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

<table>
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<th>P.DAMAGE</th>
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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


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 regularly
Daily acquisition by MODIS
Maps of Khartoum floods based on Satellite Image interpretation through UN-SPIDER and International Support
Formosat 8m Flooding Extent - 9 Aug 2013

Legend:
- Settlements
- Nile
- Formosat_9Aug2013
- Hillshade of Khartoum_dem1.img

Value:
- High: 181
- Low: 0

Projection: WG 84
Datum: WGS84
MODIS 500 m
MODIS 250 m

MODIS 250 m Floods Extent - 5-12 Aug 2013

Map Extent

Legend

Value

High: 10
Low: 0

Shendi
Khartoum North
El Gusteya
El Hossain
Rushen

Projection WGS84
Datum WGS84

0 0.125 0.25 0.5 Km
Radarsat2 50m Floods Extent - 13 Aug 2013

Map Extent

Legend:
- Towns
- Nile
- FLOODS_20130813_Flood
- Hillshade of Khartoum
- Datum: WGS84
- Projection: WGS84

Value:
- High
- Low

Scale: 0.125 - 0.25 - 0.5 km
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

- Soba Valley
- Hseeb Valley
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)
No distinct drainage course ends up at the Nile. Water flows freely in different directions along the Flood Prone Area.
2- Flood – prone areas
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.
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

Journalists town
South eastern part of the Eastern Soba area

ASTER 13/8/2013
B- Agricultural Schemes
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

Green Valley
The influence of Dams on flood risk reduction
Dams have reduced the flood impact by retaining a large part of water.
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.
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
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
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.