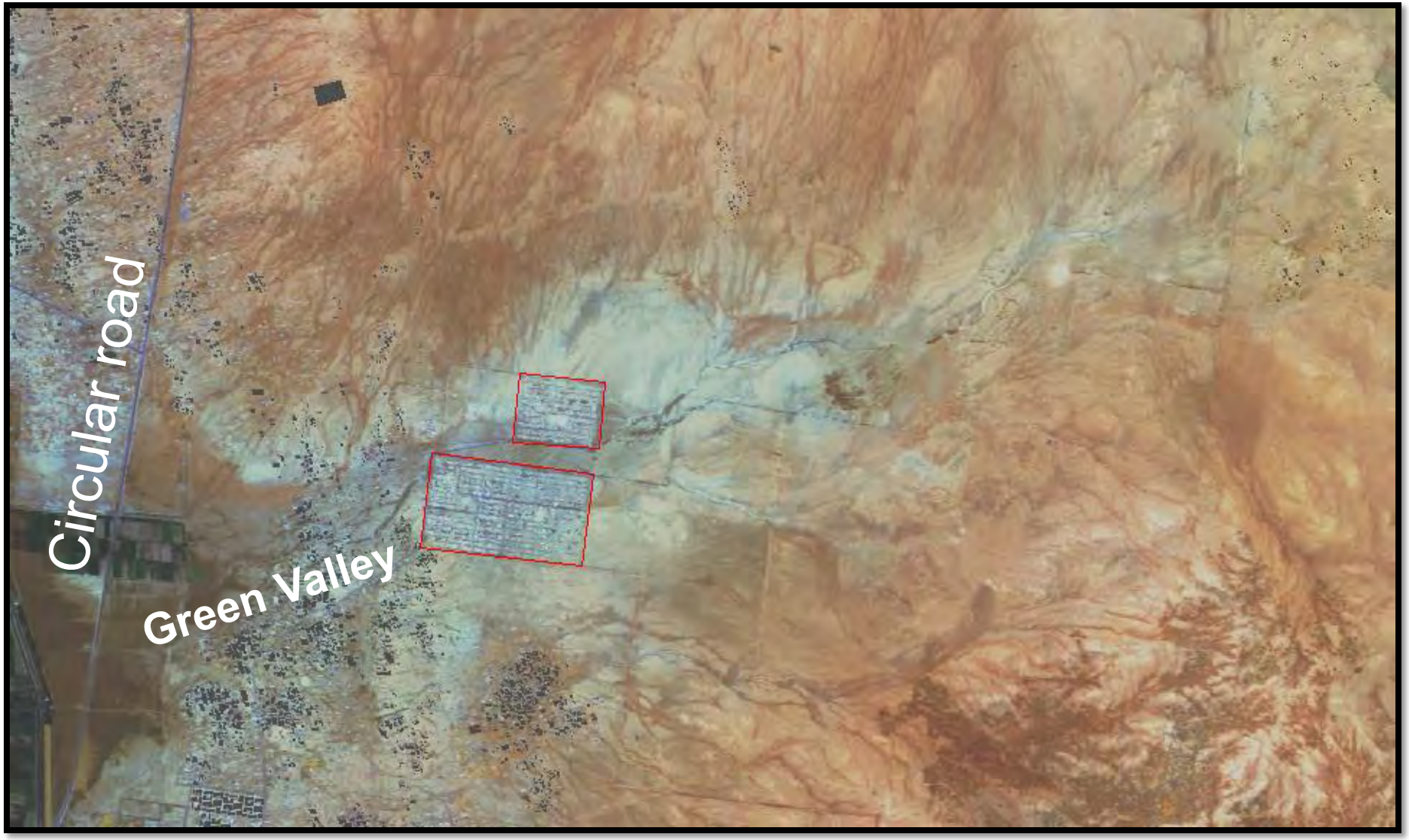
Fomosat 8 August 2013



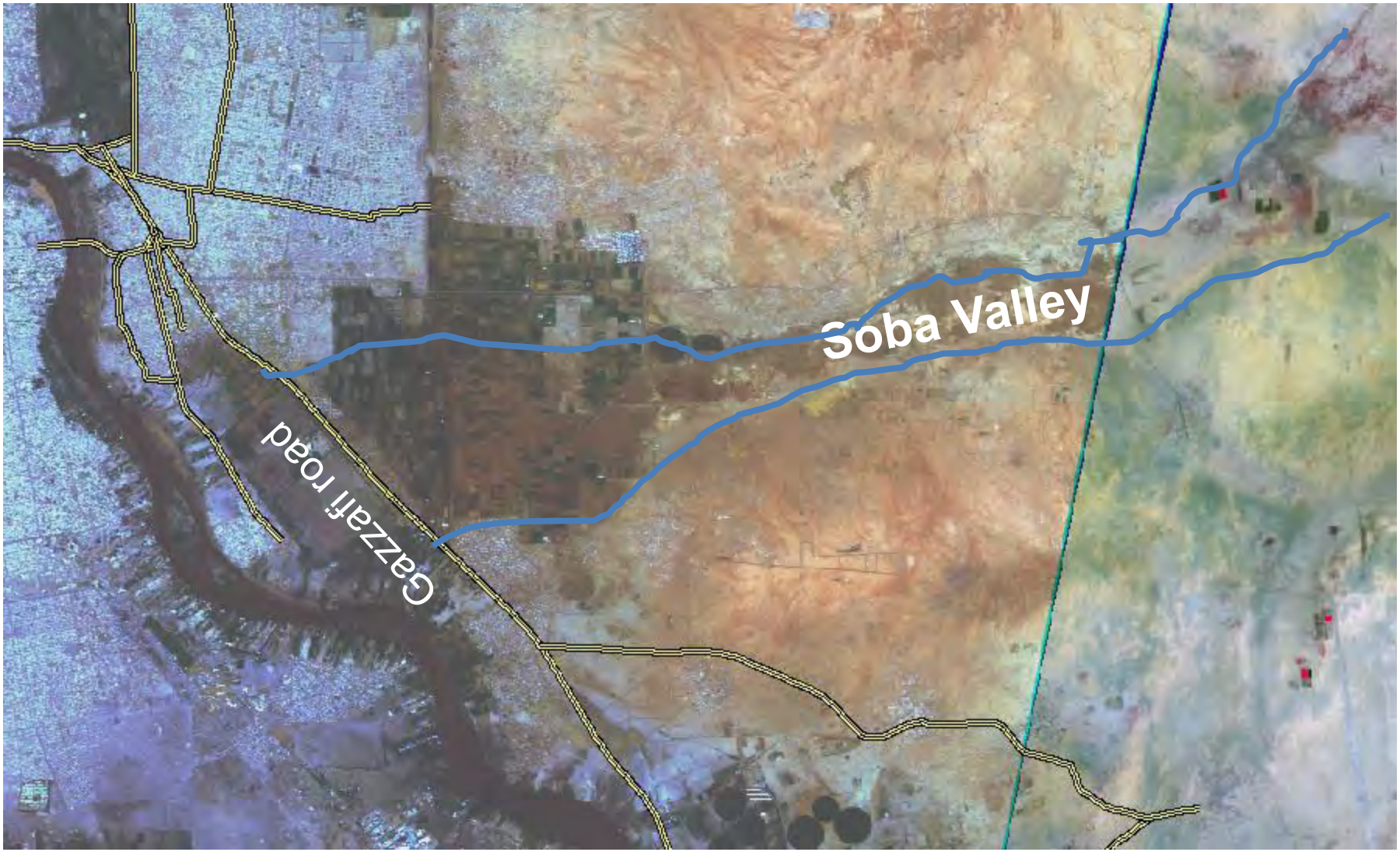
Part of the Journalists town was constructed in the middle of the water course



Road construction across Valleys

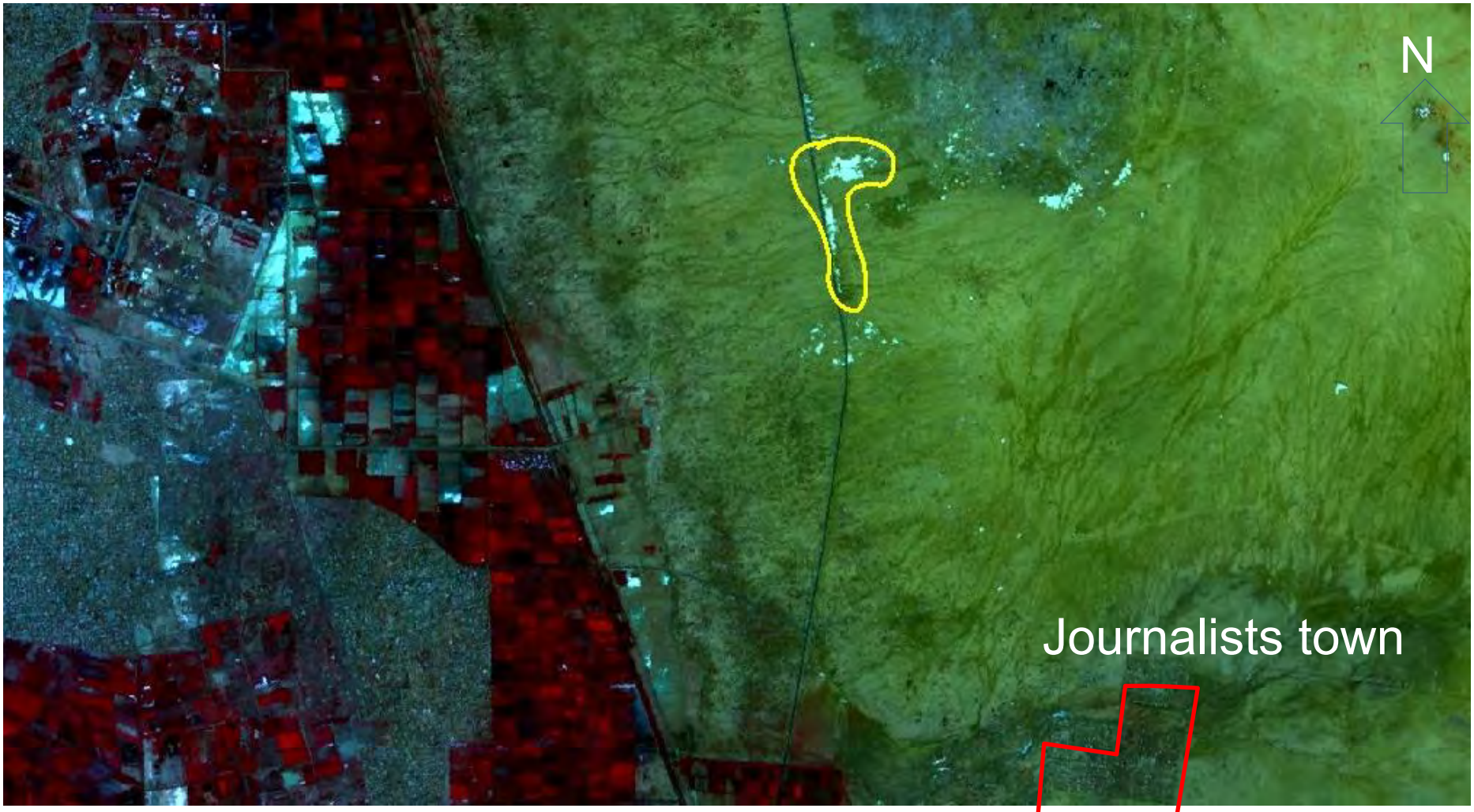


Roads across a valley



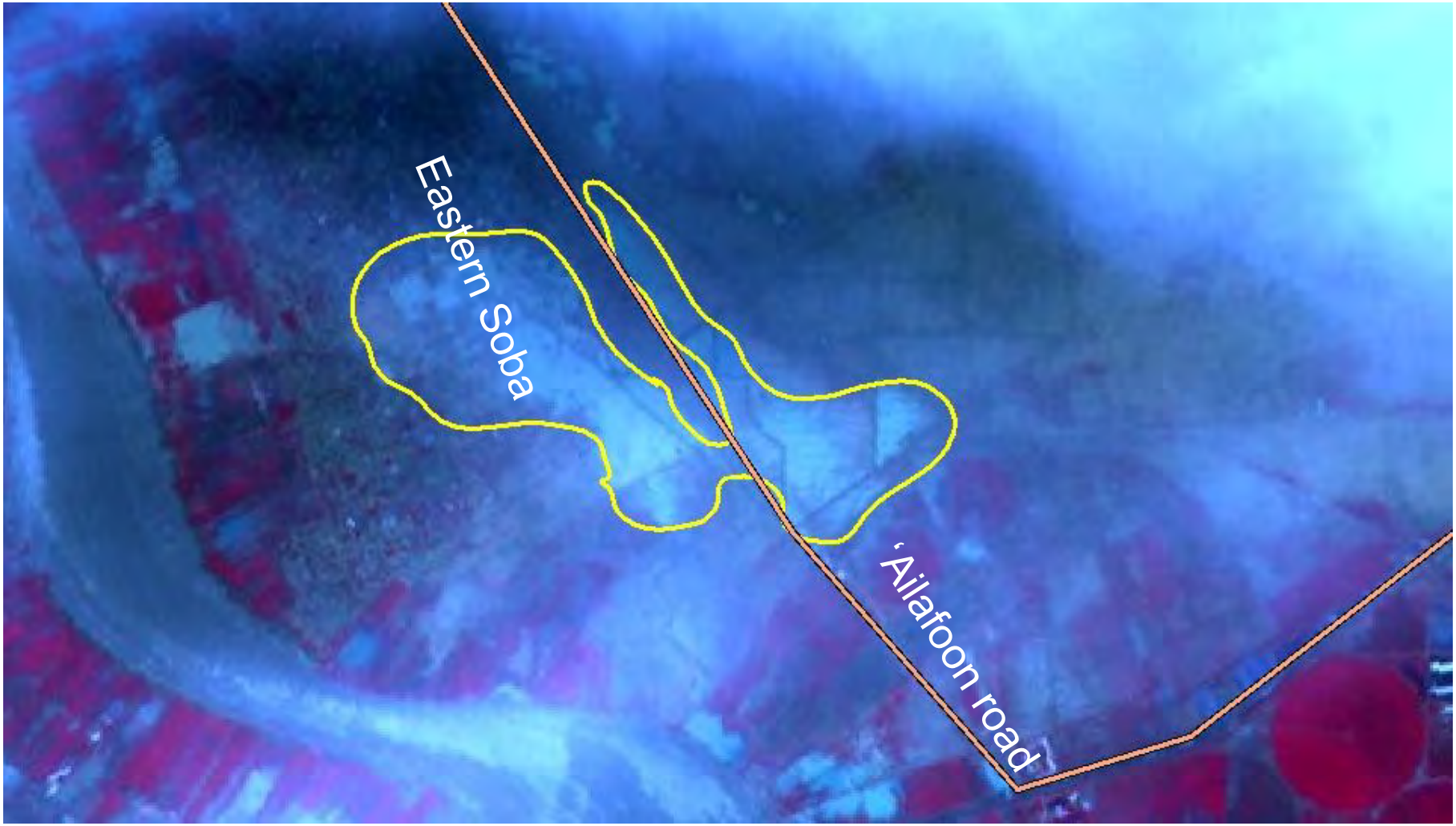
Circular road has retained part of the flood water

ASTER 13/8/2013



South eastern part of the Eastern Soba area

ASTER 13/8/2013

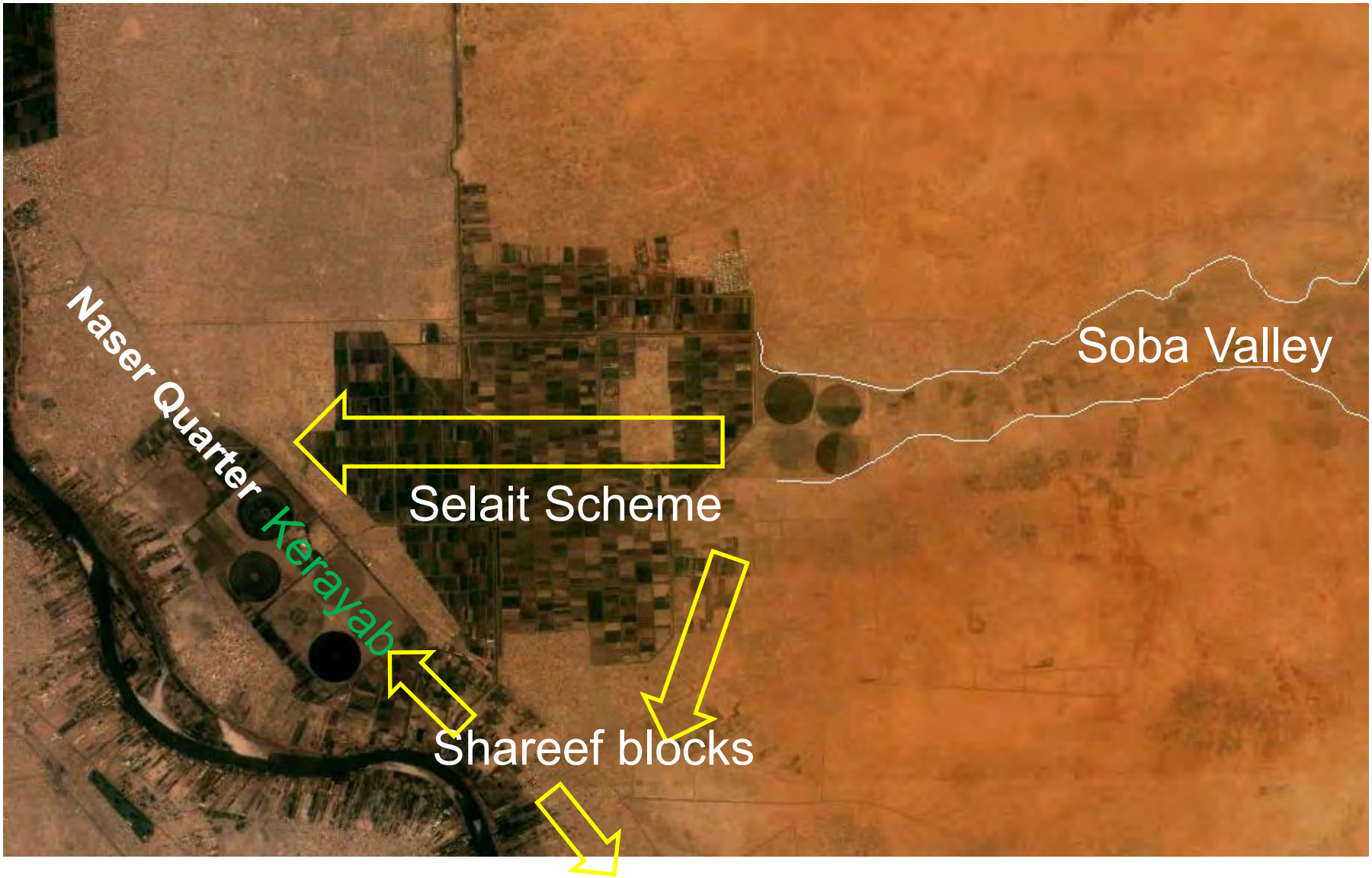


B- Agricultural Schemes

ASTER 13/8/2013

Flood water rushing towards Selait Agricultural Scheme

Rush of Soba Valley floods towards Selait Agric. Scheme and three Residential areas

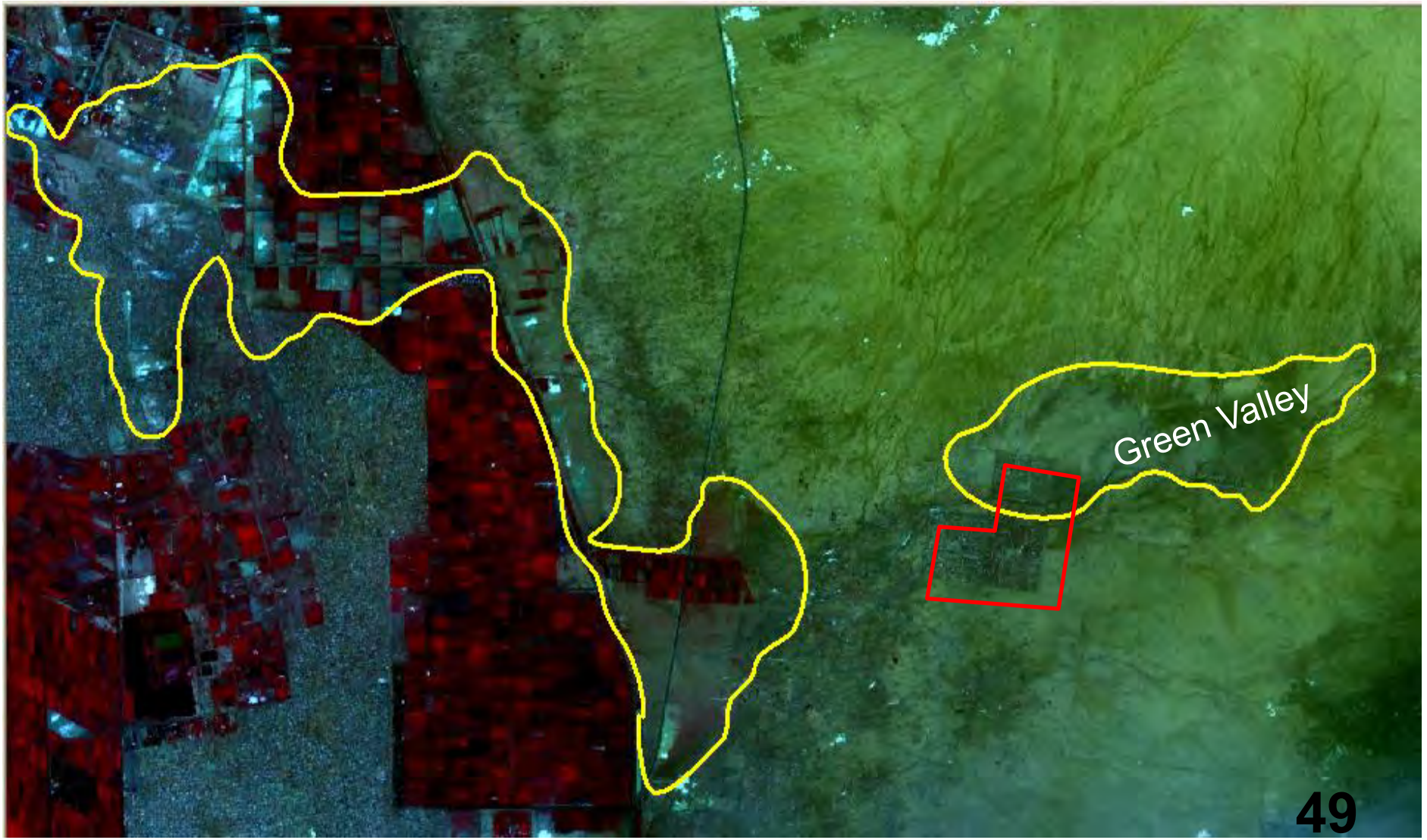


Areas affected by Soba Valley Floods

Formosat 8 August 2013

Agricultural scheme affected by flood

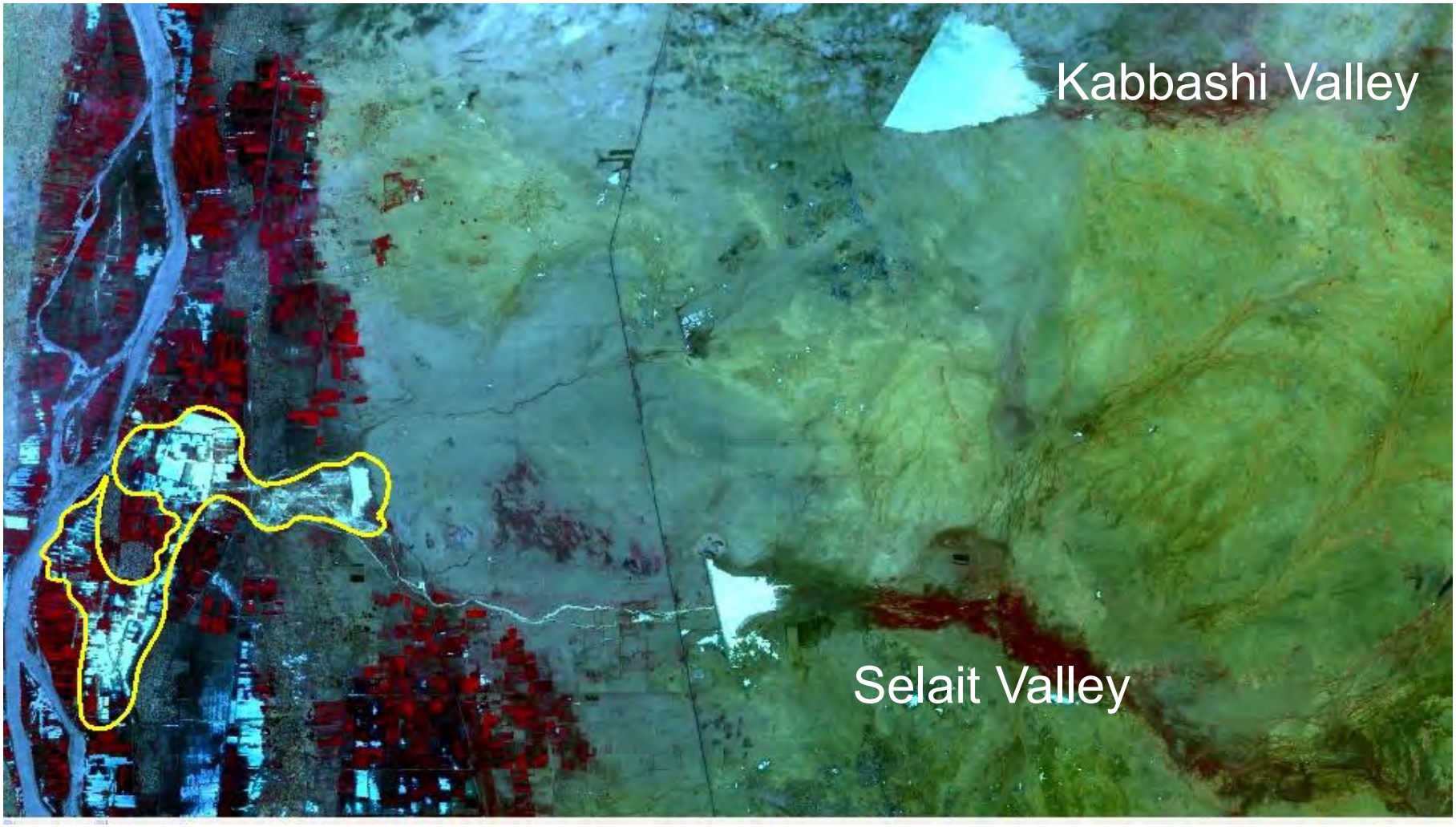
ASTER 13/8/2013



The influence of Dams on flood risk reduction

Dams have reduced the flood impact by retaining a large part of water

ASTER 13/8/2013



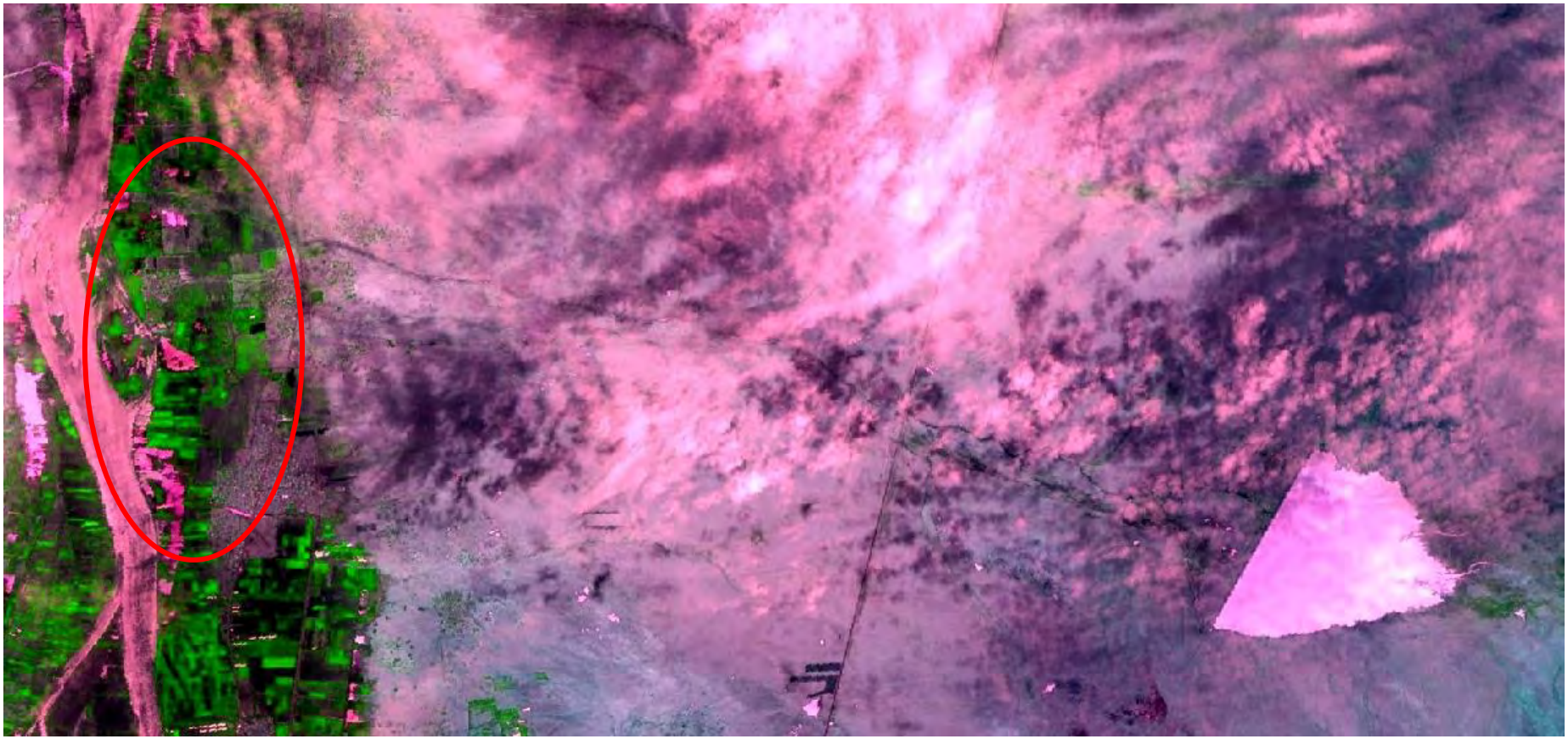
Selait Valley dam – Flooded Agric. Areas

Formosat 8 August 2013

Due to the surplus flood water, the part of water in excess of the dam's capacity has caused serious damages to the agric. schemes

Kabbashi Valley Dam

ASTER image, August, 13,2013



Capacity of Kabbashi Valley dam has been adequate to retain the flood water, hence there have been no damage. Construction of such dams on the other major valleys such as Soba Valley represents an effective solution.

Causes of damages

Factors that contribute to high flood risk, from Satellite images perspective

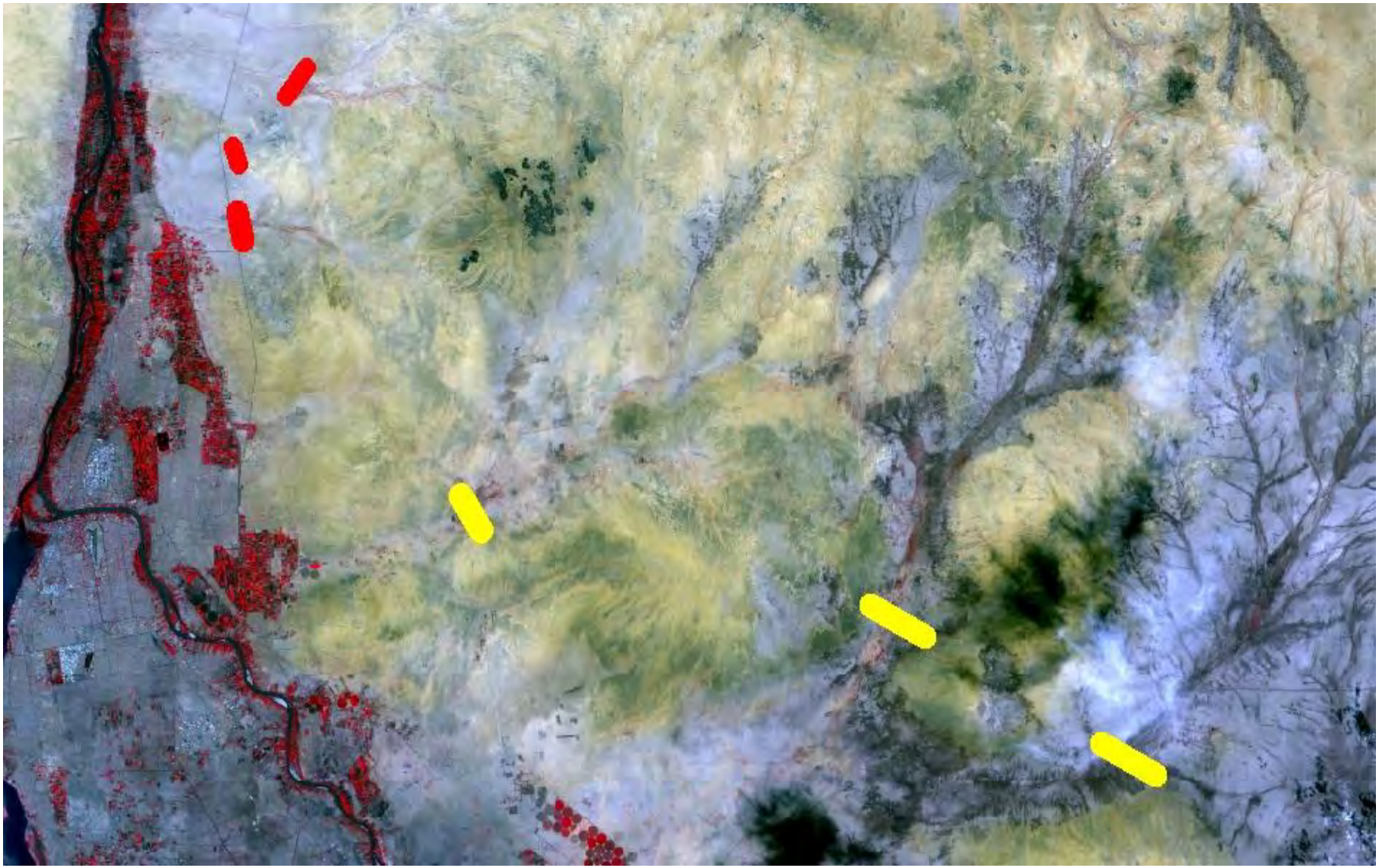
1- Topography, Drainage patterns (dendritic) that induce and accelerate flood;
2- Drainage system that ends up in deltas forming large flood prone areas where water flows in different directions in such low or gently sloping areas;
3- Lack of proper land use planning; 80% of the urban and agricultural schemes are within the flood-prone zone; and
4- Road construction intersecting valleys without proper drainage system.

Proposed Solutions From satellite Image perspective

Proposed solutions

1. Construction of Dams;
2. Construction of buildings and establishment of projects away from water courses;
3. Construction of proper drainage systems;
4. Development of satellite based geo-information services;
5. Building geodatabase for strategic planning and decision support.

Construction of Dams

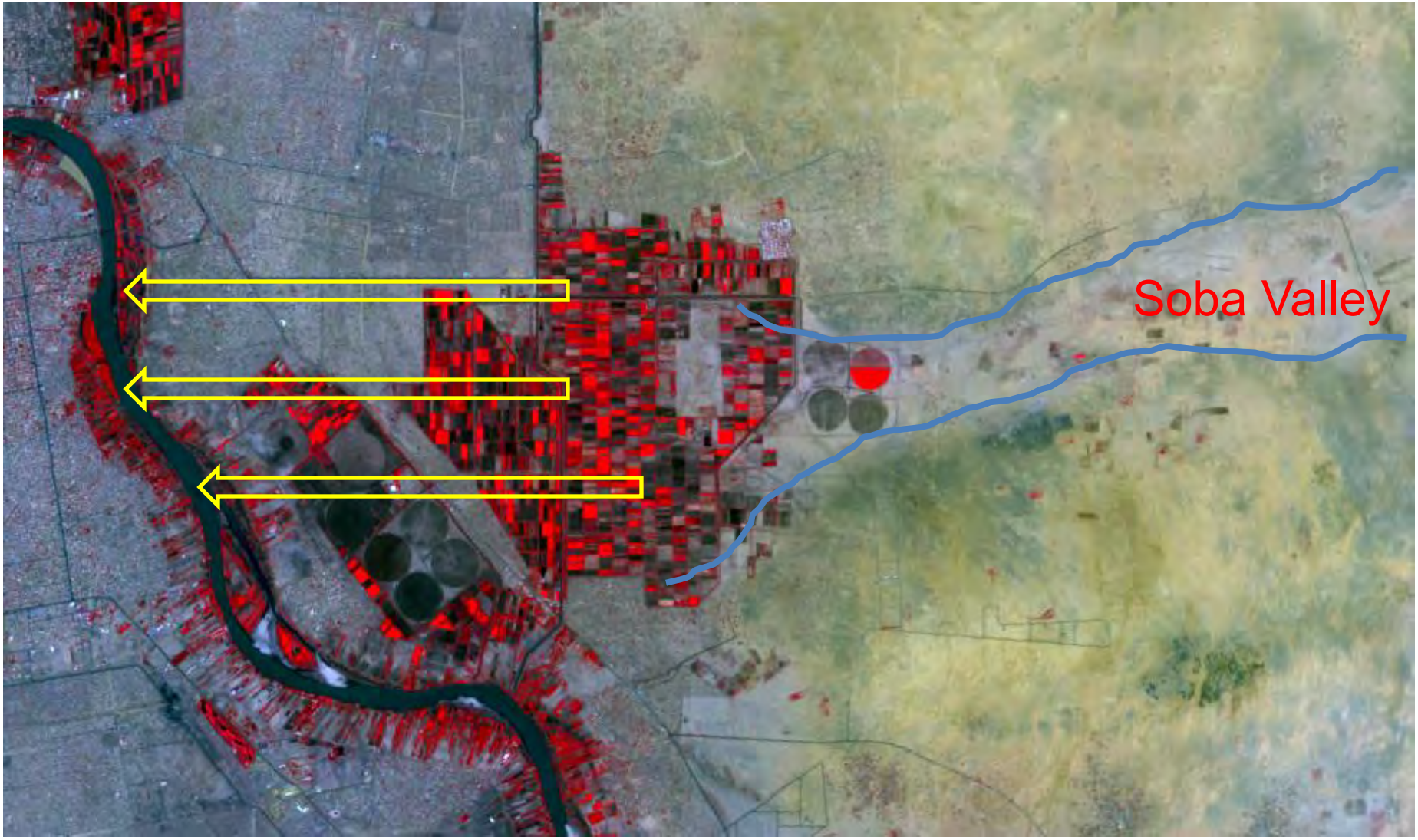


Construction of proper drainage system

Formosat 8 August 2013

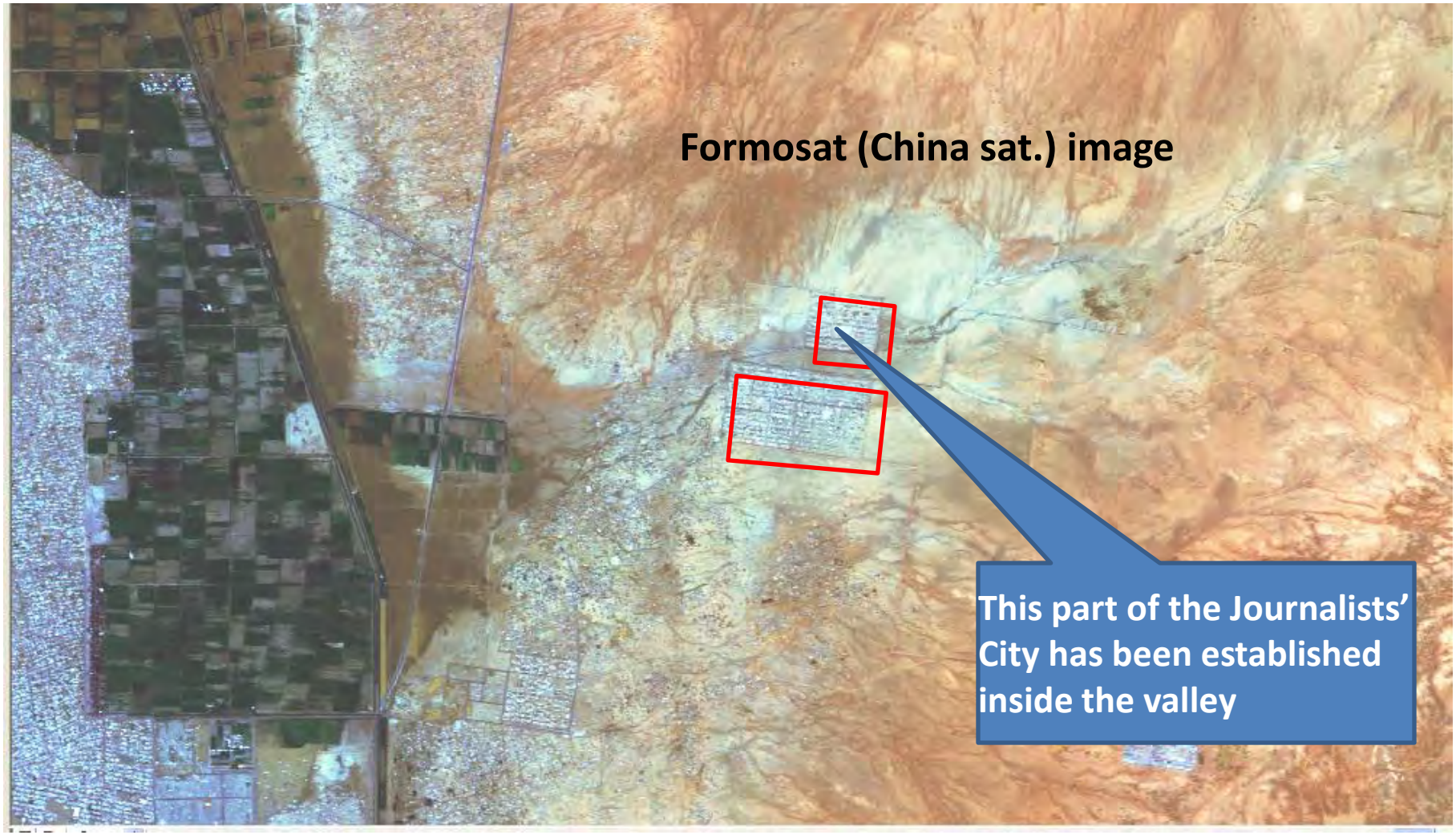
Due to the surplus flood water, the part of water in excess of the dam's capacity has caused serious damages to the agric. Schemes because of the lack of proper drainage system

Construction of adequate drainage systems



Construction of settlements away from the water courses
The Green Valley

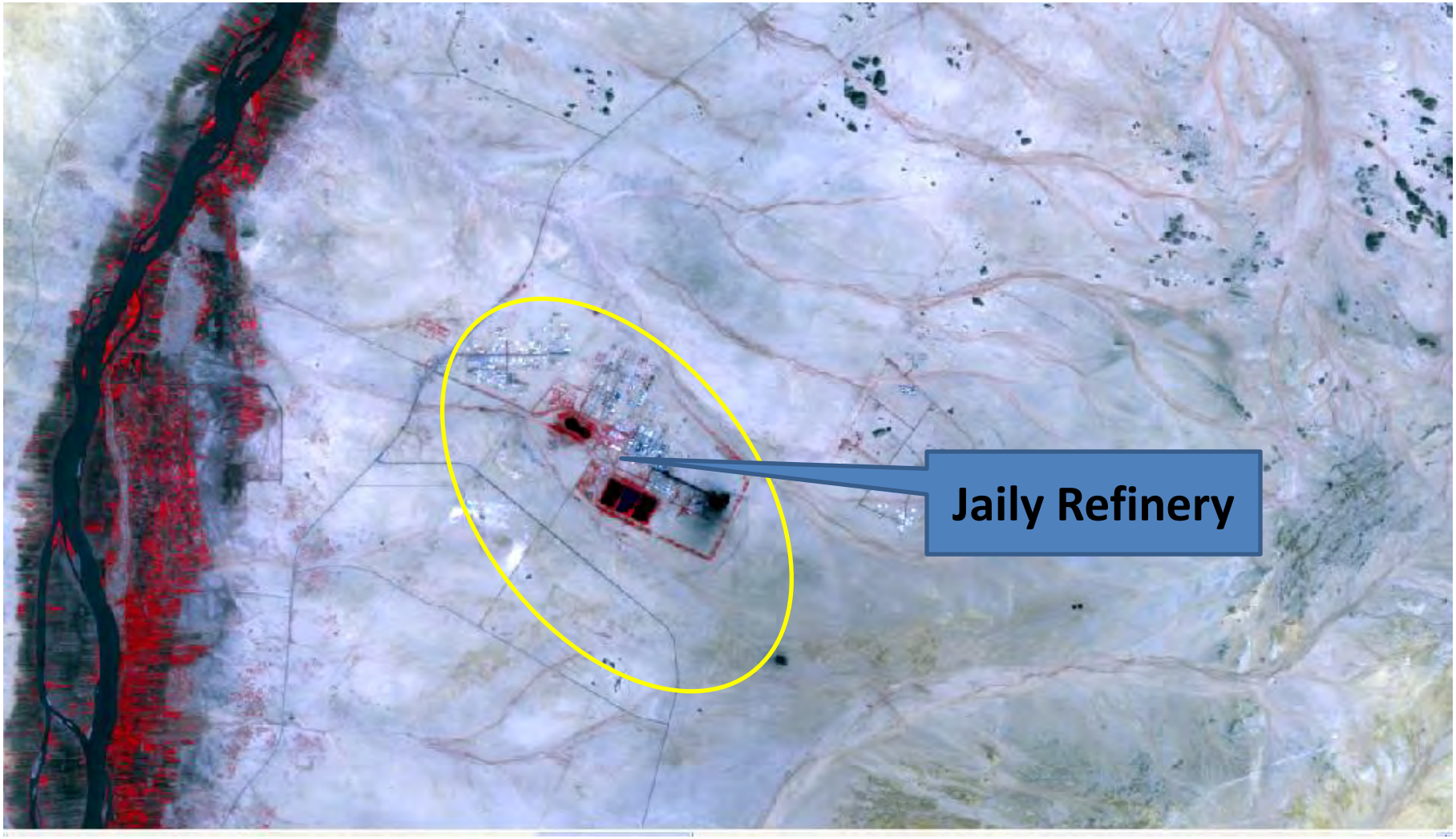
Dated: August, 8, 2013



The Green Valley has caused major damages of each of the Journalists', Idd Babiker Cities and some other agric. areas. As seen in the image, there is no dam across the valley, and some part of the Journalists' City has been established inside the Valley.

Example of Good Site Selection - avoiding building the structures inside the valleys

Landsat 2011



Avoiding the valleys and at the same time using them for drainage

Agric. projects should not be established inside the valleys

Selait project has represented a barrier for Soba Valley water course, a situation that led to the spread of water in many directions

Recommendations

- Enforce capacity building concerning the use of space based information in DRM through UN- SPIDER and other international support agencies.
- Ensure and support cooperation and information and data sharing.
- Ensure the availability and accessibility of remote sensing data and DEMs that provide rapid methods of mapping and monitoring flooded areas and predicting possible extensions on the flood.
- Delineate the flood plain or flood–prone areas in advance to flood event and consider them as risk areas.
- Prepare flood inundation maps to delineate the actual flooded areas.
- Produce flood damage assessment maps.
- Establish Disaster Risk Management database.