Mapping and Detecting Influences of Vegetation Cover on Runoff and Torrents in Khartoum State, Sudan

Contents

Background:

- Natural hazards have increased lately, and attracted attention at regional and global levels (Saud, 2011). Arid and semi-arid regions are highly of global concern because of their multi-dimensional issues (Tulu, 2010). These regions, including Sudan, are characterized by greater level of runoff and torrents that lead to degradation of the environment. . Overall, climate change has influenced the magnitude and the distribution of the most important driving force of the hydrological cycle, i.e., rainfall (IPCC, 2007).

Background-Cont.

- Runoff is defined as movement of water over the Earth's surface towards low lying areas, ending up in a catchment area (Dimitriou, 2011). Runoff and torrents create negative impacts on agricultural production, infrastructure and water quality across the world.
- Vegetations are very important components of the ecosystem. Their destruction will have an adverse effect on ecosystems' functional roles in the environment. Hence, there is a need to monitor, conserve and utilize vegetations sustainably (Gadiga, 2015).

Background-COnt.

- Mapping land use and land cover (LULC) are key spatial data affordably derived from remote sensing, and are necessary to identify runoff and torrents. It is stated that, higher vegetation cover results in better water-holding capacity, reduces runoff, and improves infiltration (Yuksel et al., 2008).

Problem Statement

- Natural hazards occupy vital concern on the national and regional scale. Hence, they are raised as apriority issues in many geo-environmental assemblies (Saud, 2010). The frequency of catastrophic events has been recently increased in different regions of the world including Sudan.
- Khartoum State (such as Omdurman and Sharg El-Neel) is an appropriate example of natural hazards i.e. land topography and water related hazards, where the runoff and torrents are lately have become a region’s signpost.

Problem Statement-Cont.

- Runoff and torrents are characterized as major threats to socio-economic, environment and sustainable land management. In this occasion, it said that these threats have triggered in recent years because the vegetation cover has been degraded. In sake of truth, this study attempted to look at the role of vegetation in confronting or contributing to the effects. Therefore, mapping these threats in spatio-temporal scale at their catchments could help in hazard's planning procedure.

Study Objectives:

1. Map and quantify changes of vegetation cover over 1994, 2009 and 2018.
2. Analyze the influence of vegetation cover on runoff and torrents.
3. Develop strategies for controlling runoff and torrents based on the current topography and vegetation cover status in the study area.

Research Hypothesis:

1. There are extreme changes in vegetation cover in the study area.

2. Changes in vegetation cover play major roles in runoff and torrents events.

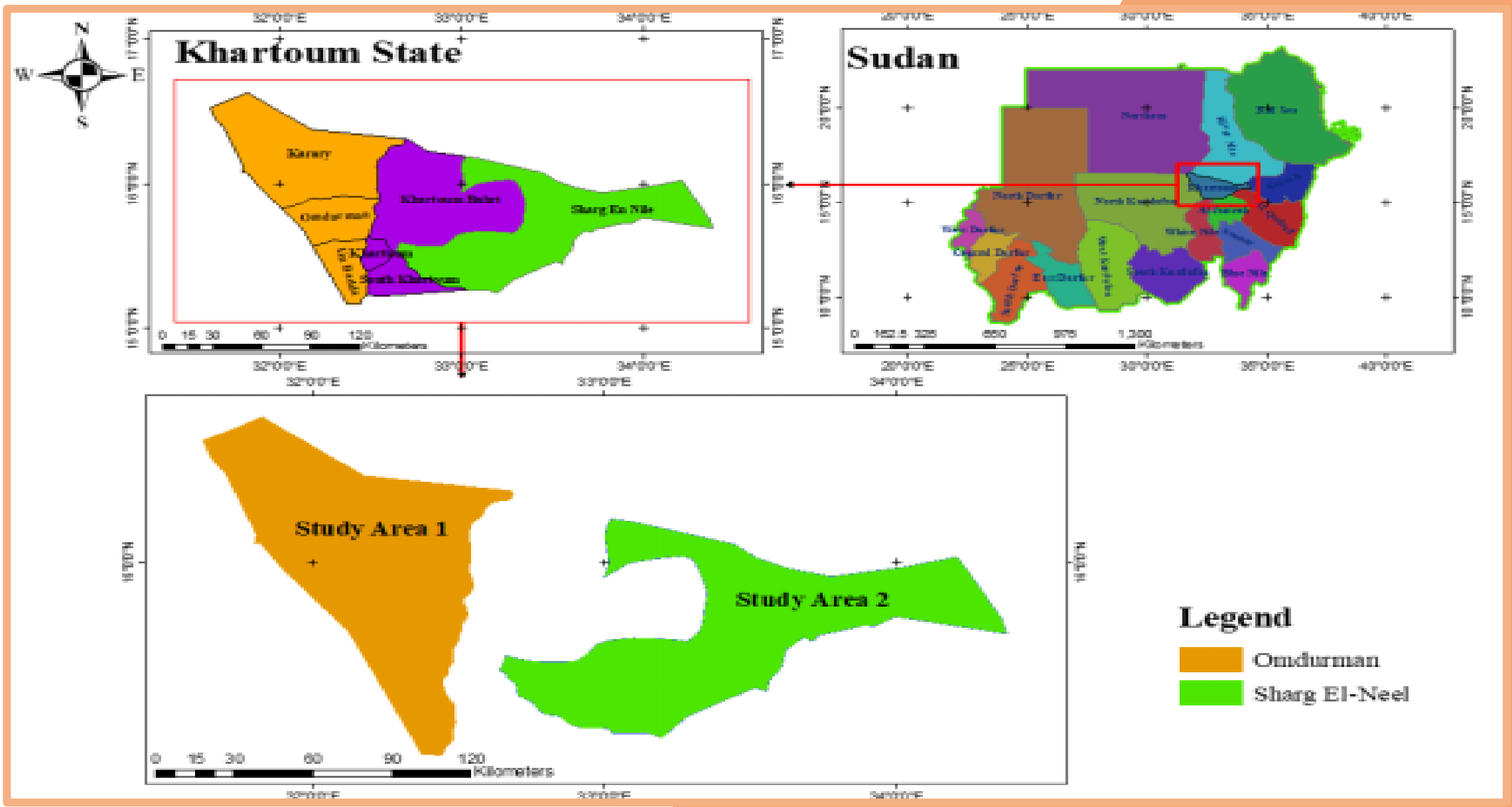
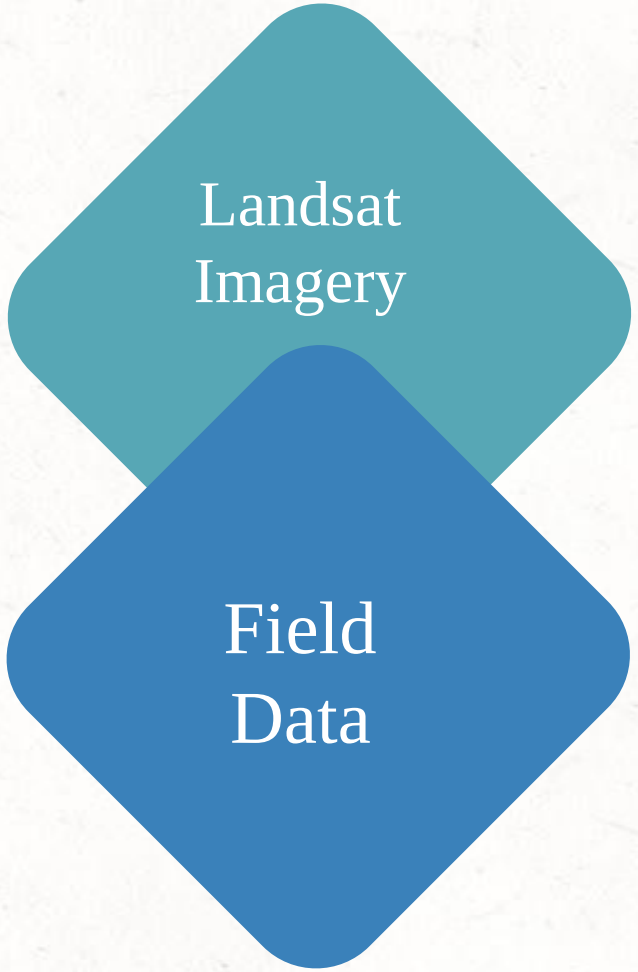


Fig.1: Map of the Study Area

Data Sources:



The Landsat (TM) of 1994-2009 and Landsat (OLI/TIRS) of 2018 downloaded from (USGS-GloVis)

Field Observation was done in March 2019, the data were collected from the study area

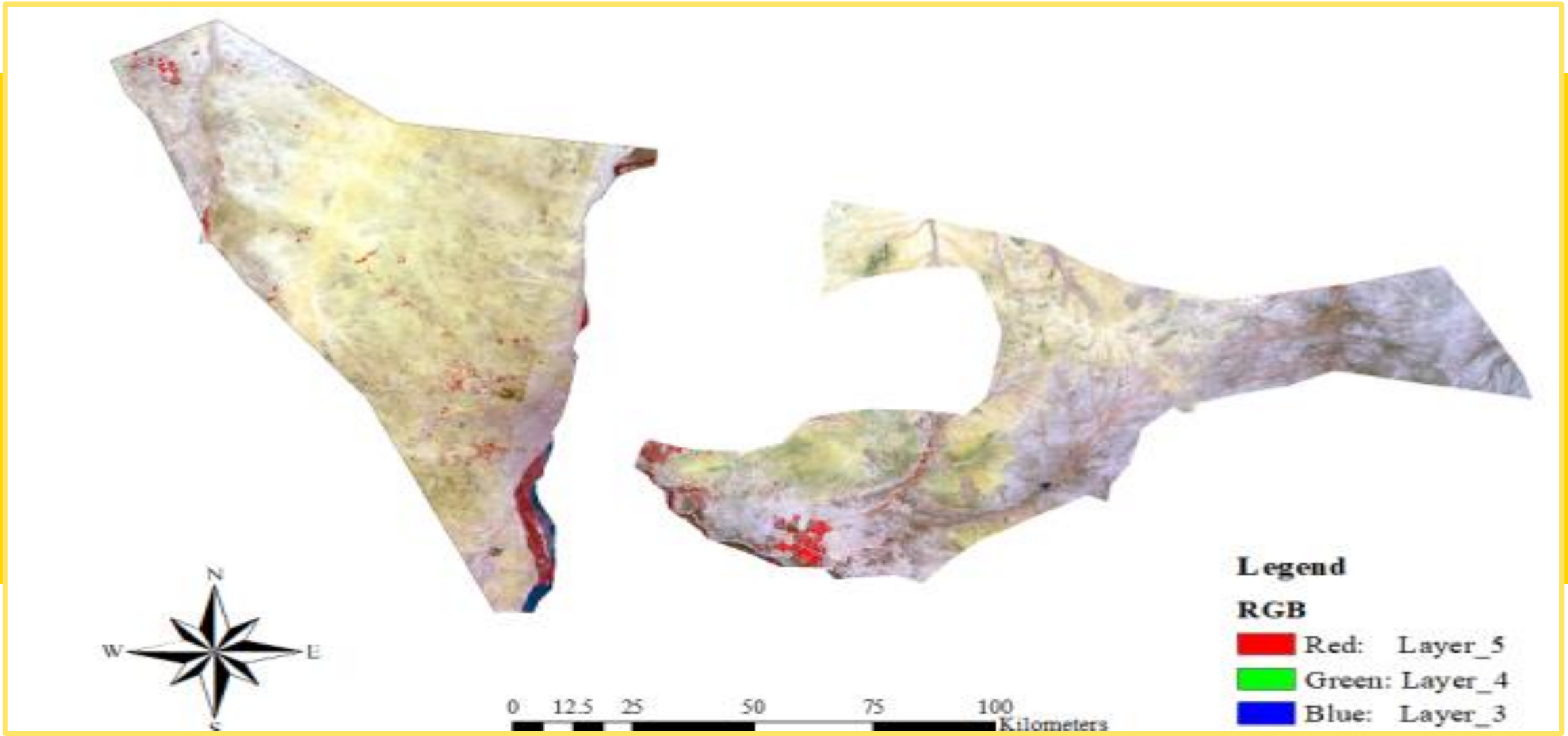


Fig.2: Landsat Images of the Study Area

Methodology:

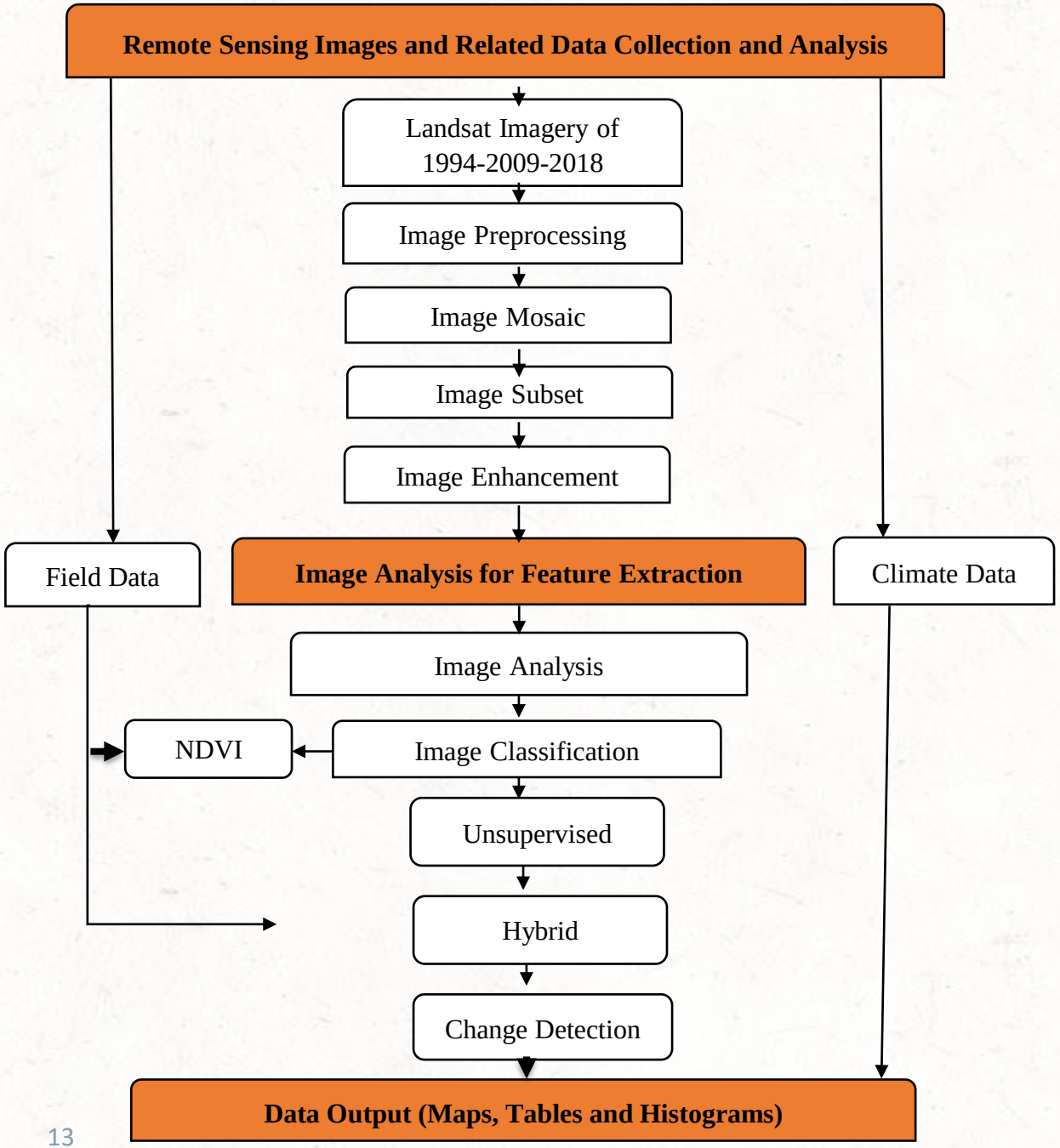


Fig.4: Flow diagram for the Data Analysis

Results and Discussion

- LULC status and changes of Omdurman area
- LULC status and changes of Sharg El-Neel area
- NDVI value and classes of Omdurman area
- NDVI value and classes of Sharg El-Neel area

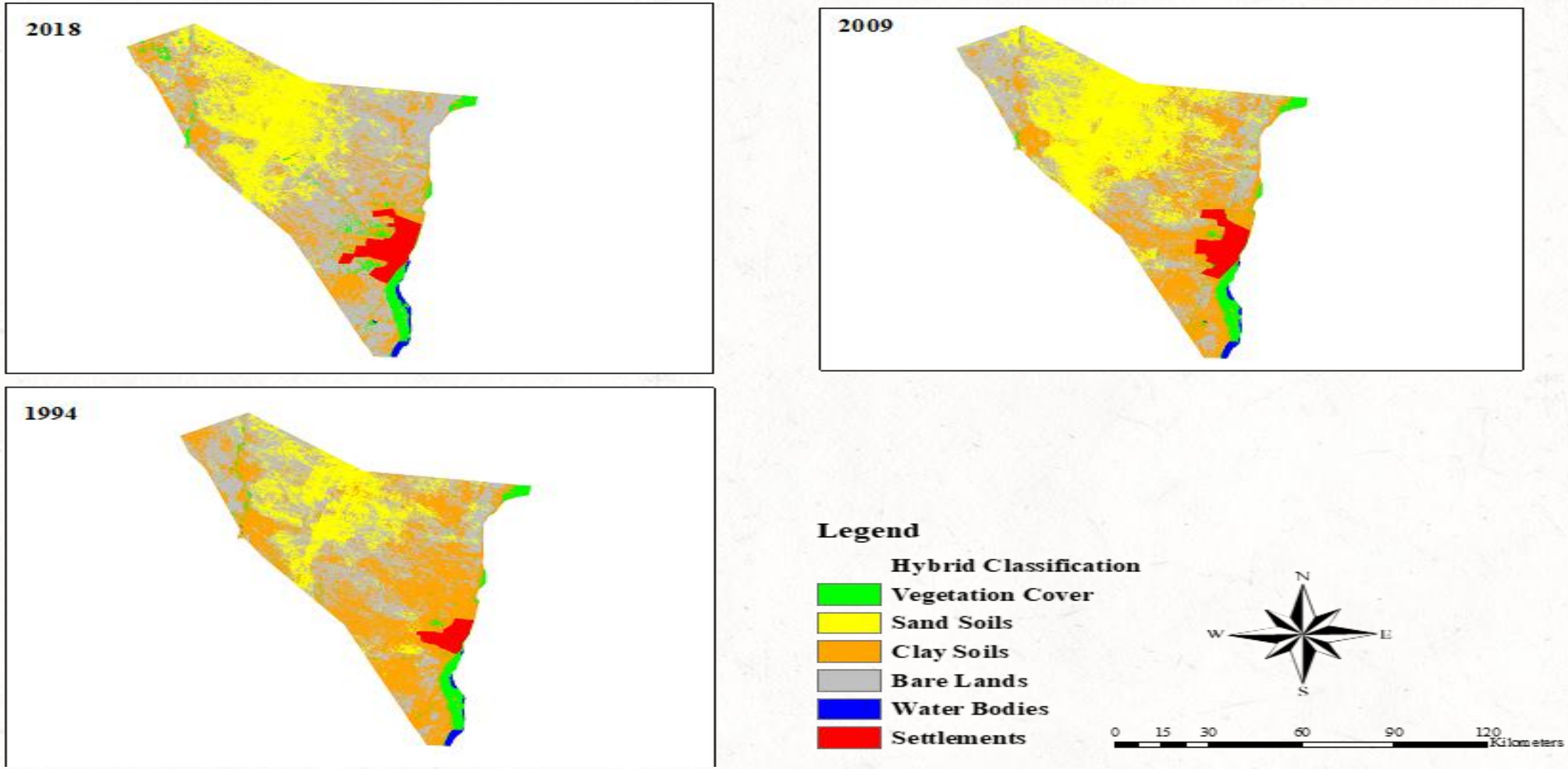


Fig.5: LULC Classification of Omdurman Area Over 1994, 2009 and 2018

Results and Discussion-Cont.

Table1: Changes in the LULC Areas of Omdurman Over 1994, 2009 and 2018

Years	**1994**		**2009**		**2018**		**LULC Changes**		
LULC classes	(ha)	(%)	(ha)	(%)	(ha)	(%)	1994-2009	2009-2018	1994-2018
Vegetation Cover	24906.7	3.2	23600.9	3.1	32603.8	4.2	-130508	9002.9	7697.1
Sandy Soils	143586	18.6	269468	34.9	213382	27.6	125882	-56086	69796
Clay Soils	310723	40.2	213652	27.6	163485	21.2	-97071	-50167	-147248
Bare Lands	274053	35.5	231619	30	321493	41.6	-42434	89874	47440
Water Bodies	3710.16	0.5	4185.99	0.5	5213.7	0.7	475.83	1027.71	1503.54
Settlements	15943.4	2.1	30396.1	3.9	36745.2	4.8	14452.7	6349.1	20801.8

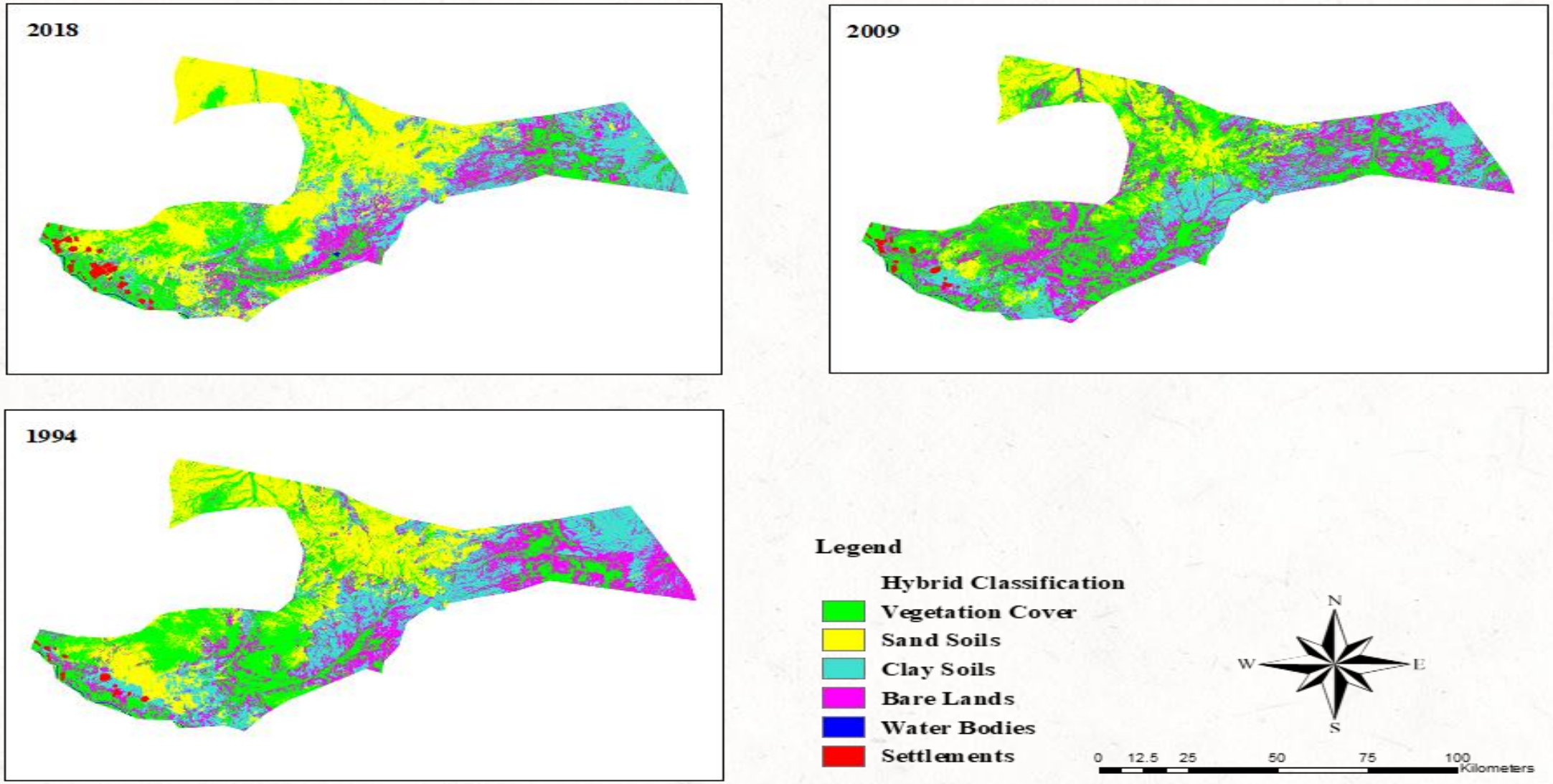


Fig.6: LULC Classification of Sharg El-Neel Area Over 1994, 2009 and 2018

Results and Discussion-Cont.

Table 3: Changes in the LULC Areas of Sharg El-Neel Over 1994, 2009 and 2018

Years	**1994**		**2009**		**2018**		**LULC Changes**		
LULC classes	(ha)	(%)	(ha)	(%)	(ha)	(%)	1994-2009	2009-2018	1994-2018
Vegetation Cover	227801	31.4	299937	41.3	179520	24.7	72136	-120417	-48281
Sandy Soils	190838	26.3	107722	14.8	277683	38.3	-83116	169961	86845
Clay Soils	162326	22.4	132216	18.2	154744	21.3	-30110	22528	-7582
Bare Lands	140614	19.4	180933	24.9	102980	14.2	40319	-77953	-37634
Settlements	849.06	0.1	675.45	0.1	1364.67	0.2	-173.61	689.22	515.61
Water bodies	3310.47	0.5	4255.02	0.6	9446.58	1.3	944.55	5191.56	6136.11

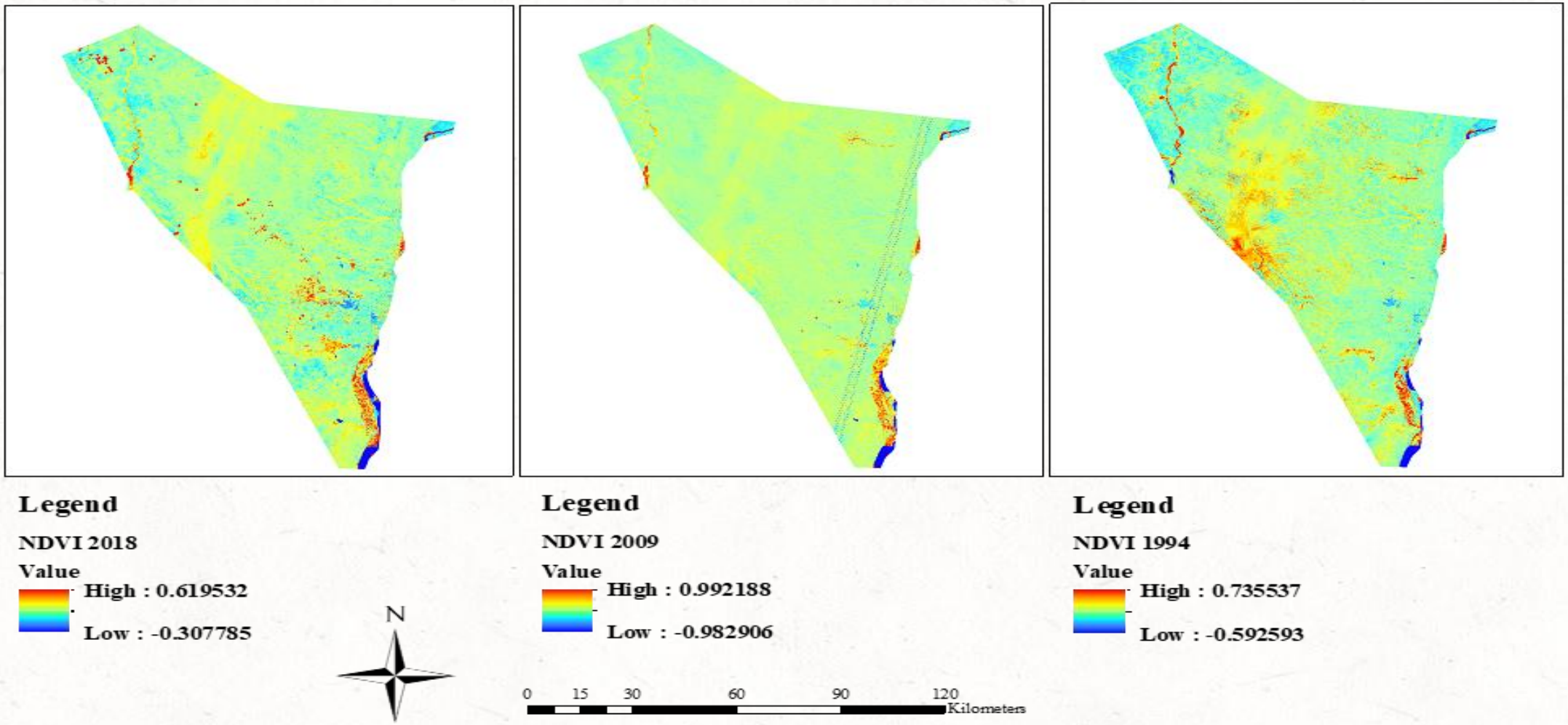


Fig.7: NDVI Value of Omdurman for the Year 1994-2009 and 2018

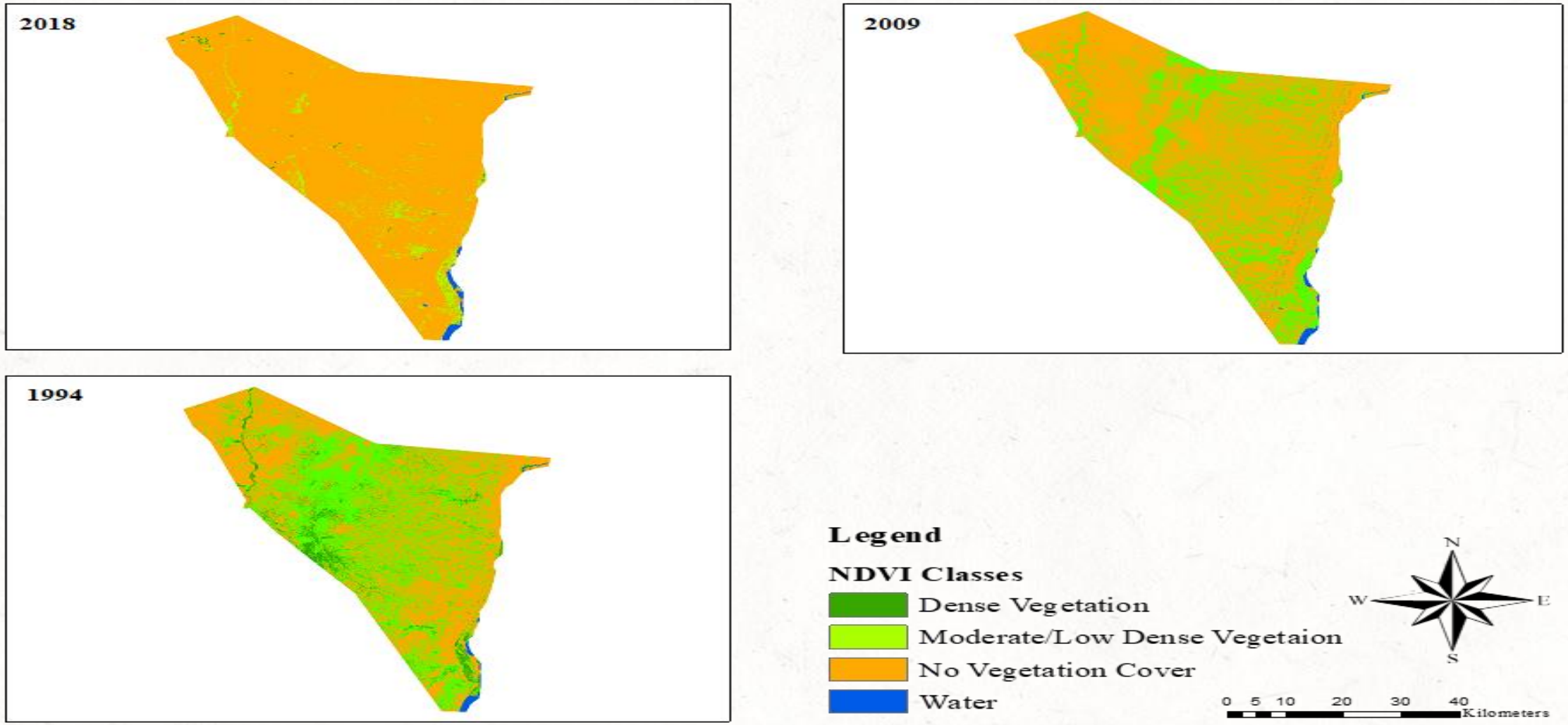


Fig.8: NDVI Classes of the Images Omdurman for the Years 1994, 2009 and 2018.

Results and Discussion-Cont.

Table 2: Area of NDVI Value of Omdurman for the Years 1994, 2009 and 2018

Years	**1994**	**2009**	**2018**
NDVI Classes	(ha)	(ha)	(ha)
Dense Vegetation	69517.2	12259.1	15979
Moderate/Low Dense Vegetation	288962	307603	408569
No Vegetation Cover	339328	341005	342117
Water	4903.02	51220.89	6257.7

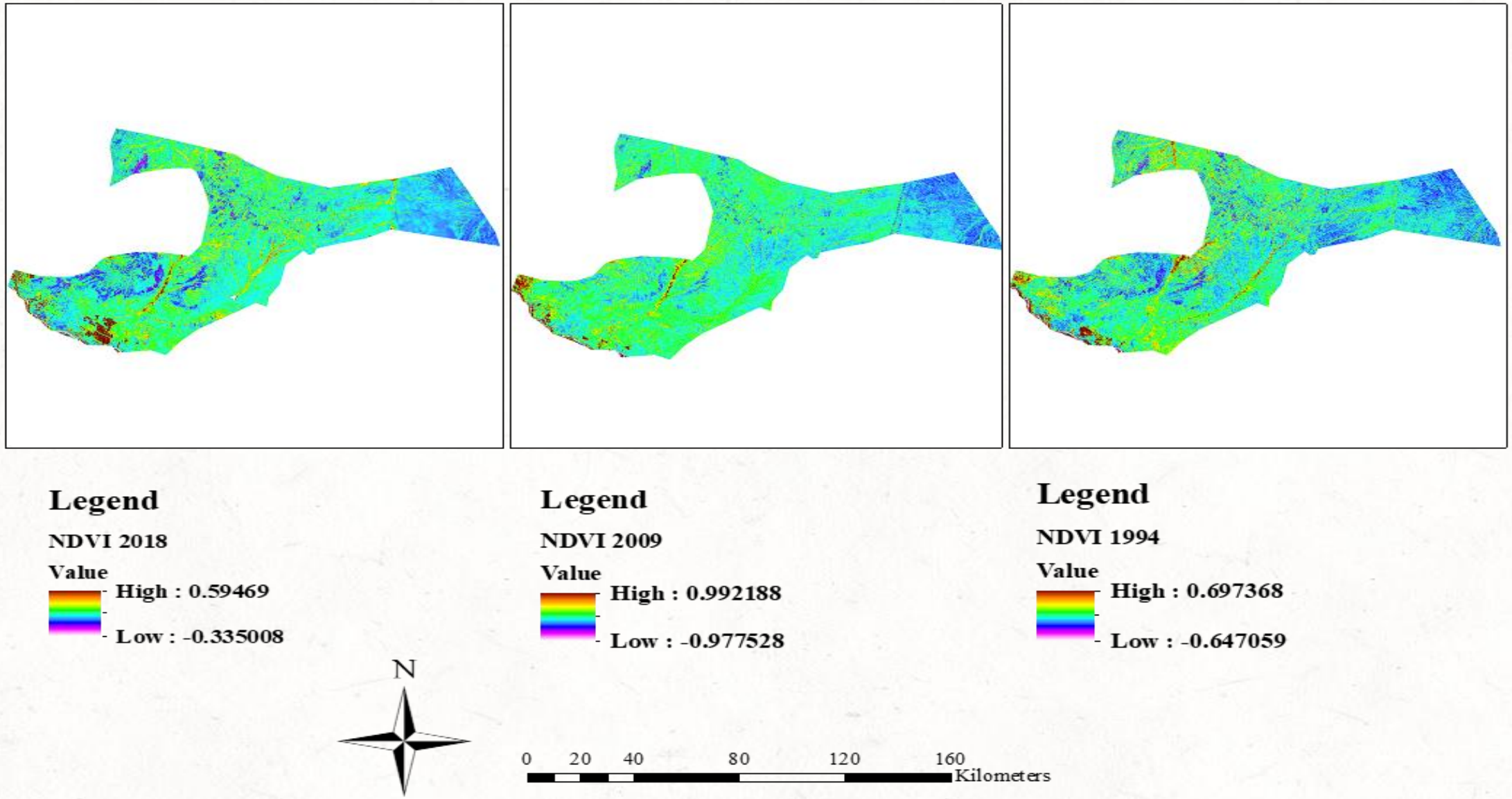


Fig.9: NDVI Images of 1994-2009 and 2018 of Sharg El-Neel Study Area

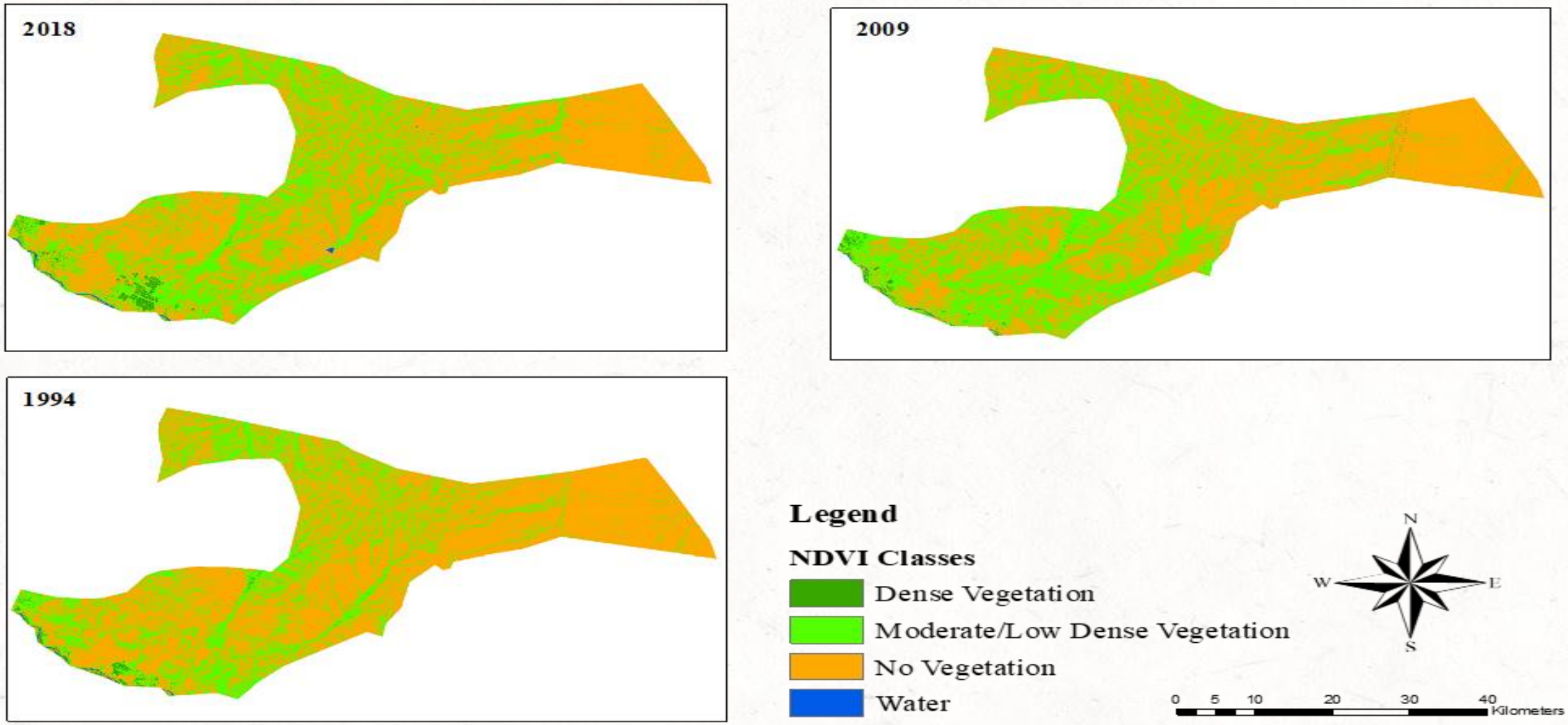


Fig.10: NDVI Classes of the Images of Sharg El-Neel for the Years 1994, 2009 and 2018

Results and Discussion-Cont.

Table 4: Area of NDVI of Sharg El-Neel for the Years 1994, 2009 and 2018

Years	**1994**	**2009**	**2018**
NDVI Classes	(ha)	(ha)	(ha)
Dense Vegetation	14707.6	10214.9	82338.1
Moderate/Low Dense Vegetation	241468	170533	339635
No Vegetation Cover	411294	413021	176119
Water	58268.6	34663.8	30928

“Vegetation cover throughout the study period of Omdurman and Sharg El-Neel showed decreasing in their areas due to fluctuation in rainfall amounts and the reduction maybe affected by anthropogenic activities and population pressure which cause increase in bare land during the last year which exposed the land surface to runoff and torrents events.”

Conclusion and Recommendations:

- The results determined and validated the changes of LULC led to influence on runoff and torrent at regional scale.
- The result revealed that major LULC changes were taken place (bare land, sandy soil, clay soil, vegetation cover and urban area) in the periods of the study.
- The research concluded that the changes over time by human activities and natural terrain of the land significantly alter hydrological process and cause disaster on the study area, thus planning and adaptation measures should be taken to stop this hazard.

Conclusion and Recommendations-Cont.

- The research recommended to Afforestation and reforestation programme which have significant role in reducing runoff water.
- Creation of water harvesting to collect runoff and torrent water.
- Prevention of housing in low-lying areas by establishment of channels to permit runoff and torrent water.

Thanks