Flooding in the State of Khartoum, Sudan

GIS For Appropriate Flood Risk Planning Towards a Sustainable Economic Development.

Case study of Khartoum State, Sudan

ALMOJTABA M.H.HASSABO

Who am I
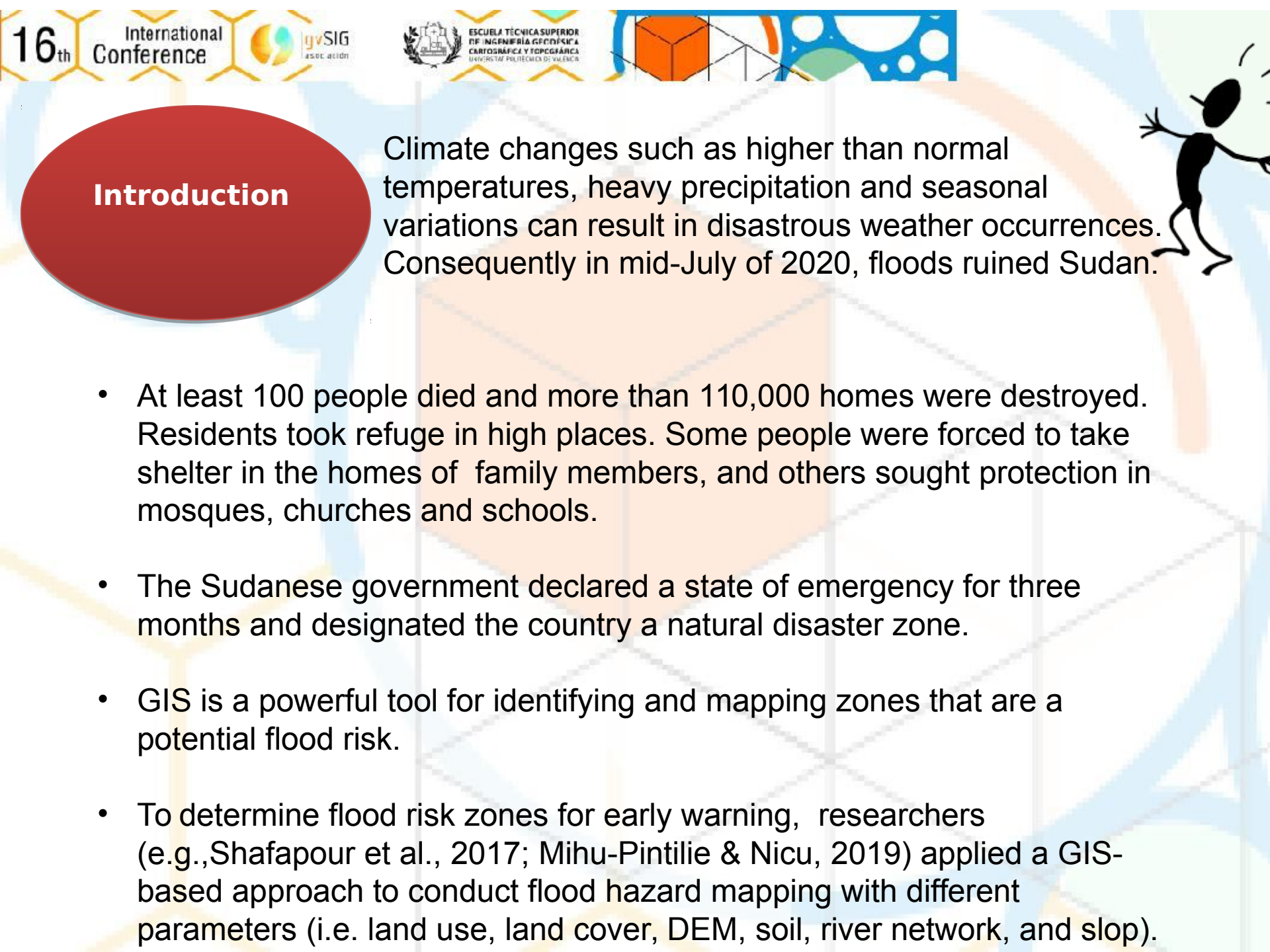
Almojtaba M.H.Hassabo

I am an GIS economic development planner.

I am interested in the following aspects of this project:

GIS for Livelihoods
GIS for Business Intelligence
GIS for Economic Development
GIS for Development Planning
GIS for Risk Management

shorbji12@gmail.com

Introduction

Climate changes such as higher than normal temperatures, heavy precipitation and seasonal variations can result in disastrous weather occurrences. Consequently in mid-July of 2020, floods ruined Sudan.

- At least 100 people died and more than 110,000 homes were destroyed. Residents took refuge in high places. Some people were forced to take shelter in the homes of family members, and others sought protection in mosques, churches and schools.

- The Sudanese government declared a state of emergency for three months and designated the country a natural disaster zone.

- GIS is a powerful tool for identifying and mapping zones that are a potential flood risk.

- To determine flood risk zones for early warning, researchers (e.g.,Shafapour et al., 2017; Mihu-Pintilie & Nicu, 2019) applied a GIS-based approach to conduct flood hazard mapping with different parameters (i.e. land use, land cover, DEM, soil, river network, and slop).
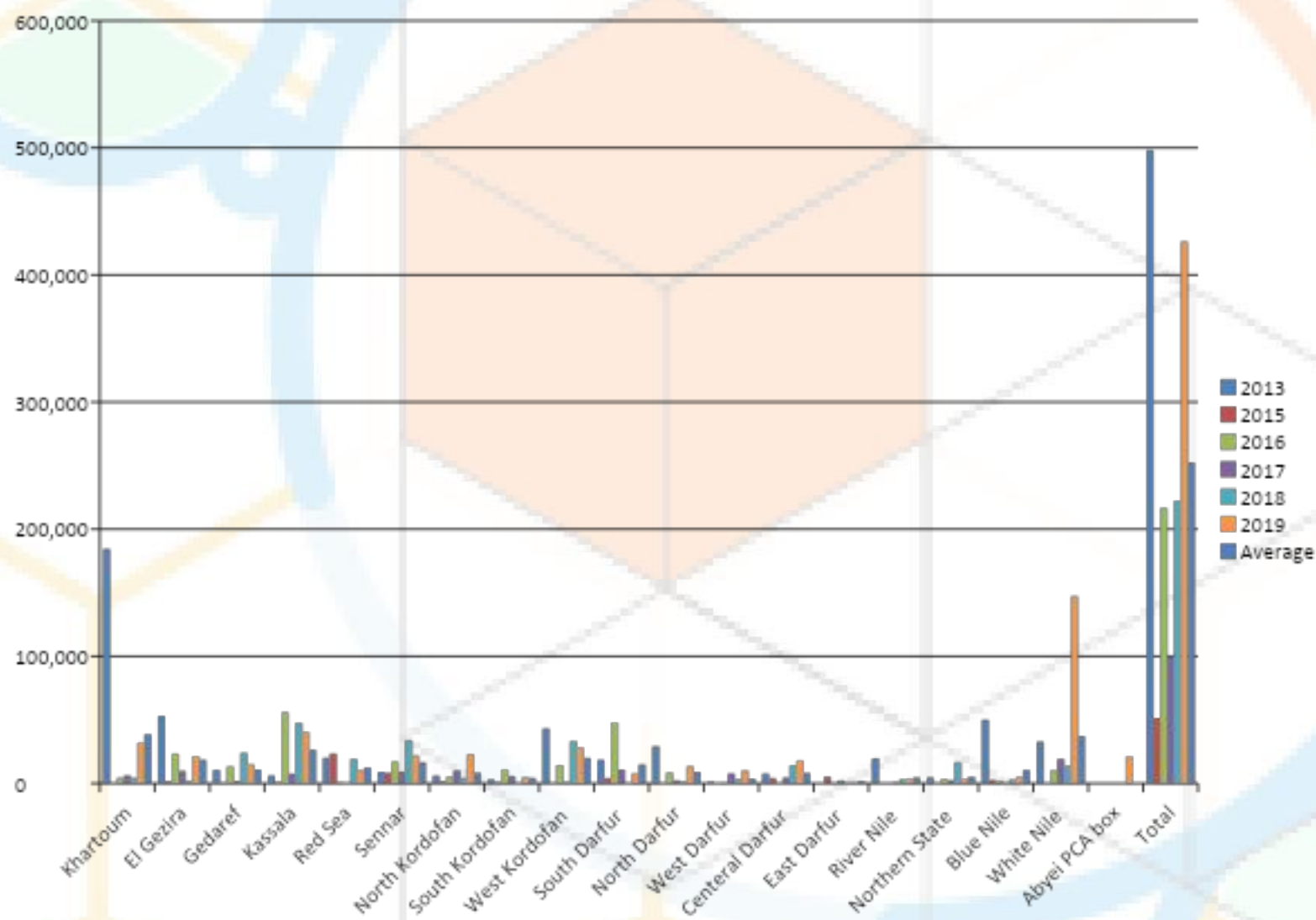
Sudan

In

Crisis

2020

Damages and losses \ Sudan flood\ October 2020 \Source Humanitarian Aid Commission (HAC)

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
		Location	Houses		Affected people			Public Utilities							
	State	Locality/Village	Completely Destroyed	Partially damage	# of HHs	# of people	Deaths	Infrastrucure	Edu.	Health	Agric	Animals	Latrins	Water	Others
Khartoum		E. Nile	950	2734	3684	18420	3						720		
		Jebl Awlia	3000	2000	5000	25000									
		Karari	76	9	85	425									
		Omdurman	5000	3000	8000	40000									
		Ombada	184	198	382	1910									
		Khartoum	360	4	364	1820									
		Bahri	2800	200	3000	15000	1								
Total			12370	8145	20515	102575	4	0	0	0	0	0		0	0
Blue Nile		Bout	310	1190	1500	7500		1 dam	1			156	218		14 generate + 8 Pumps
		Bau/Wad Abook	215	757	972	4860									1generate
		Al-Rosiris	4057	3576	7633	38165									
		Damazin	1809	2201	4010	20050									
		Gissan	33	1262	1295	6475									
		Wad Almahi	93	1822	1915	9575									
Total			6517	10808	17325	86625		0	1	0	0	250		0	0
West Kordofan		Alfula	118	192	310	1550	1						612		
		Abyie	150	850	1000	5000									
		Alnuhud	479	627	1106	5530	2			1		47	111		66
		Gebeish	1034	178	1212	6060	1					26	98		
		Abo Zabad	281	1032	1313	6565			6			9	215		
		Wad Banda	440	390	830	4150				1		30	590		27
		AlUdyyia	218	492	710	3550							12		2
		Alsunuot	448	227	675	3375			1	1			29		2
Total			3168	3988	7156	35780		0	7	3	0	150	1667	0	97
River Nile		Addamer	708	53	761	3805					707		558		5
		Abu hamad	551	445	996	4980	3	bridge					2430		5
		Almatmma	64	75	139	695							450		
		Shendi	10	55	65	325	3						1010		
		Atbara	366	0	366	1830							358		

Damages and losses \ Sudan flood\ October 2020 \Source Humanitarian Aid Commission (HAC)

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
	Barbar	1001	408	1409	7045	2		5				406		shops
Total		2700	1036	3736	18680		0	5	0	707	47	5212	0	10
Kassala	Telkok	1475	400	1875	9375						150			500 sack of sorghum
	Hamashkorib	809		809	4045									
	N. AlDalta	725	615	1340	6700						350	350		
	Wad Alhilew	199	339	538	2690						5	34		
	Rifi Kassal	175	1082	1257	6285									
	Rifi Aroma	908	1034	1942	9710			11	1	1	150	71		11 stores
Total		4291	3470	7761	38805		0	11	1	1	1521	6273	0	0
Red Sea	Haya	667	221	888	4440	2		6						2 mousques
	Dordeib	39	109	148	740						14			90
	Agig	0	271	271	1355				641				5 wells	50 shops
	Gebeit	16	42	58	290			2						
	Tokar	1360	7415	8775	43875	2		8	1479		93		6 wells	75
Total		2082	8058	10140	50700		0	16	2120	0	162		0	165
Al Gezira	AlManagil	1026	149	1175	5875	4		8		1950		91		2 mousques
	AlGurashi	1723	530	2253	11265	3		5		1050		82		
	S. Algazira	304	980	1284	6420							35		
	E. Algezira	430	675	1105	5525									
	Greater Mdani	675	87	762	3810									
	Um Algura	96	374	470	2350									
	Alhasahisa	1551	889	2440	12200							10		
	Alkamlin	2121	653	2774	13870							504		
Total		7926	4337	12263	61315		0	13	0	3000	60	1057	0	0
Northern	Adabba	541	713	1254	6270	1						28		
	Halfa, ngola, dalgo, Alborgig	550	708	1258	6290	0								
					0									
Total		1091	1421	2512	12560	1	0	0	0	0	0	555	0	0
S. Darfur	Nayala	24	260	284	1420						9			
	Dreig	0	65	65	325									
	Otash	0	3000	3000	15000	2		2 classes						
	Musa	0	138	138	690									

Damages and losses \ Sudan flood\ October 2020 \Source Humanitarian Aid Commission (HAC)

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Total		24	3463	3487	17435			0	0	0	0	60	346	0	0
White Nile	AlDwim	45	122	167	835										
	Rabak	49	67	116	580							29		1	
	Kosti	638	543	1181	5905										
	Guli	1194	777	1971	9855							54			
	Tendalti	947	190	1137	5685										
	AsSalam	2254	0	2254	11270										
	Um Rimta	40	34	74	370							83			
	Aljabalin	326	340	666	3330				1						
	AlGetina	95	0	95	475				3					3	
Total		5588	2073	7661	38305			0	4	0	0	347	772	4	0
S. Kod	Abkrshola	425	215	640	3200										
				0	0										
total		425	215	640	3200	17		0	0	0	0	17	62	0	0
N. Darfur	AlFasher	1908	3704	5612	28060							740	3		
	Kakabyia	7141	7088	14229	71145	15							7013		
	Kutum	618	2382	3000	15000										
	Al-Kuma	550	1250	1800	9000										
	Alleit	4	342	346	1730										
Total		10221	14766	24987	124935			0	0	0	0	887	7016	0	0
E. Darfu	AlDean	208	950	1158	5790										
	AlFardos	650	3903	4553	22765										
Total		858	4853	5711	28555	0		0	0	0	0	0	450	0	0
Sinnar	Sinnar	702	941	1643	8215	1			2				485		
	E. Sinnar	537	498	1035	5175								277		
	AlSuki	946	339	1285	6425	2							243		
	AlDali	994	732	1726	8630								474		
	Singa	4708	177	4885	24425								115		
	Abu Hgar	2445		2445	12225								1516		
Total		10332	2687	13019	65095			0	2	0	0	32	3110		0
	AlGurriesha	695	2354	3049	15245				7			91			34
	W. Gallabat	241	136	377	1885	1			7					bridge	
ef	AlRahad	55	78	133	665										

Damages and losses \ Sudan flood\ October 2020 \Source Humanitarian Aid Commission (HAC)

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Gedaref	AlRahad	55	78	133	665									
	AlFashaga	1204	1182	2386	11930					2684 feddan				bridge
	E. Gallabt	96	75	171	855									
	AlFau	0	398	398	1990									3 shops
	Baladiat Algadare	5	0	5	25									bridge
	Gala Alnahal	15	238	253	1265	3		9			431			
Total		2311	4461	6772	33860	7	0	23	0	0	522	900	0	34
N. Kordofan	Um Dam	600	2700	3300	16500									
	W. Bara	0	242	242	1210									
	Um Rwaba	273	867	1140	5700			17	1	4000				
	Sheikan	0	29	29	145									
Total		873	3838	4711	23555				1	4000	2382	751	0	34
W. Darfur	Forbranga	230	38	268	1340									
	Krenik	2282	4386	6668	33340									
	Al Geneina	3147	3671	6818	34090									
Total		5659	8095	13754	68770							22		
Central Darfur	Zalingi	978	913	1891	9455									
	Rokoro	37	5	42	210									
	Mukjar	24	30	54	270									
	Nertiti	19	4	23	115									
	Azoum	43	231	274	1370									
	Bendesi	76	53	129	645									
	Um- Dukhun	96	25	121	605									
	Garsila	997	493	1490	7450									
Total		2270	1754	4024	20120							49		
Abyei	southern circle	223	1515	1738	8690									
	Al-Mousil	246	1375	1621	8105									
	UM-ElKhair	123	877	1000	5000									
	Al-Radaya	52	785	837	4185									
	Gouli	92	561	653	3265									
total		736	5113	5849	29245	0	0	0	0	0	0	0	0	0
G. Total		79442	92581	172023	860115	29	0	82	2125	7708	6437	28242	4	340

floods-affected-people_sudan_2013-to-2019 \Source Humanitarian Data Exchange

Khartoum State Damages

Due to the geographical conditions, climate change, heavy rainfall and high temperatures, flooding has increased in the Khartoum area of Sudan.

Damages and losses \ Khartoum flood\ October 2020

Floods- affected-people_Khartoum_2013-to-2019
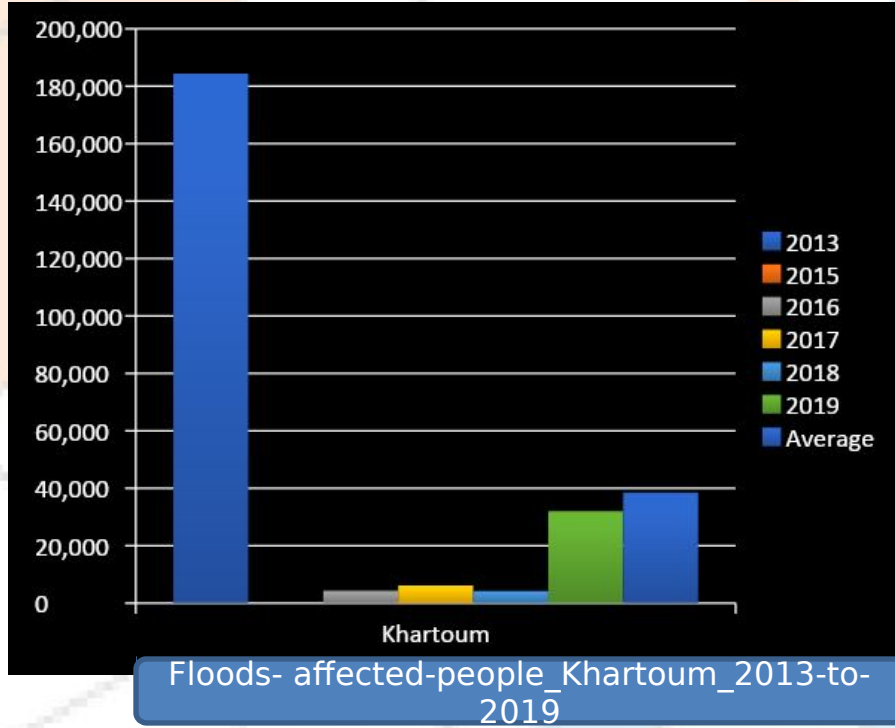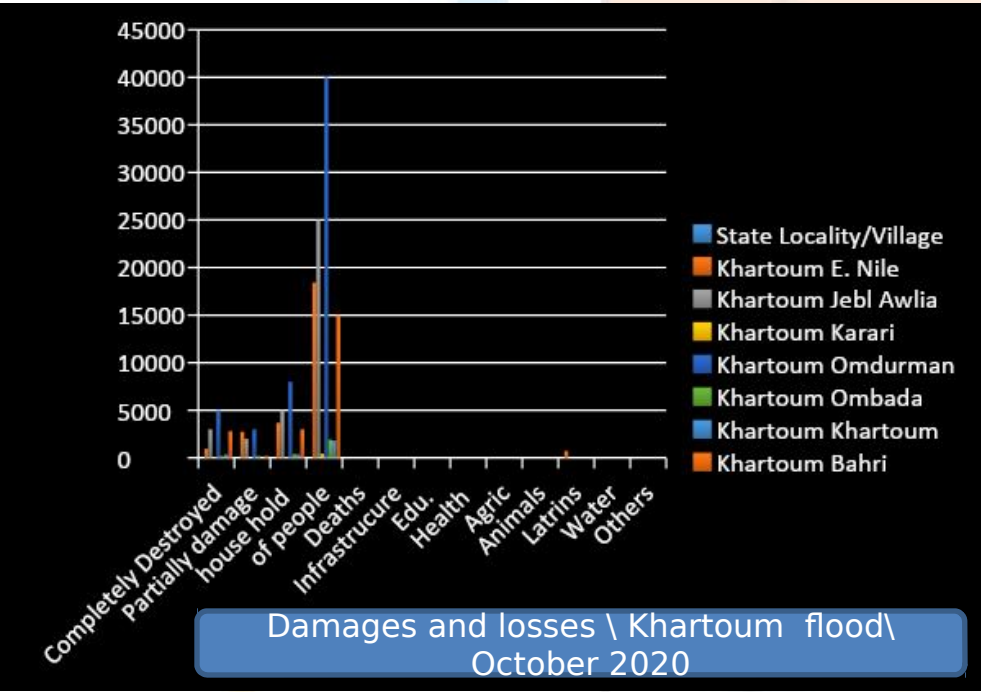
	Completely Destroyed	Partially damage	Affected house hold	Affected people	Death
Tottal	12370	8145	20515	102575	4

In what direction does the Nile flow?

The Nile is the only major river that flows from south to north - crossing through five distinct climate zones.

NILE RIVER FLOW

N

The Nile Profile

EGYPT

SUDAN

ERITREA

SOUTH SUDAN

ETHIOPIA

DRC

UGANDA

KENYA

RWANDA

BURUNDI

TANZANIA

Nile
Length: ~6,695km
Flow rate: ~2,700 m³/s

Blue Nile
Length: ~1,450km
Flow: ~85% of river

White Nile
Length: ~3,700km
Flow: ~15% of river

~100ℓ

Water from the Nile can fill **~27,000 bath tubs** every second

5,566km

NYC

LND

The Nile is longer than the **distance between London and New York**

The Nile Profile

Lake Tana is Ethiopia's largest lake, and it is the main reservoir of the Bule Nile, providing over 80% of the river's water.

How is the Nile formed?
Lake Tana, the main reservoir of the Blue Nile, is fed from seven large permanent rivers and about 40 small seasonal rivers.

66km

84km

Lake Tana

Ethiopian Highlands

Blue Nile

@AJLabs ALJAZEERA

The Nile Profile

SUDAN
Where the two rivers meet

ETHIOPIA
The source of the Blue Nile
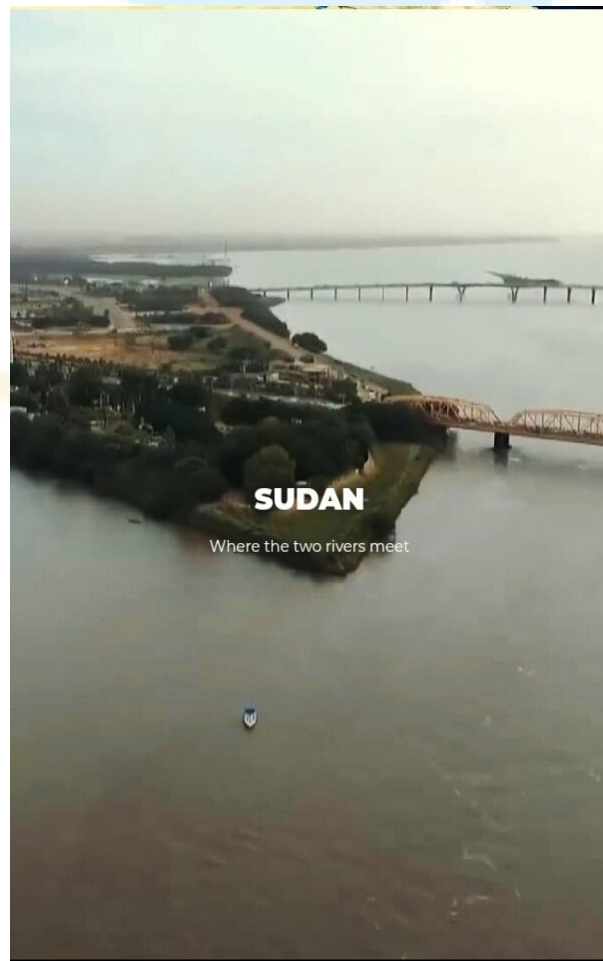
How many people live along the Nile?

The Nile Basin is shared by 280 million people across 11 countries.

The Nile Profile

NILE RIVER FLOW

N

S

EGYPT

SUDAN

DRC

	Population (million)	Living in Basin (million)
Egypt	98	94
anda	43	43
	105	42
		35
		20
		13
		12
		10
2	11	6
	81	3
a	5	2

Proportion of p living in the Nile B
Values rounded up
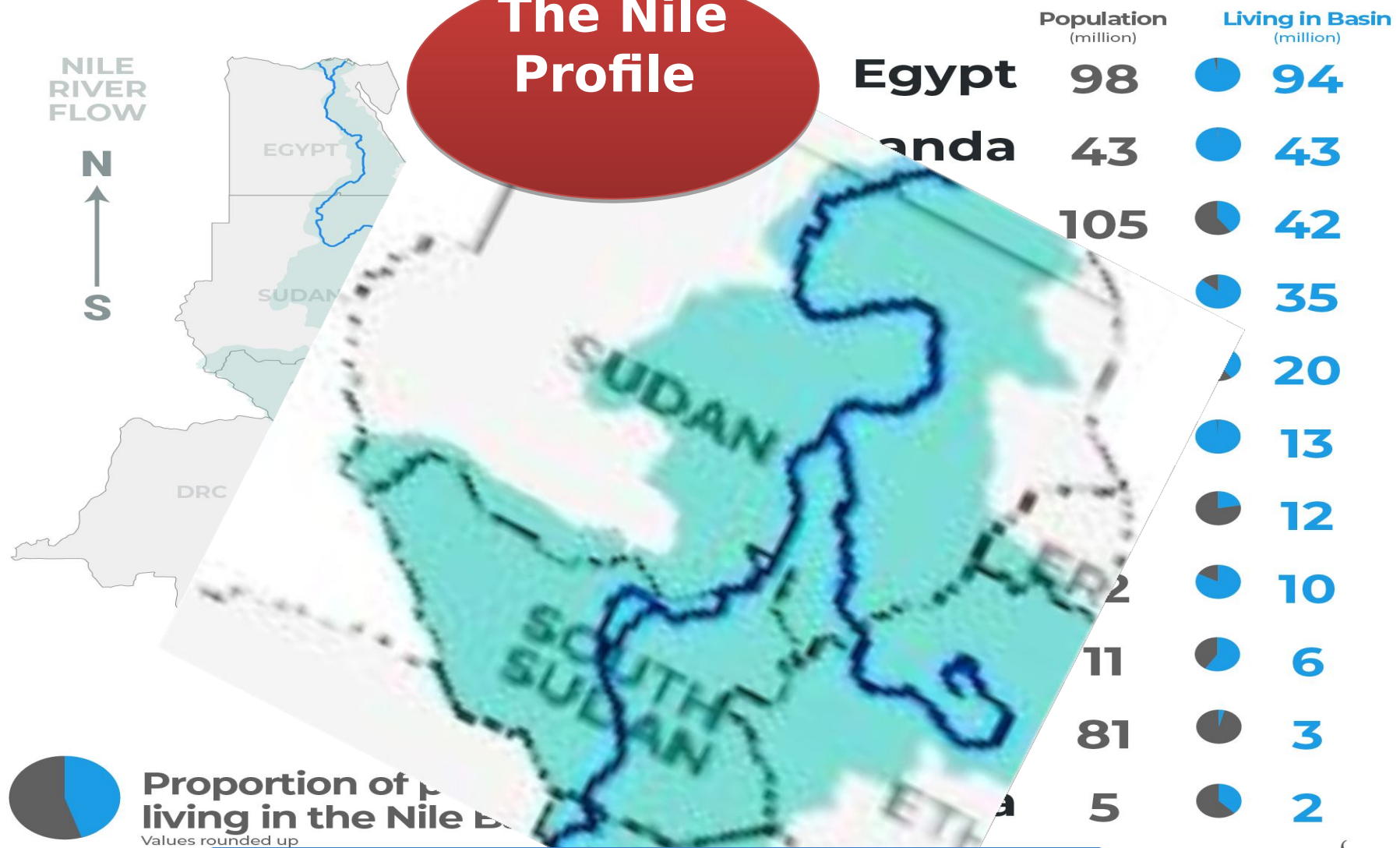
The population of Sudan is 41 million
(35 million living in Nile Basin).

@AJLabs ALJAZEERA

Temperature Changes in Sudan

Climate changes are the result of high temperature, precipitation, heavy rain and seasonal variations; therefore, these changes are responsible for flood occurrence.
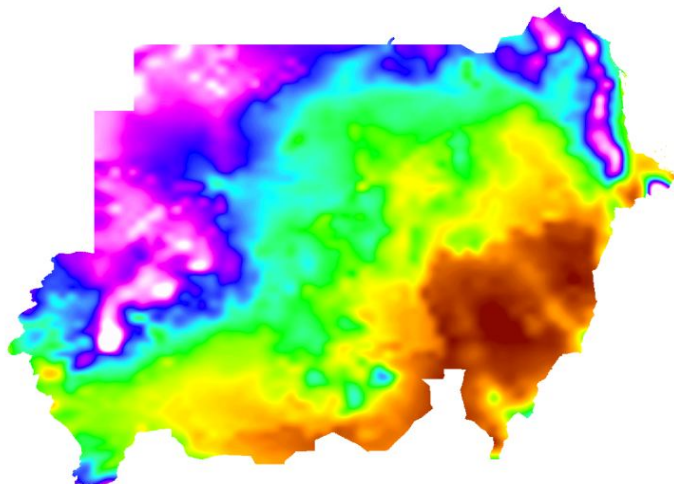
Temp_2005_Annual_Average

Value

High : 28.3202

Low : 17.8124
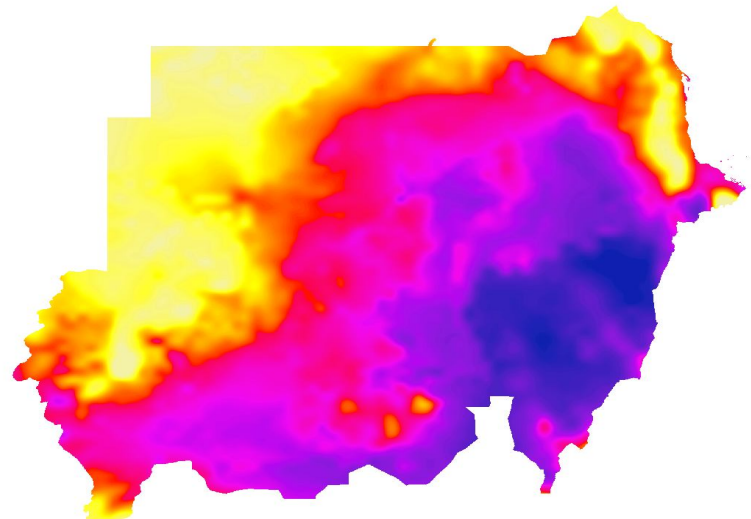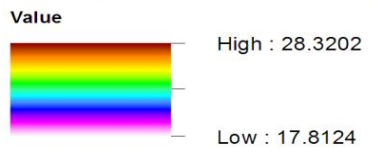
Temp_2050_Annual_Average

Value

High : 30.9671

Low : 20.4647
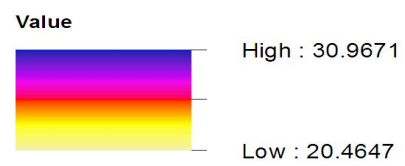
Temperature Changes in Sudan
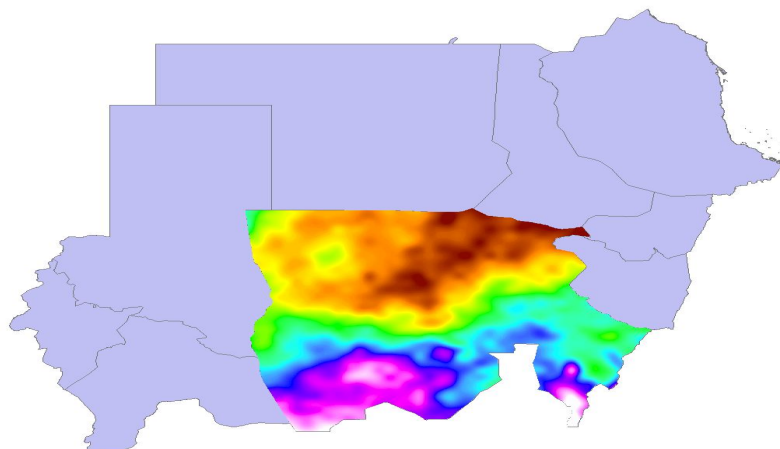
Temp_2005_2050_Diff

Value

High : 3.15045

Low : 1.52767

Sudan_Admin_2

Change in Precipitation in Sudan

Pr_2005_Total

Value

High : 3566.5

Low : 0

Pr_2050_Total

Value

High : 2412.17

Low : 1.26056
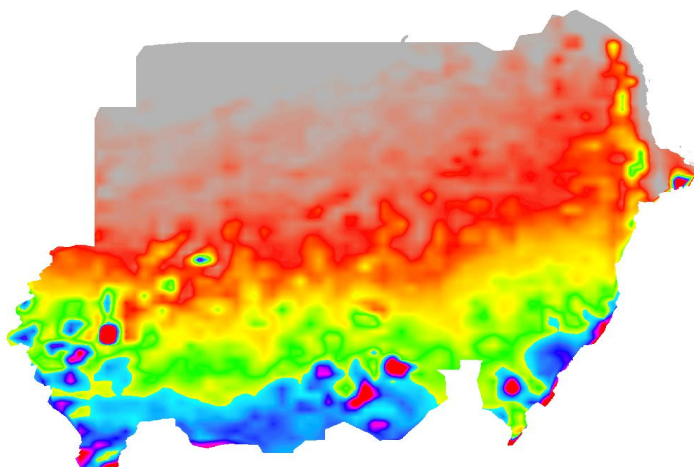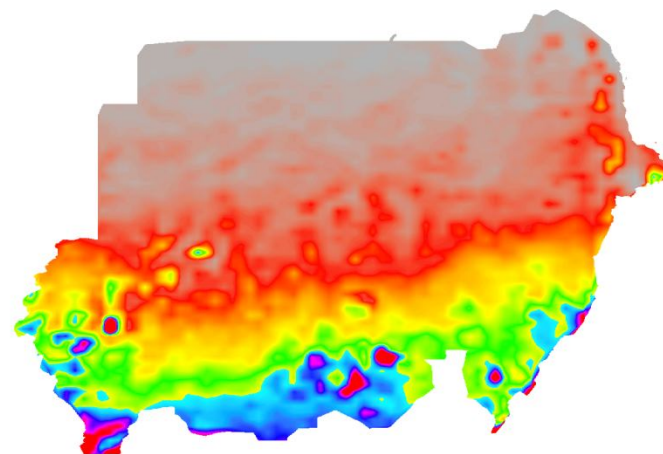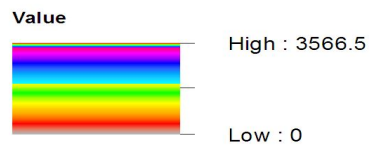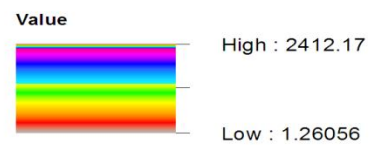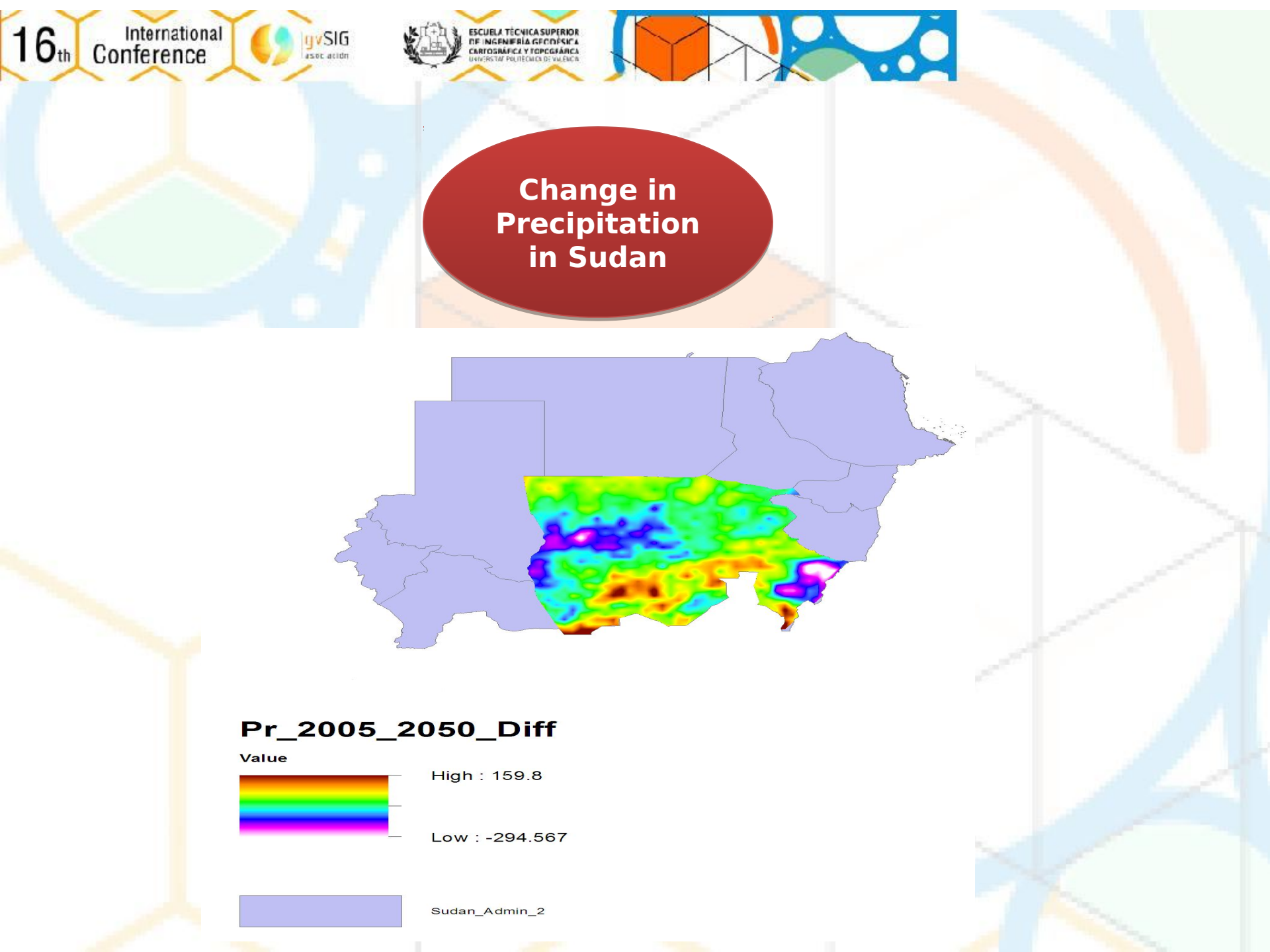
Change in Precipitation in Sudan
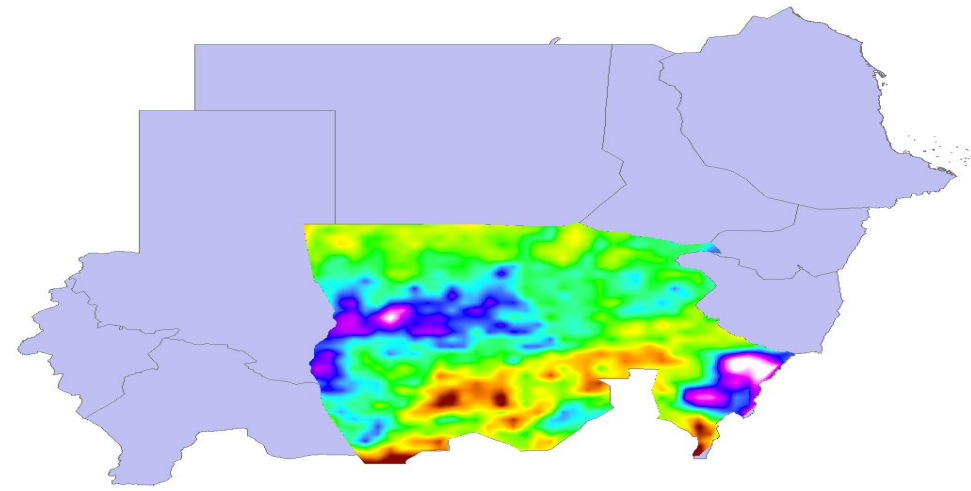
Pr_2005_2050_Diff

Value
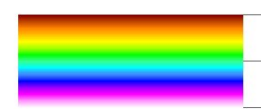
High : 159.8

Low : -294.567

Sudan_Admin_2

The Change in Relative Humidity in Sudan

RH_Mar_2005

Value

High : 72.9335

Low : 6.54216

RH_Mar_2050

Value

High : 83.6549

Low : 7.48223
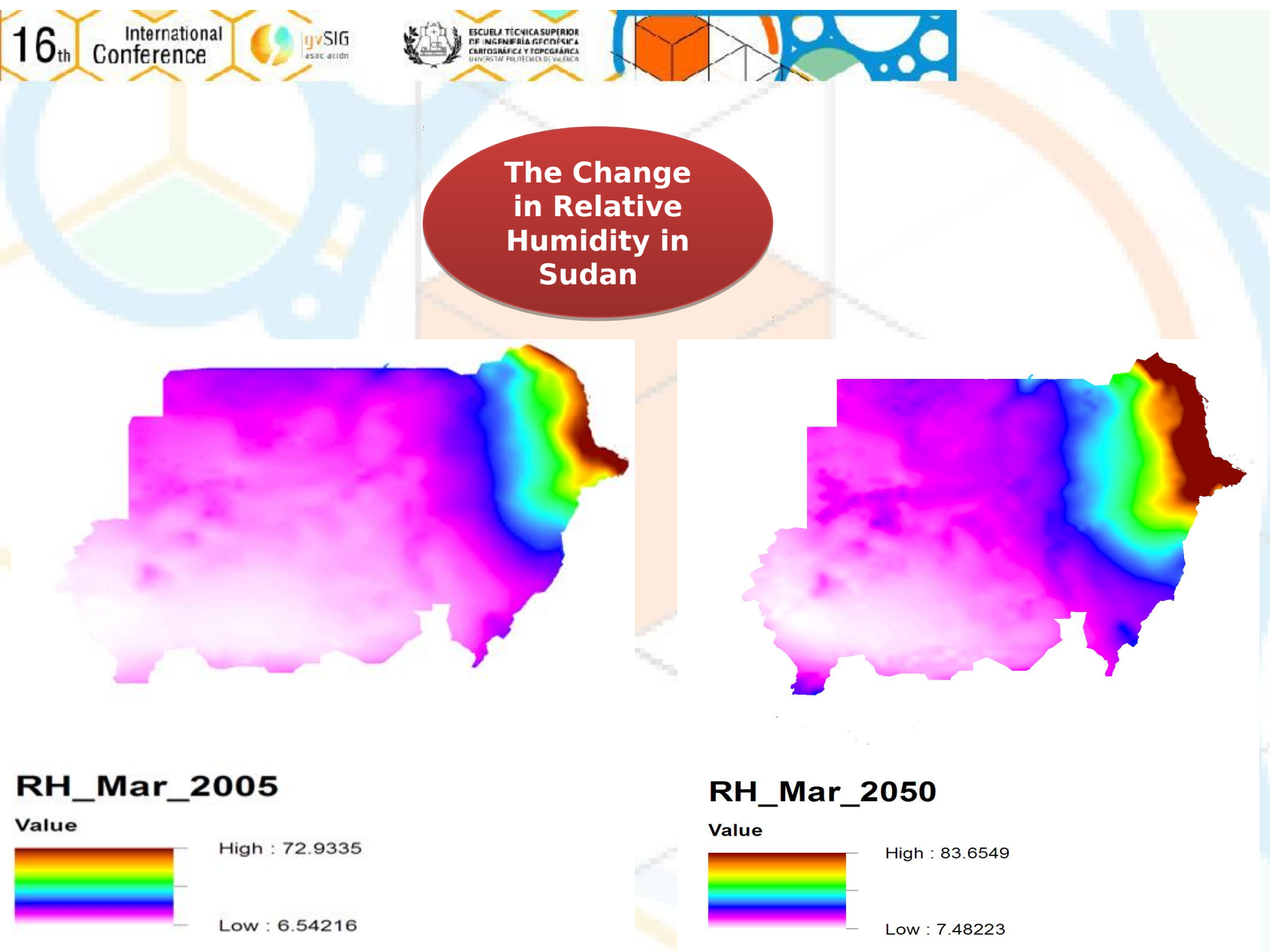
The Change in Relative Humidity in Sudan
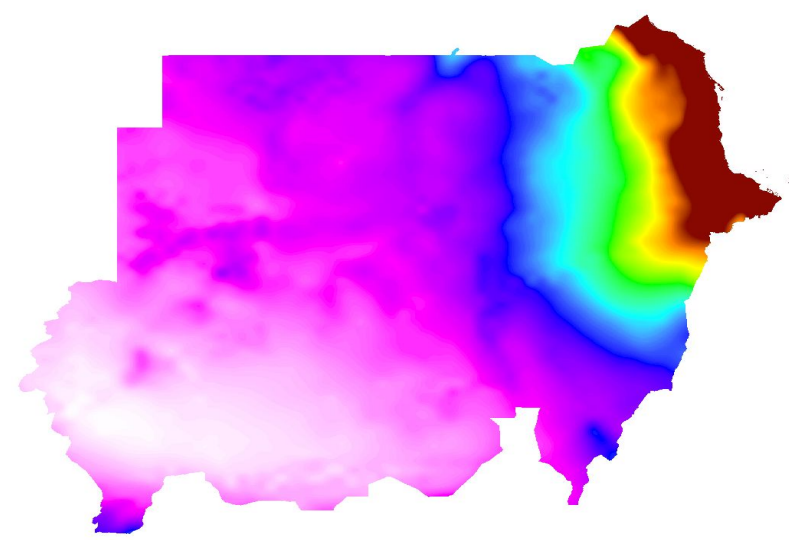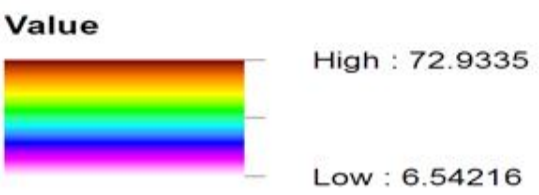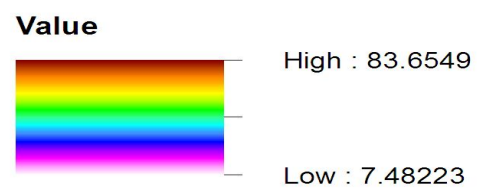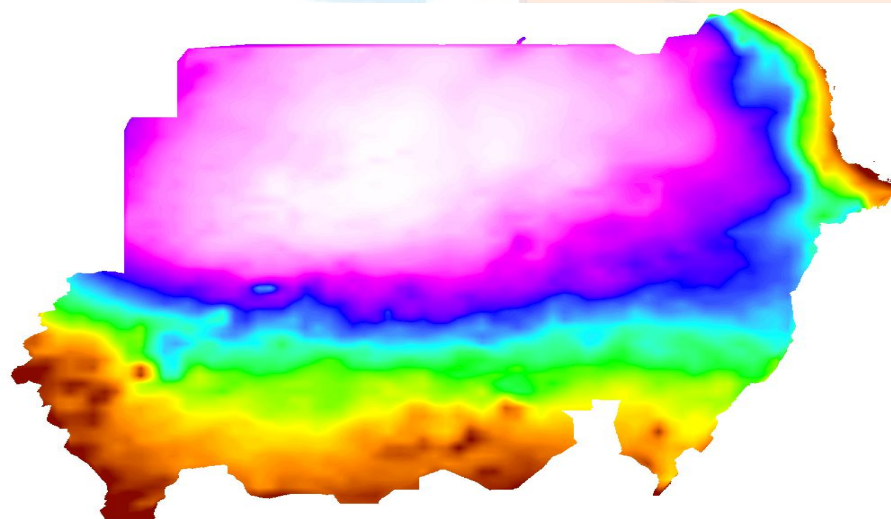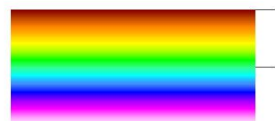
RH_May_2005

Value

High : 76.9409

Low : 10.9622
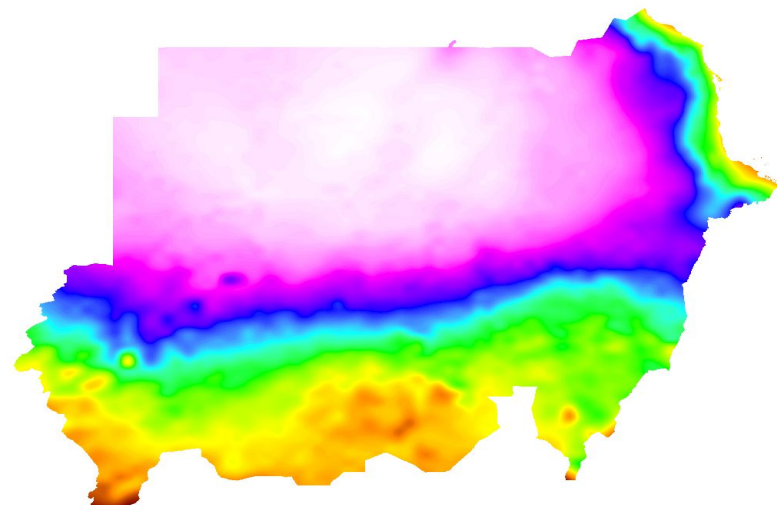
RH_May_2050

Value
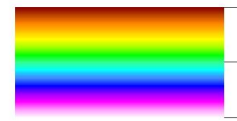
High : 86.2962

Low : 10.2462

The Change in Relative Humidity in Sudan
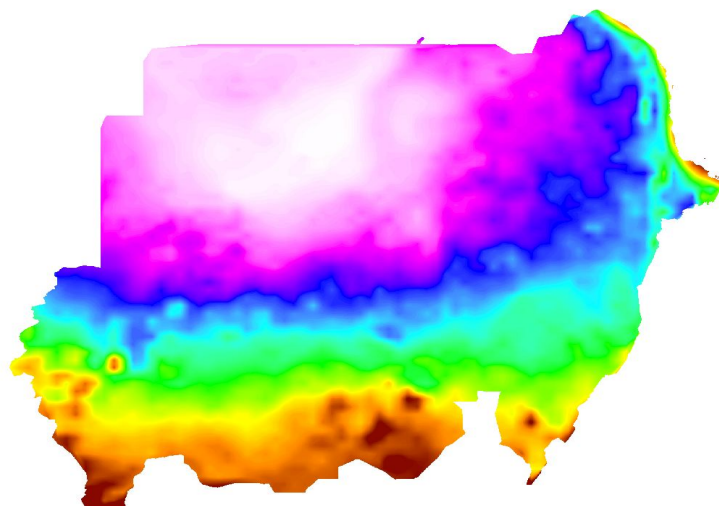
RH_Jun_2005

Value
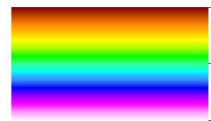
High : 74.7709

Low : 9.22253
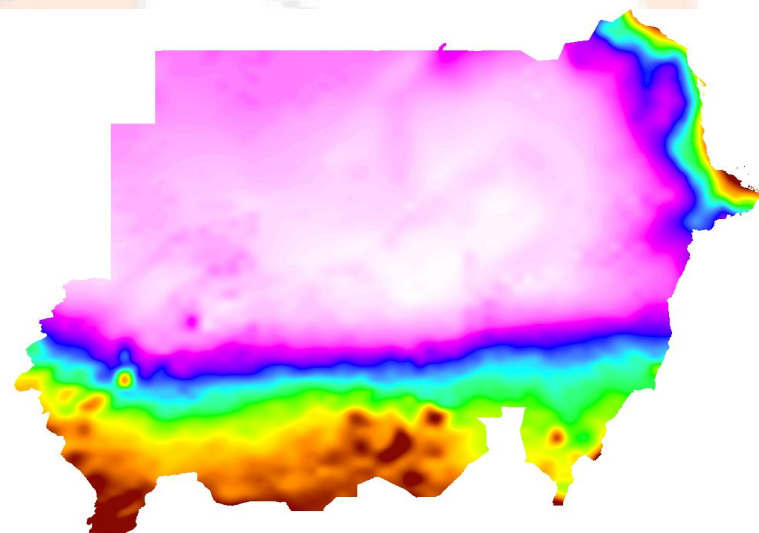
RH_Jun_2050

Value
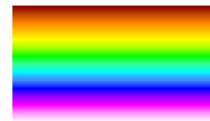
High : 86.5988

Low : 8.67787

The Change in Relative Humidity in Sudan
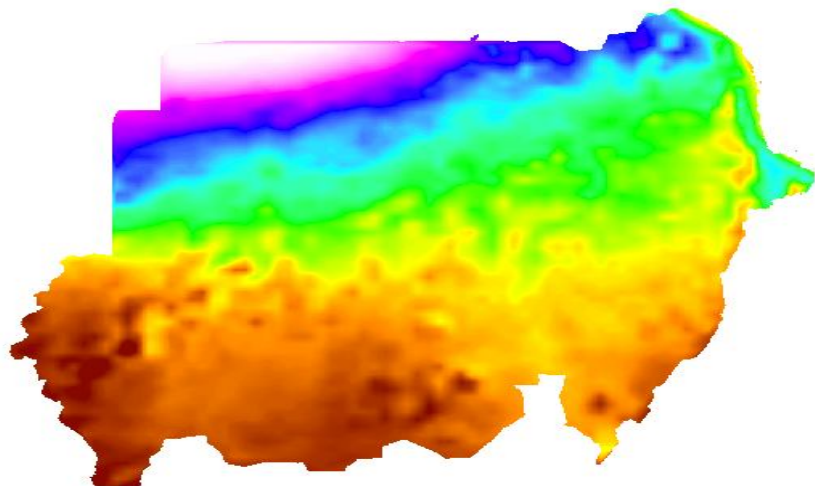
RH_Aug_2005

Value

High : 89.1351

Low : 12.4784
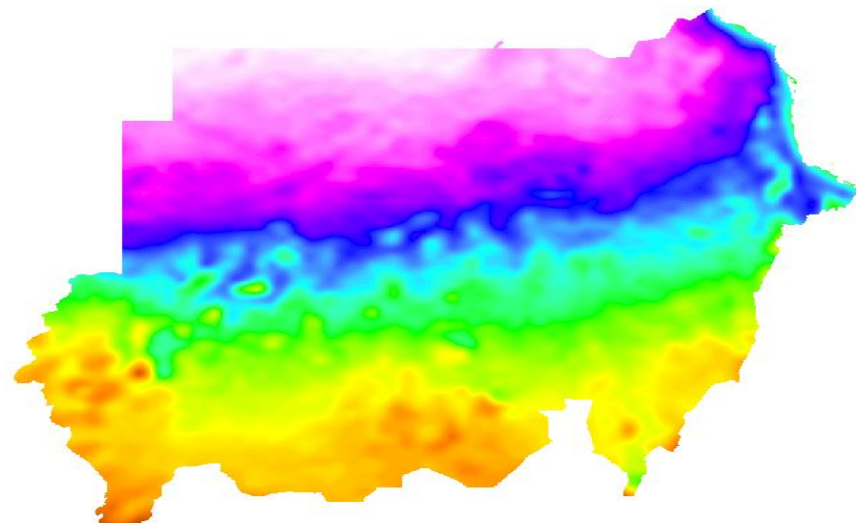
RH_Aug_2050

Value

High : 96.1045

Low : 17.4424

The Increase in the Water Level of the Blue Nile

17 M

17.43 M

1988

2020
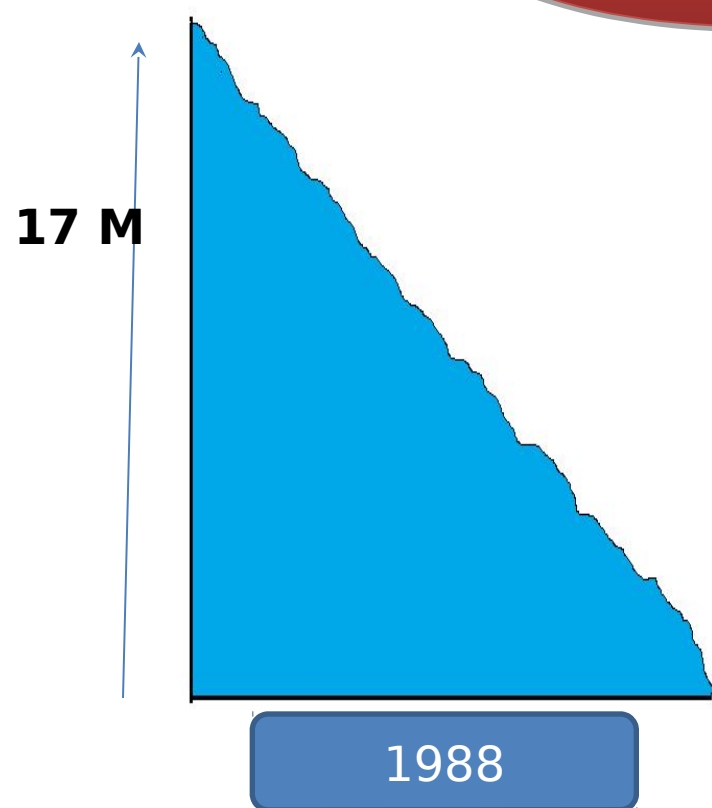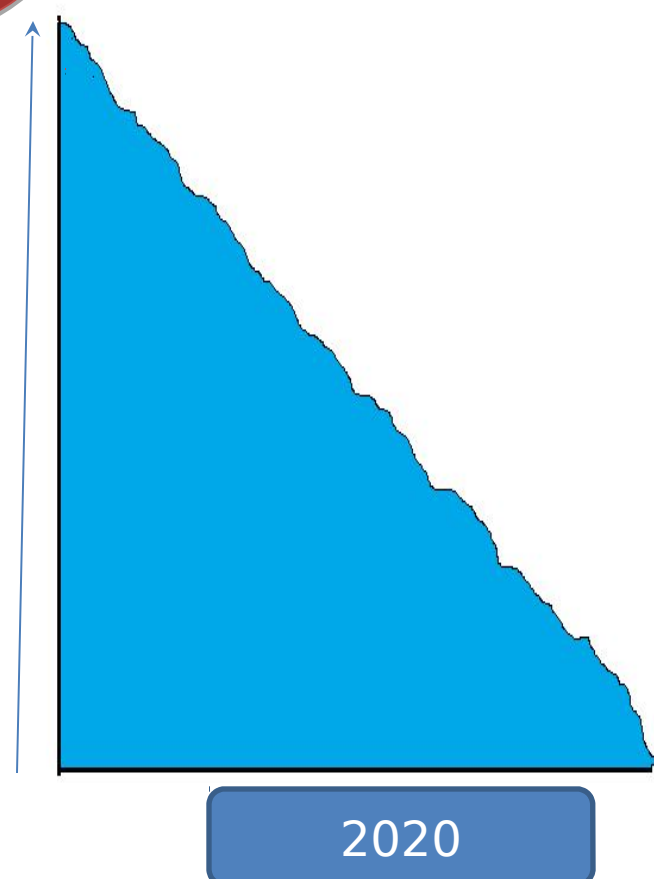
The blue Nile water Level according to Sudan minster of irrigation (OCHA)
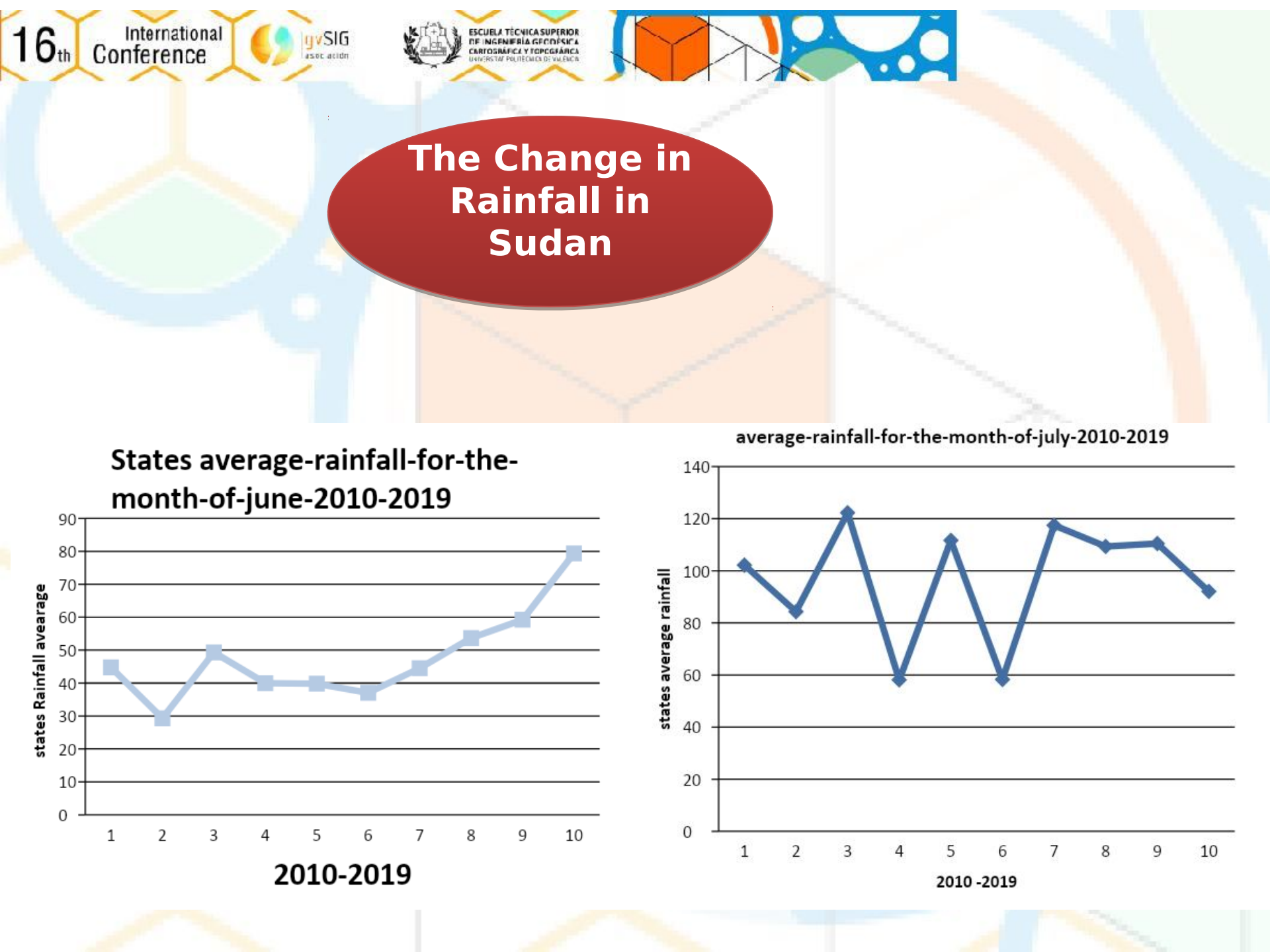
The Change in Rainfall in Sudan

States average-rainfall-for-the-month-of-june-2010-2019
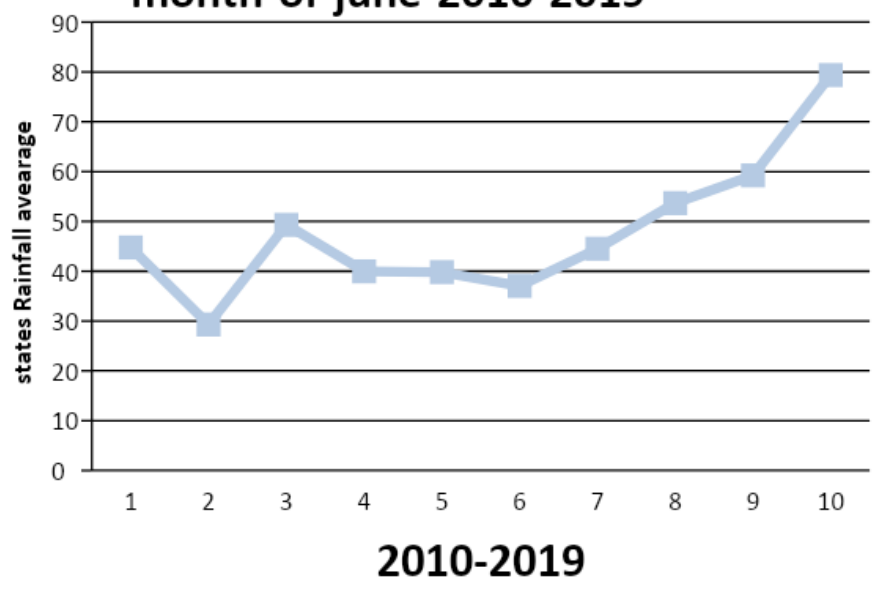
2010-2019

average-rainfall-for-the-month-of-july-2010-2019
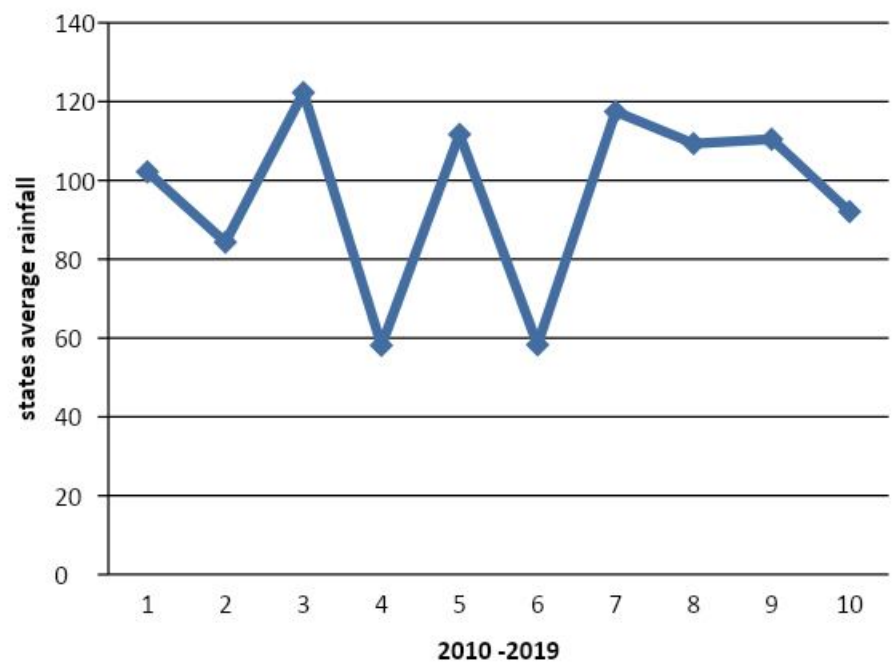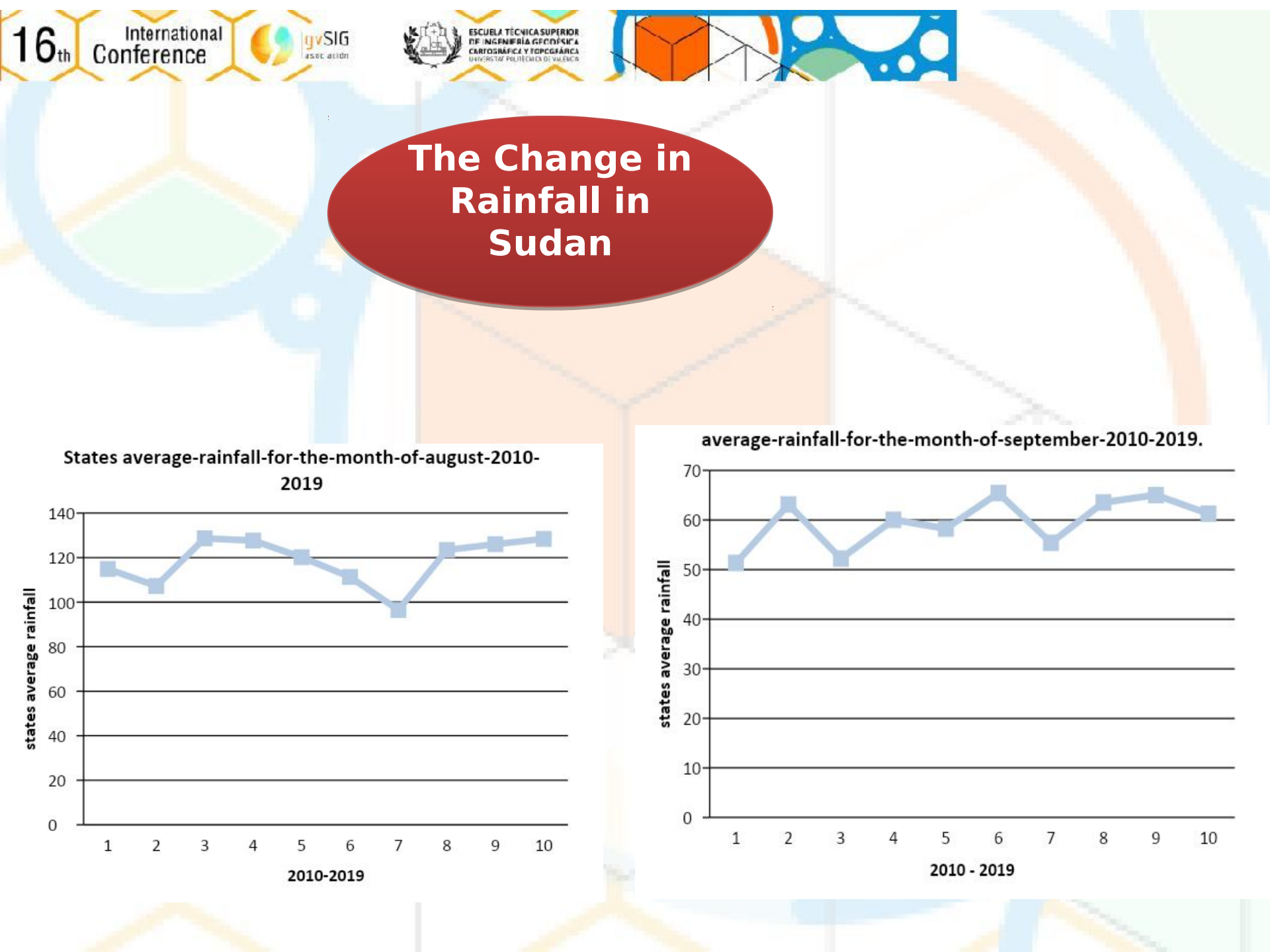
2010 -2019

The Change in Rainfall in Sudan

States average-rainfall-for-the-month-of-august-2010-2019
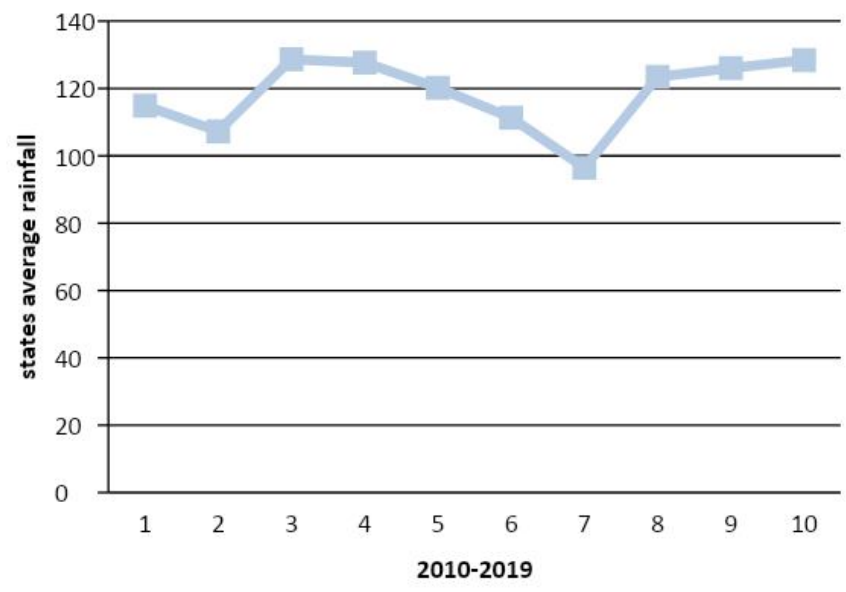
average-rainfall-for-the-month-of-september-2010-2019.
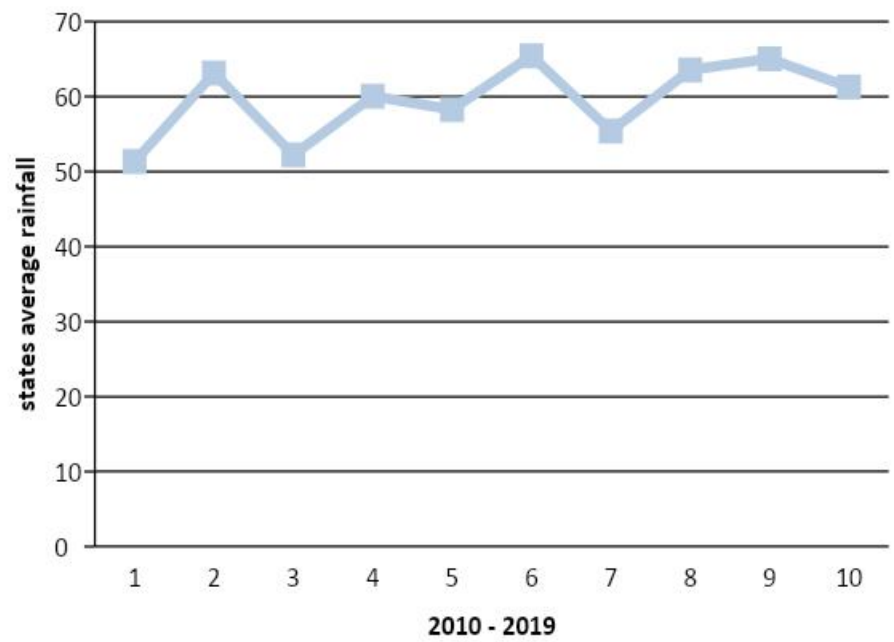
Adopted Solutions

- The Open Source Geographic Information System (gvSIG) has become a reliable alternative for many users, especially for less development countries like Sudan where limited budgets projects cannot provide the cost of installing and maintaining the commercial software.

- The present pilot project proposes the technique of flood sensitivity mapping using the Geographic Information system (gvSIG) to digitize factors such as elevation, slope, land use, distance from rivers, surface roughness, the topographic wetness index and curvature of the topography to project the risk and frequency of floods.

The Benefits of the Project

The objective of this project is to map areas, in the state of Khartoum, Sudan, prone to flood hazards, designate them as flood risk zones, create a model for developing an early warning system and share this information with the policy makers.

If the use of the Geographic Information System (gvSIG) is successful, it can be used to identify flood hazards in other states and reduce the vulnerability of people and public and private property for sustainable economic development.

.

How are we going to make this happen?

Information Gathering

Land use

Infrastructure

Hydrology

Existing maps such as:
▸ Floodplain
▸ Base map
▸ Flood Map
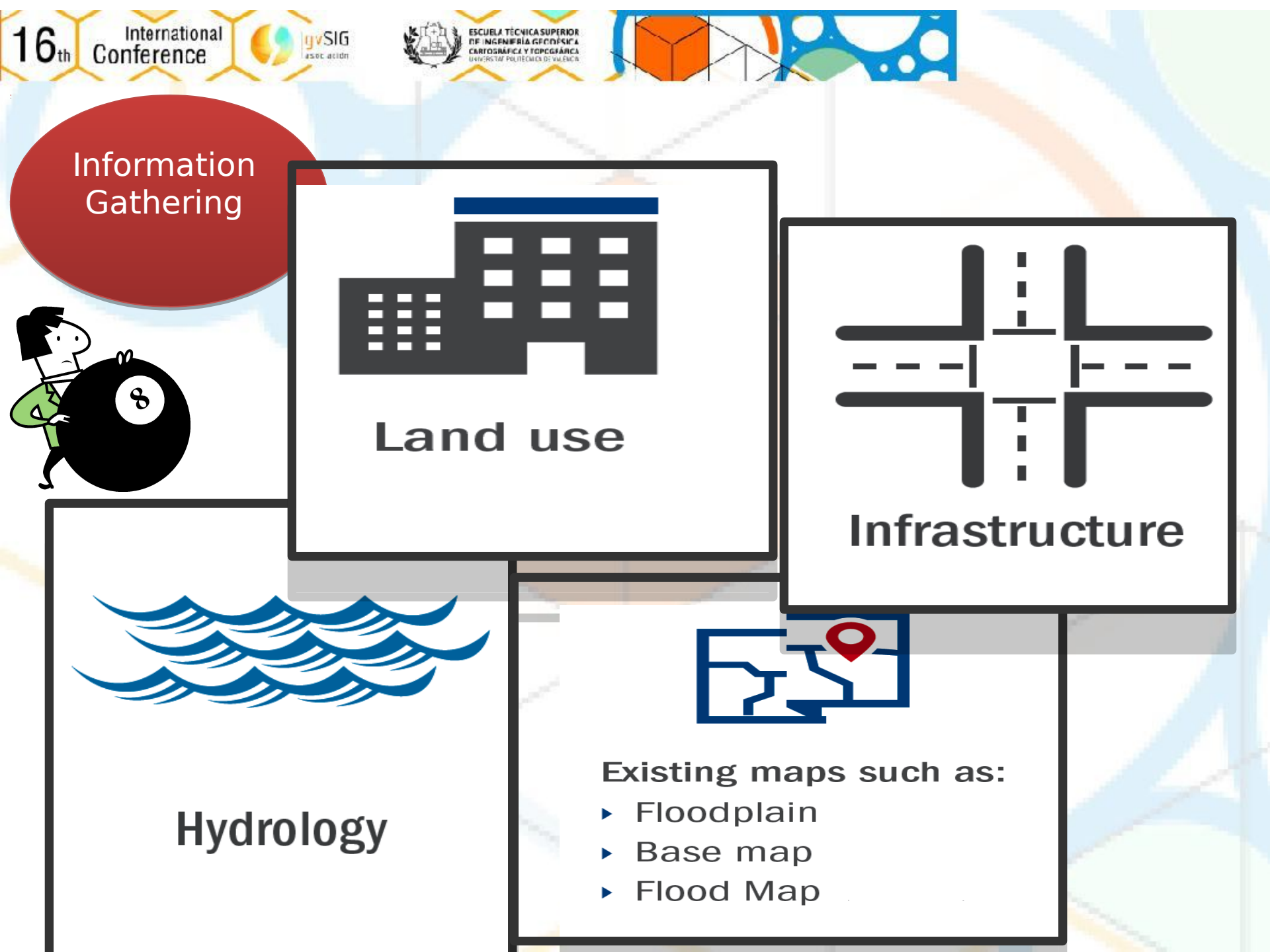
Khartoum State Elevation

Elevation
Value
High : 592
Low : 323

Nile
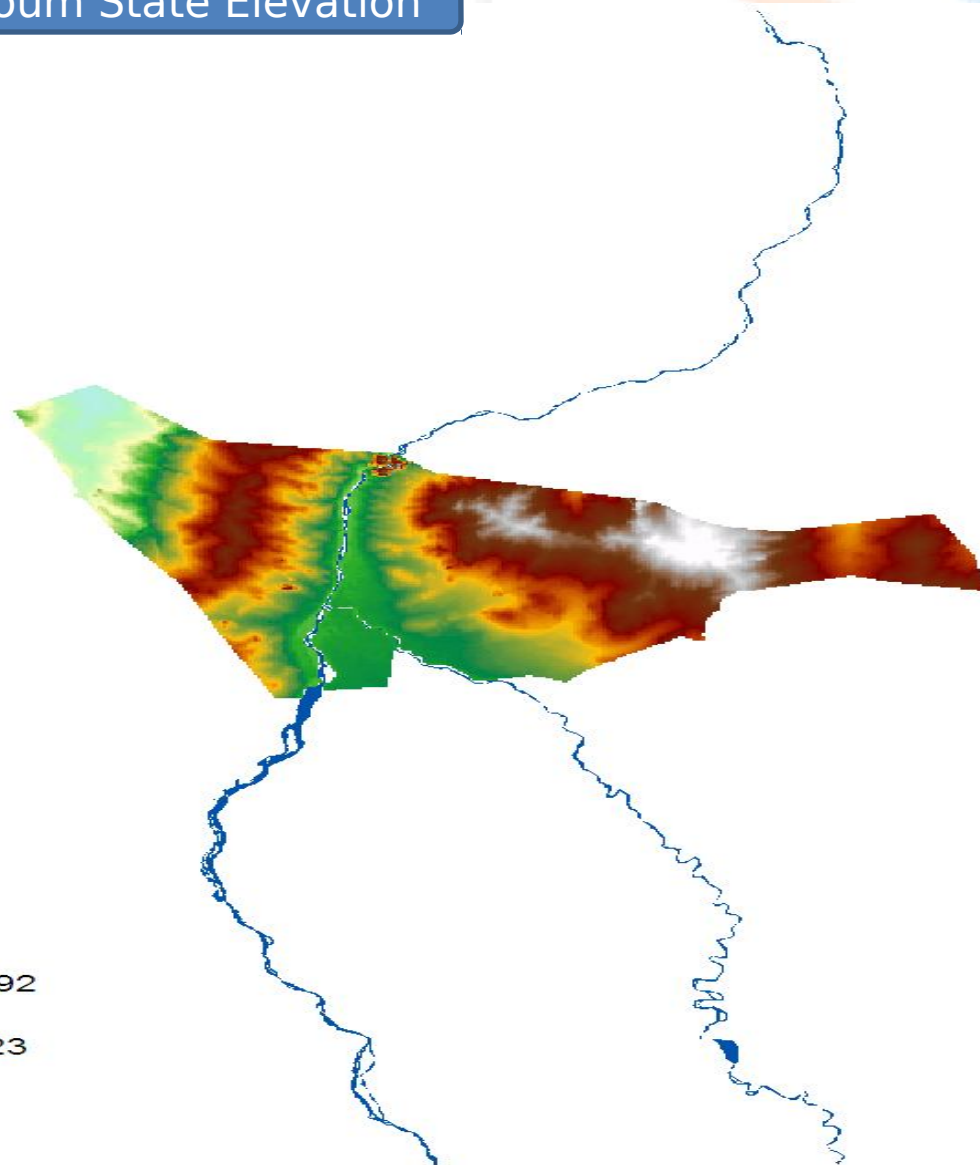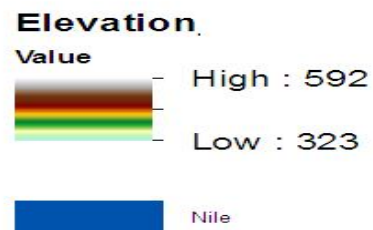
Khartoum State Contours
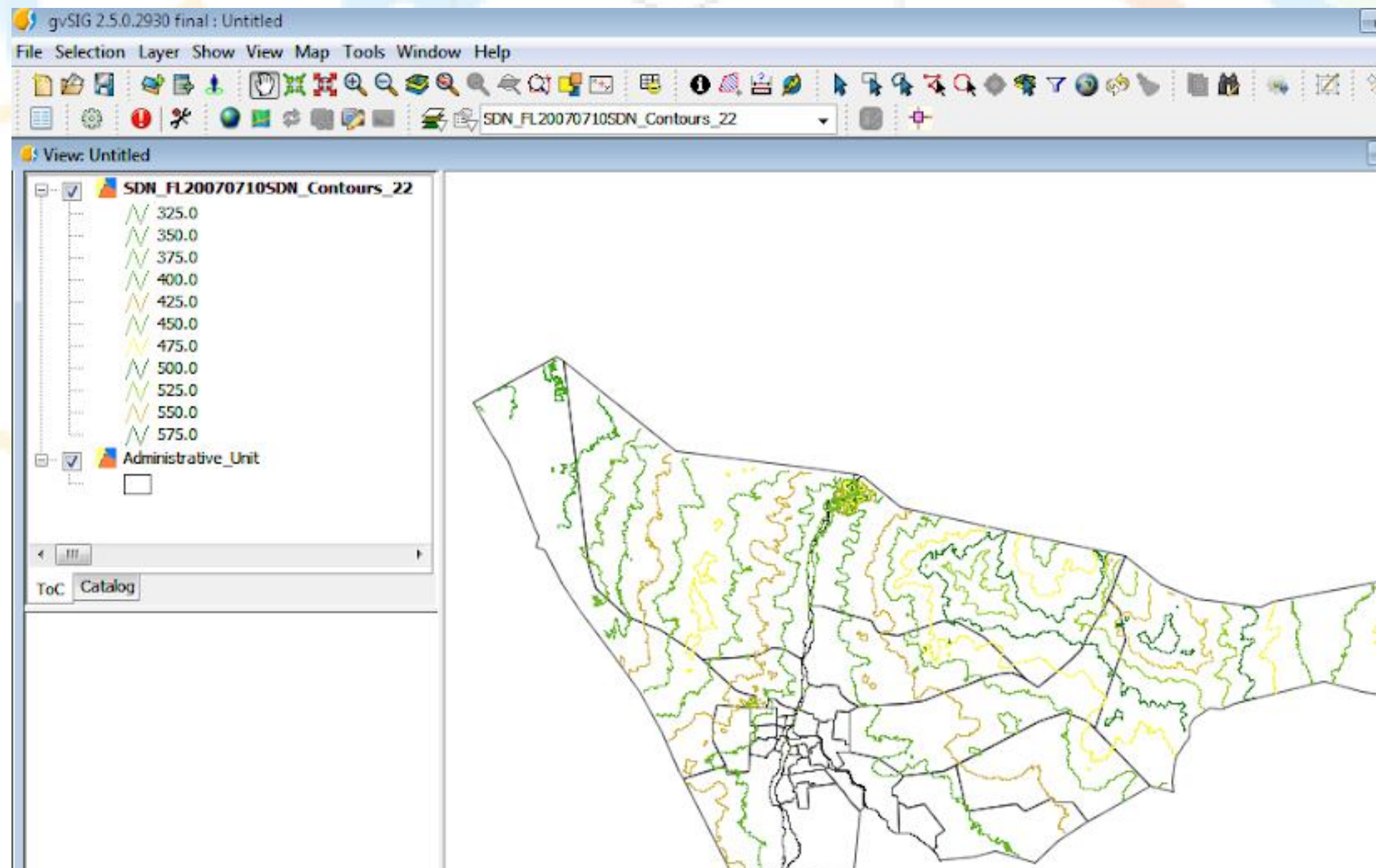
Khartoum State High Places
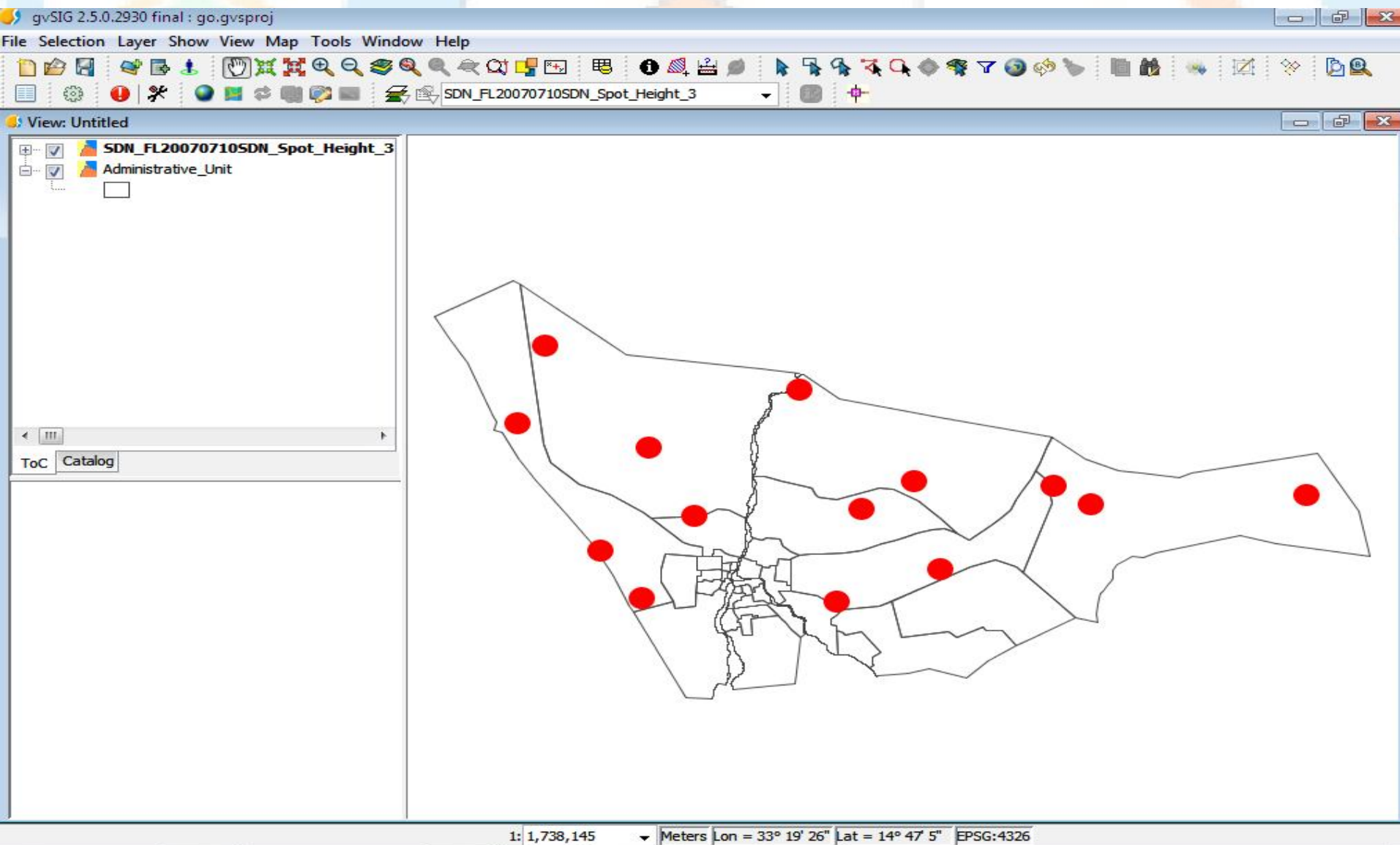
Population_Density

Value

High : 1

Low : 0.00265174

Flood History in Khartoum State

gvSIG 2.5.0.2930 final : Untitled

Selection Layer Show View Map Tools Window Help

MO_20140813_CentralSudan_Flo

View: Untitled

- [✓] TerraSAR-X-09_August_2014-MultiClass
- [ ] Formosat-2-09_August_2013-Flood
- [ ] SP_20160815_PostFlood_Khartoum
- [ ] Pleiades-14_August_2014-Flood
- [ ] TX_20160811_PostFlood_Khartoumt
- [ ] SP_20160815_PostFlood_Khartoum2
- [ ] RS2_20140808_Khartoum_Flood_2
- [ ] Formosat-2-08_August_2013-Flood
- [ ] Redarsat-2-10_August_2013-Flood
- [ ] Radarsat213August2013Flood
- [ ] MODIS-Terra-13_August_2014-Flood
- [ ] TX_20140909_Khartoum_Flood
- [ ] TX_20140810_Khartoum_Flood
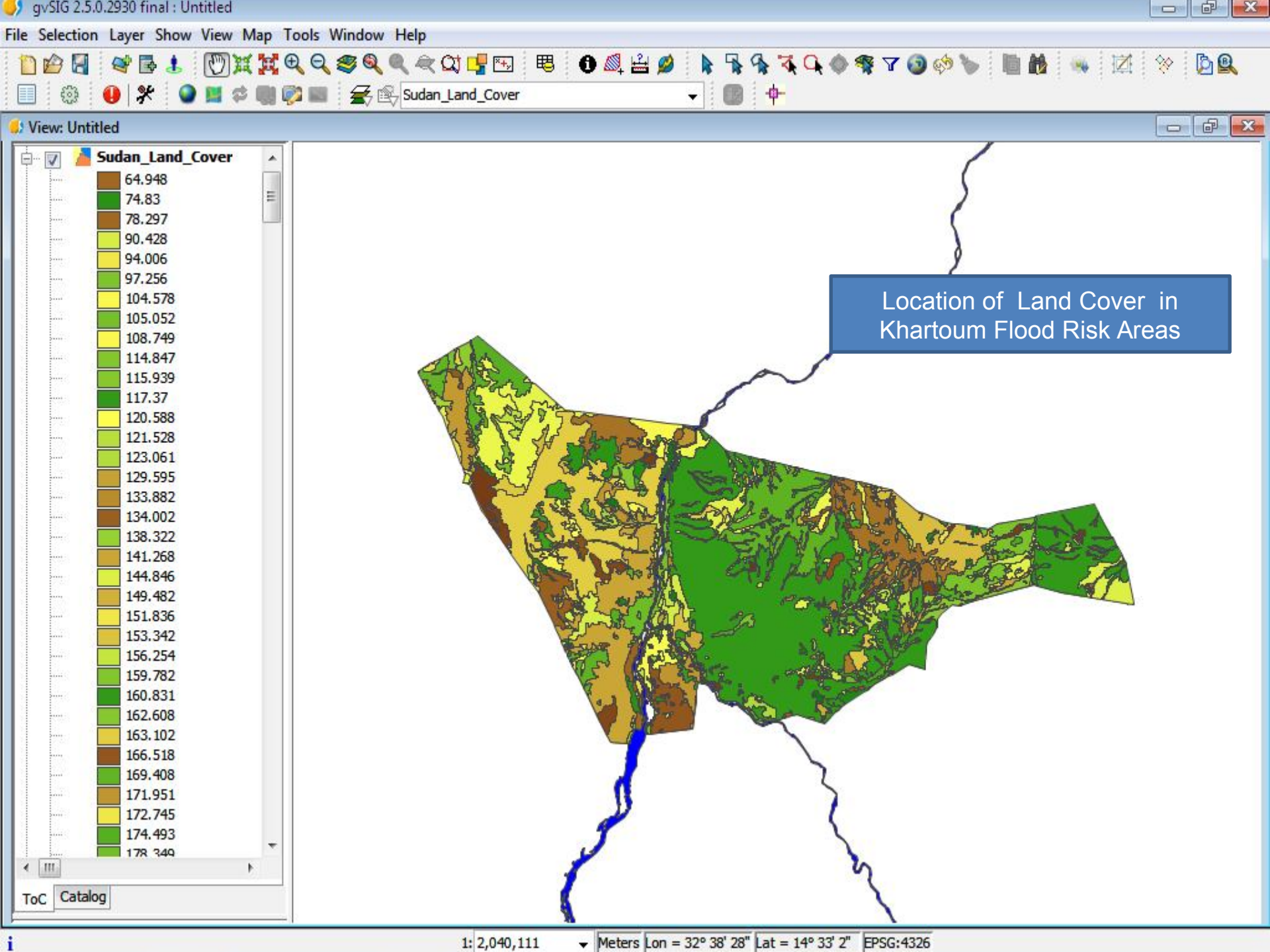- [ ] RS2_201400819_Khartoum_Flood3

Catalog
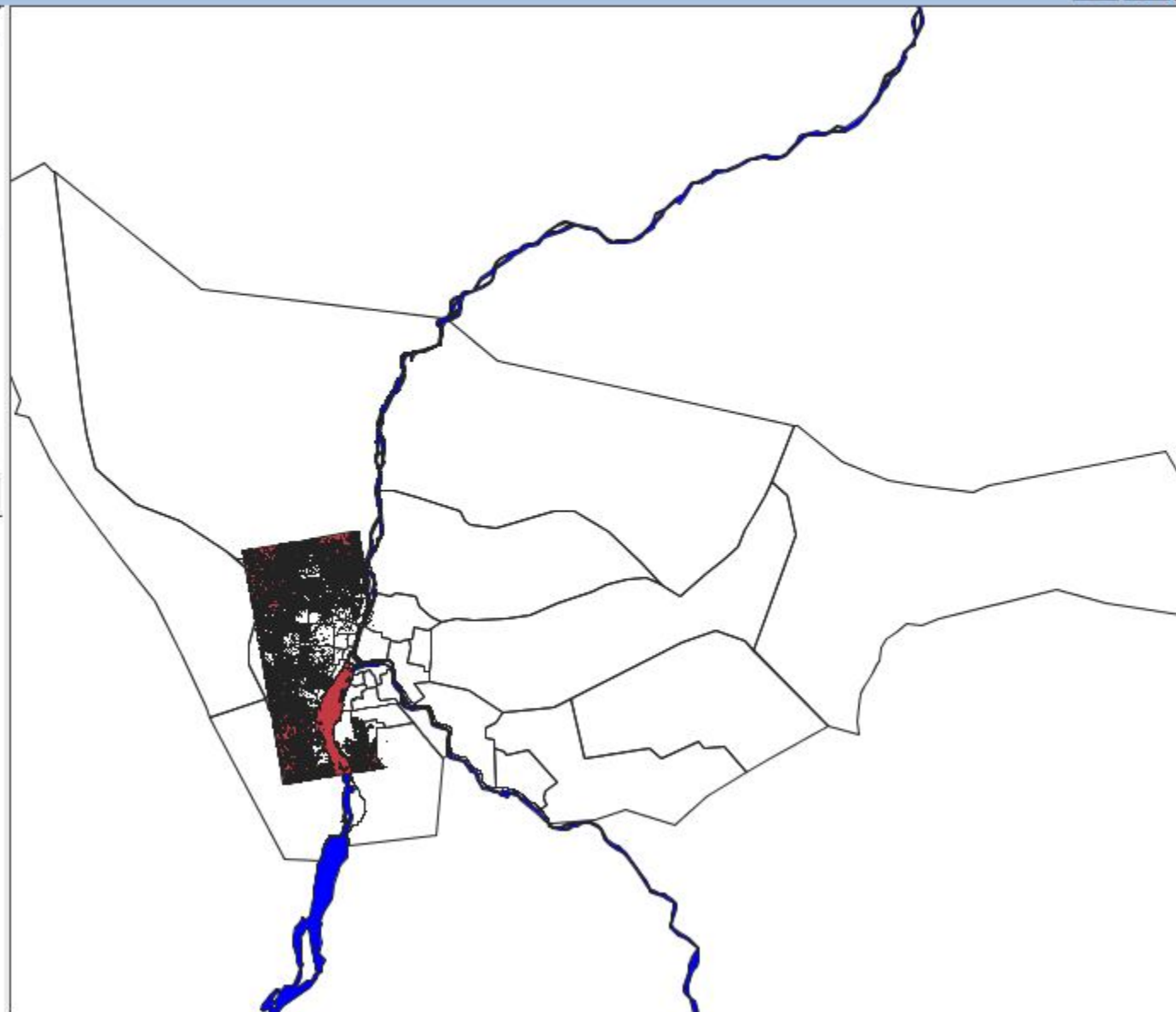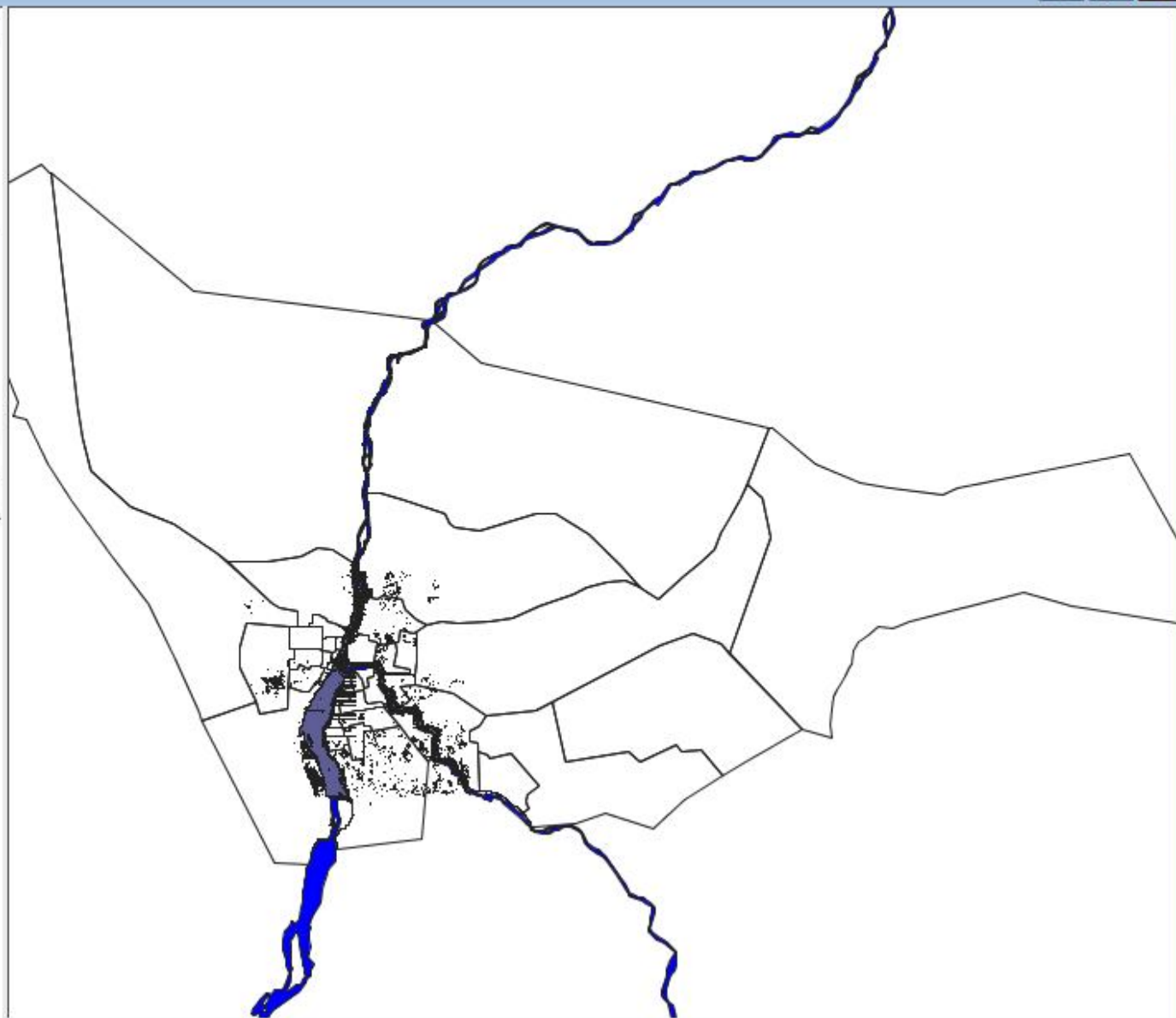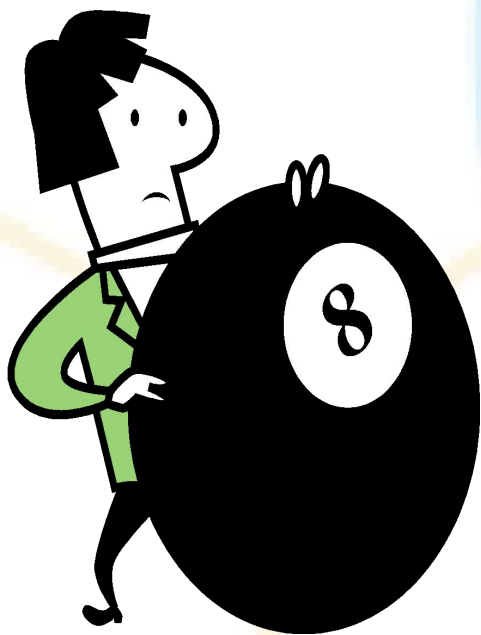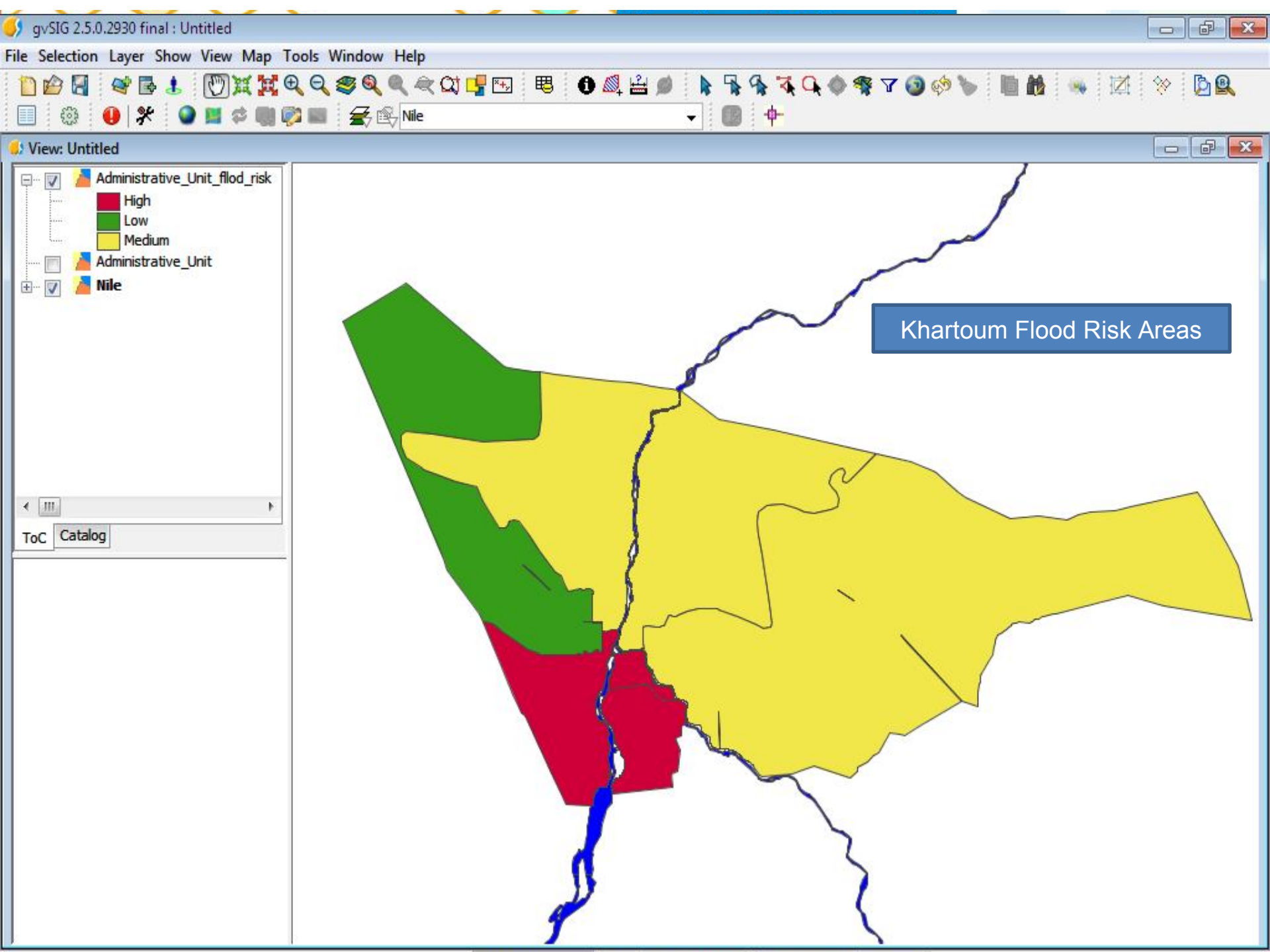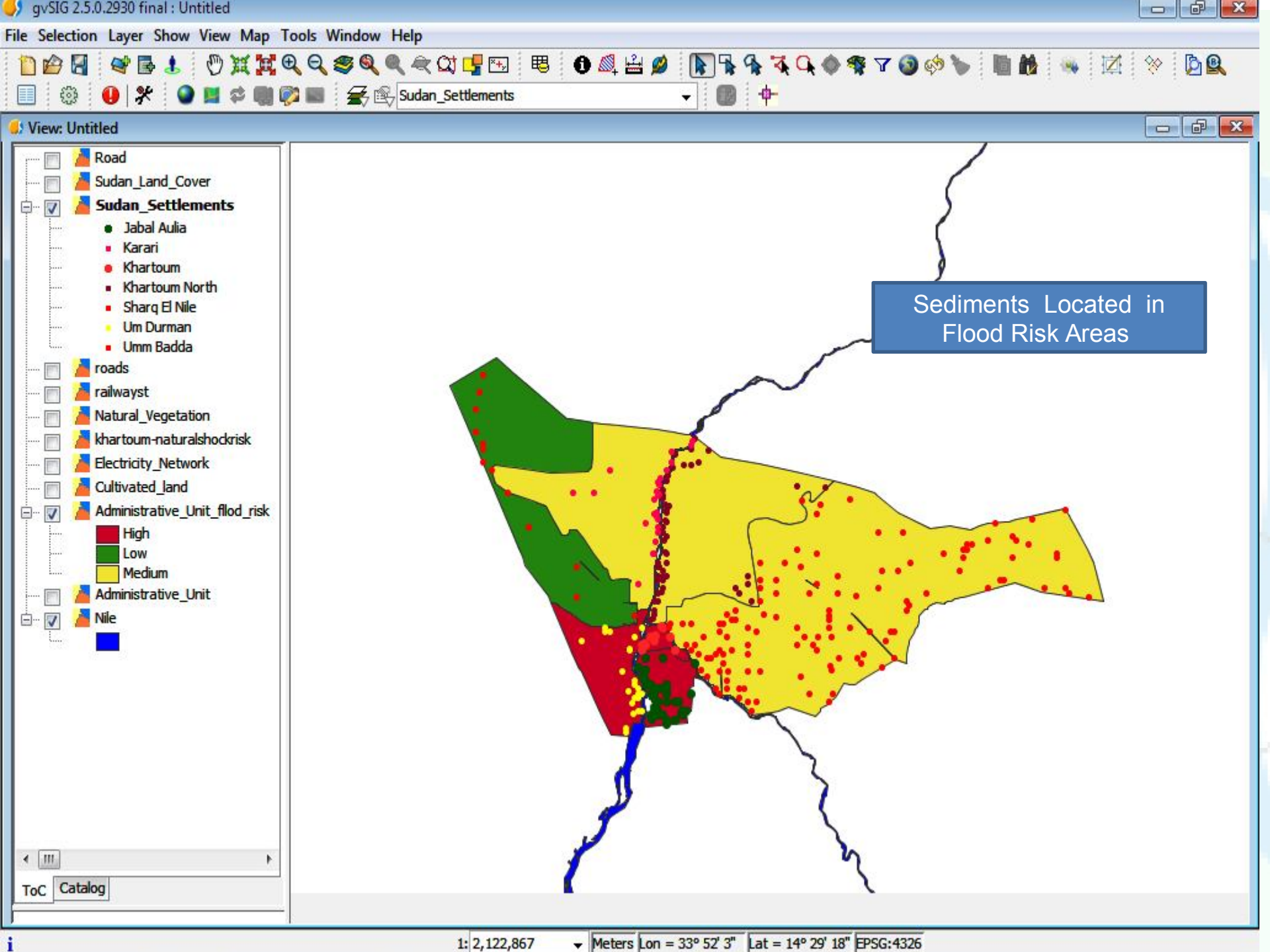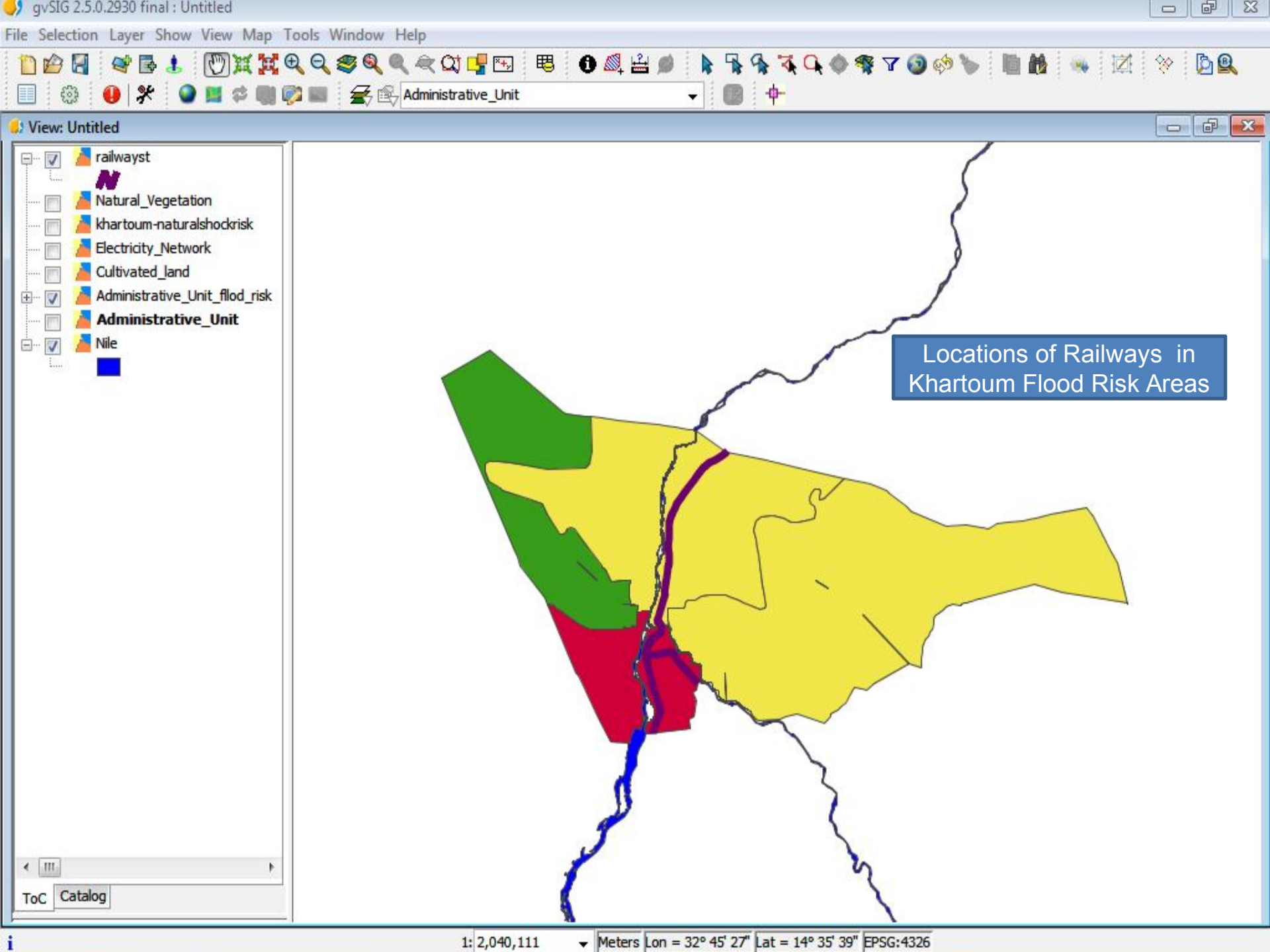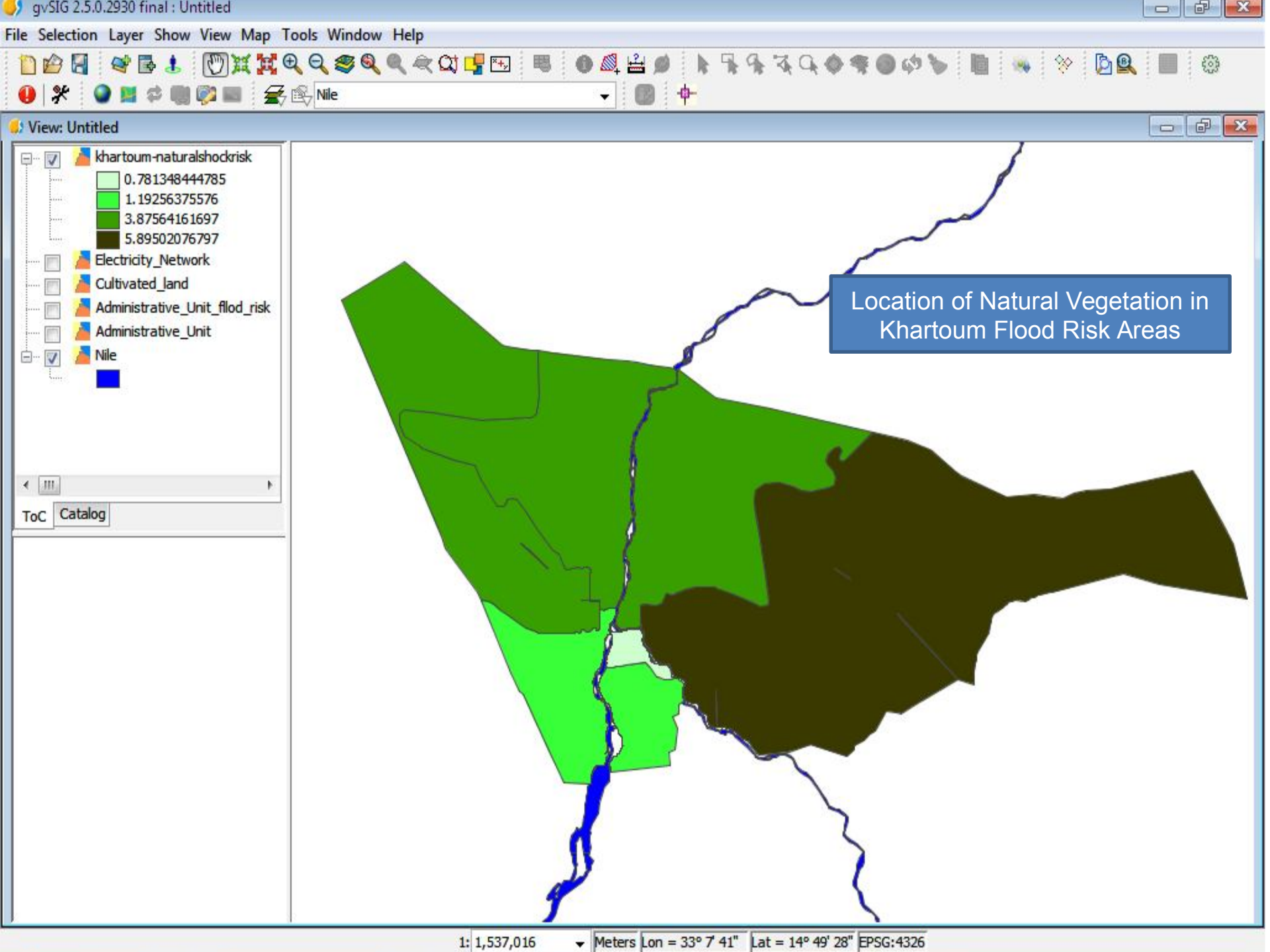
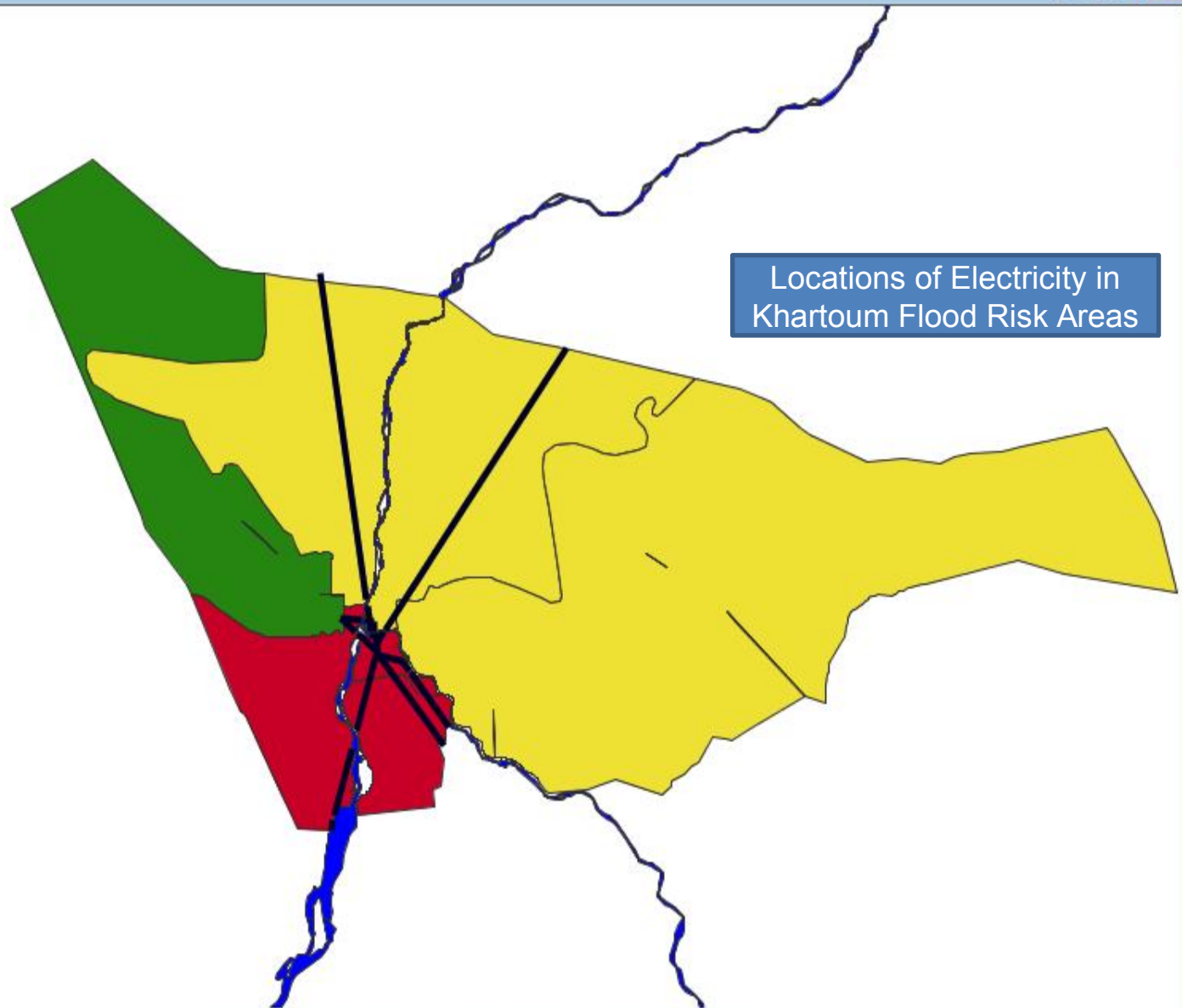1: 1,537,016   Meters Lon = 33° 0' 0"   Lat = 14° 52' 46" EPSG:4326

The Outcomes

Khartoum Flood Risk Areas

Locations of Electricity in Khartoum Flood Risk Areas

References

- https://data.humdata.org/

- https://www.unocha.org/

- https://esgf-data.dkrz.de/projects/esgf-dkrz/
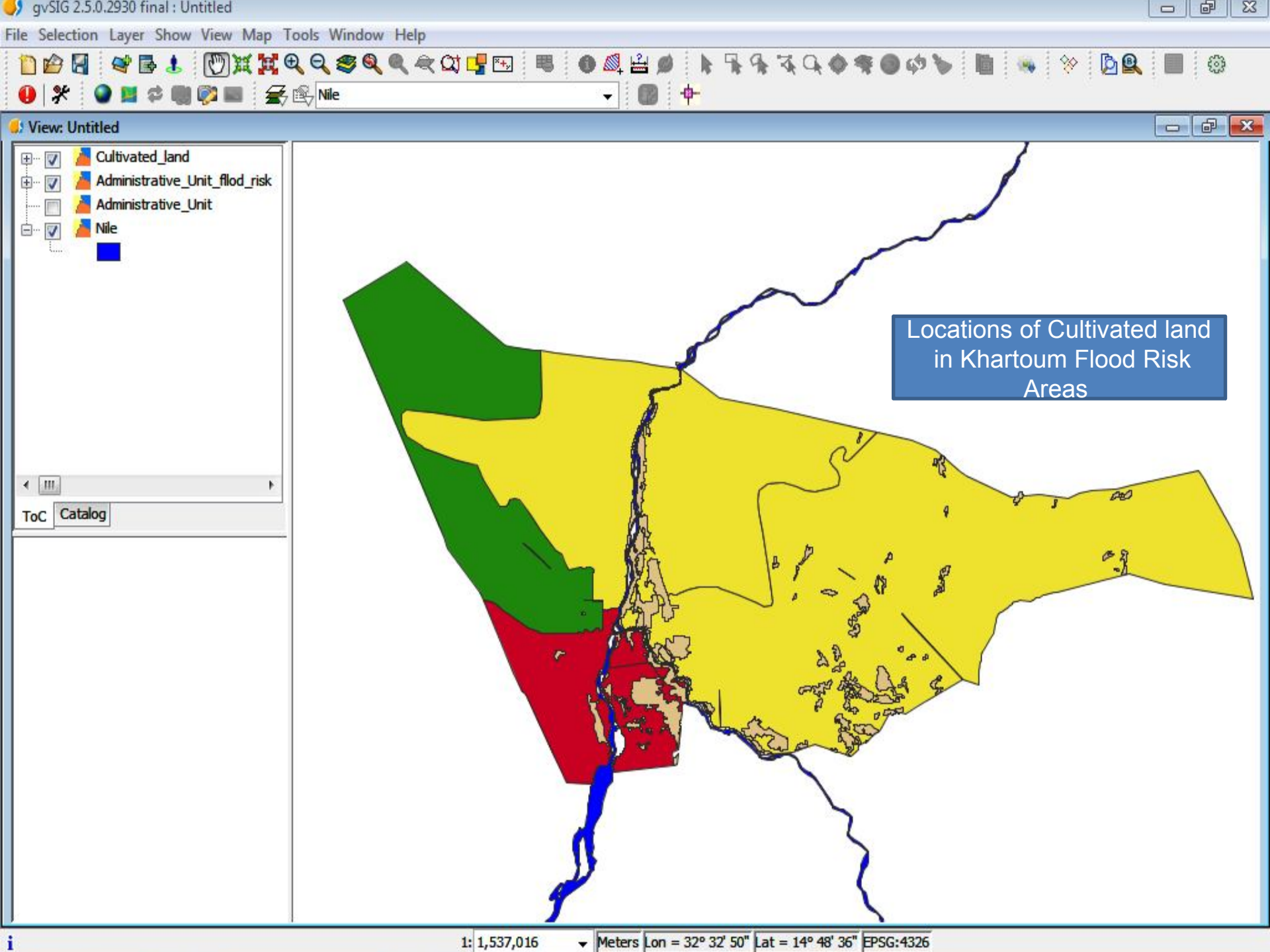
Questions?
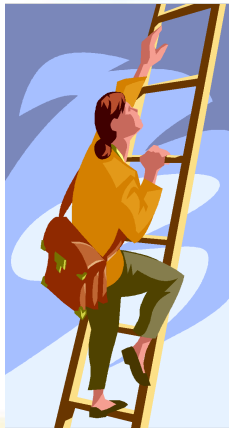
Man who say it cannot be done should not interrupt man doing it.

Chinese proverb

shorbji12@gmail.com