Impact of vegetation on the environment of Margalla Hills National Park (MHNP) Islamabad using remote sensing techniques

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Outline

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- Introduction
- Study area
- Data & Methodology
- Results
- Conclusion

Background

- Changes in vegetation cover are amongst the more evident of the alterations that mankind has caused to the global environment.
- It is estimated that 15–20% of the world's forested area has been lost through human action since 1700
- Increasingly, however, concern has been expressed that human activity is significantly altering the global climate, with potential consequences for the global distribution of vegetation.
- Changes in land cover also drive changes in climate, through alterations in, for example, the carbon and water cycles and the Earth's albedo
- Rapid growth in population, urbanization, industrialization and transportation in the Islamabad and surrounding

Background

- Margalla Hills National Park (MHNP) is located in the Potwar Plateau in the northern part of Islamabad, the Capital city of Pakistan
- To save the ecosystem, vegetation and natural environment of the Margalla Hills, it was given the status of a national park after the government recognized the growing threat to it's flora and fauna in 1980
- Earlier, to the development of Islamabad as Capital city of Pakistan, Margalla Hills forest was managed for extraction of fuel wood, hay and grazing while hunting and poaching was common in this area.

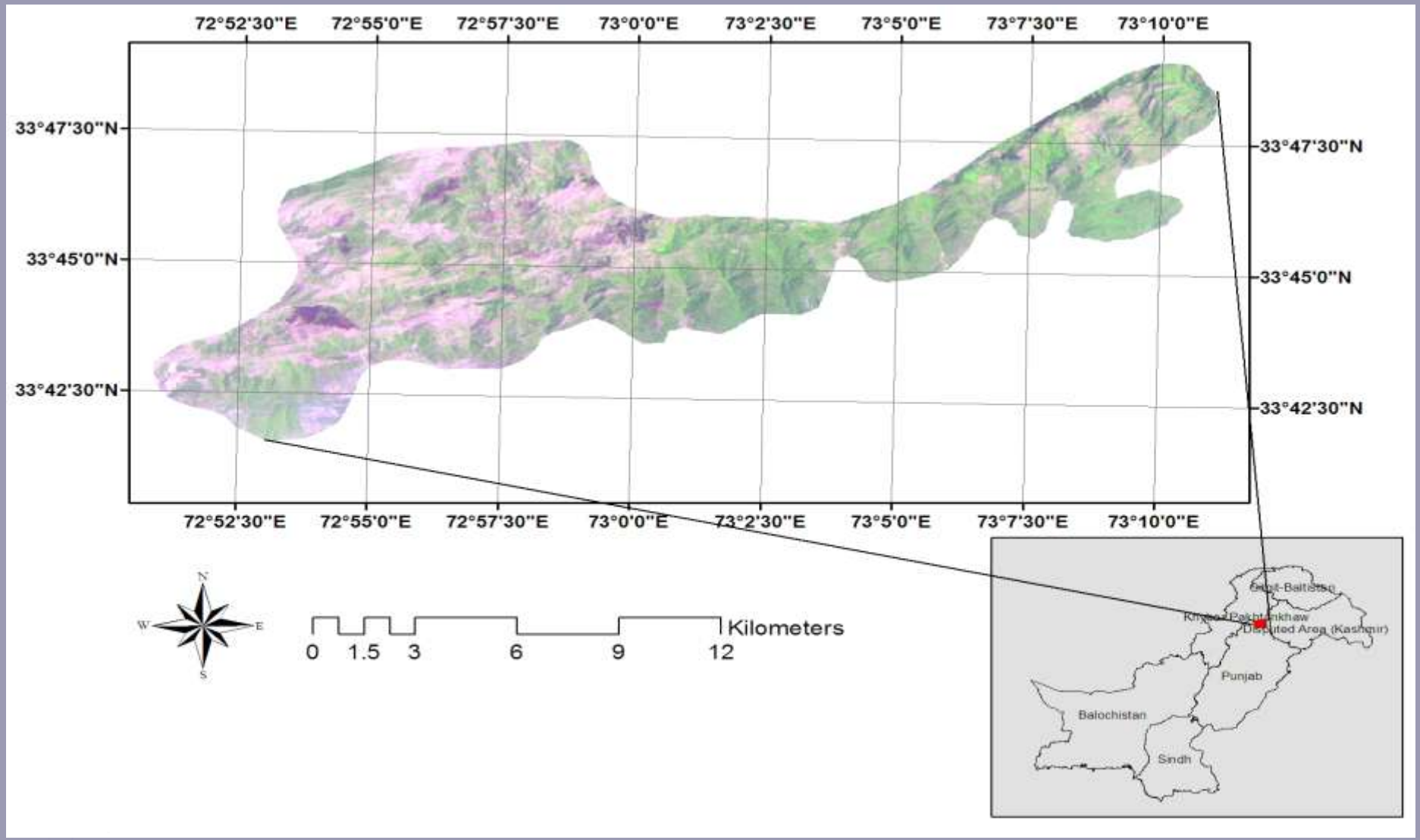
Introduction

- To analyze the impact of vegetation on the environment of MHNP, using RS and GIS techniques
- Vegetation plays a vital role on the environment, biodiversity, ecosystem, geomorphology, human health, water resources, sedimentation, weather and climate
- Spatiotemporal images of MSS, TM and ETM+ data used from 1979 to 2009
- NDVI and EVI models are applied on the satellite images to extract the vegetation covered area
- ASTER DEM is used to extract the topographic information
- Meteorological data is used to create relationship of rainfall and temperature with the vegetation and

Study Area

- Climatically there are five different seasons of the year that is winter from December to February, Spring from March to April, Summer from May to June, Monsoon from July to September and Autumn in October.
- The climate is humid with average maximum and minimum temperature of 37°C to 15°C, respectively.
- The hottest months are May to June when temperature rises up to 48°C and the coldest months are December and January when temperature falls below 0°C.
- Annual average precipitation is 1018 mm most of which, is received during the Monsoon season.
- According to the 1998 census, the total population of the city was 0.8 million and average annual population growth rate from 1981 to 1998 was 5.10, whereas estimated

Study Area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0 1.5 3 6 9 12
Kilometers
Punjab
Balochistan
Sindh

Data & Methodology

- Landsat satellite data
- ASTER DEM
- Meteorological data
- Population data

Data & Methodology

Sr. #	Acquisition date	Satellite series	Sensor	Path	Row
1	September 02, 1979	Landsat-3	MSS	161	37
2	September 09, 1992	Landsat-5	TM	150	37
3	May 21, 2000	Landsat-7	ETM+	150	37
4	May 30, 2009	Landsat-5	TM	150	37

Data & Methodology

$$NDVI=(R_{NIR}-R_{RED})/(R_{NIR}+R_{RED})$$

Where

R_{RED}=Reflectance of Red band

R_{NIR}=Reflectance of near Infrared band

Data & Methodology

$$EVI = (R_{NIR} - R_{RED}) / (R_{NIR} + C_1 R_{RED} - C_2 R_{Blue} + L) \times G$$

Where

R_{NIR} = Reflectance of near Infrared band

R_{RED} = Reflectance of red band

R_{Blue} = Reflectance of blue band

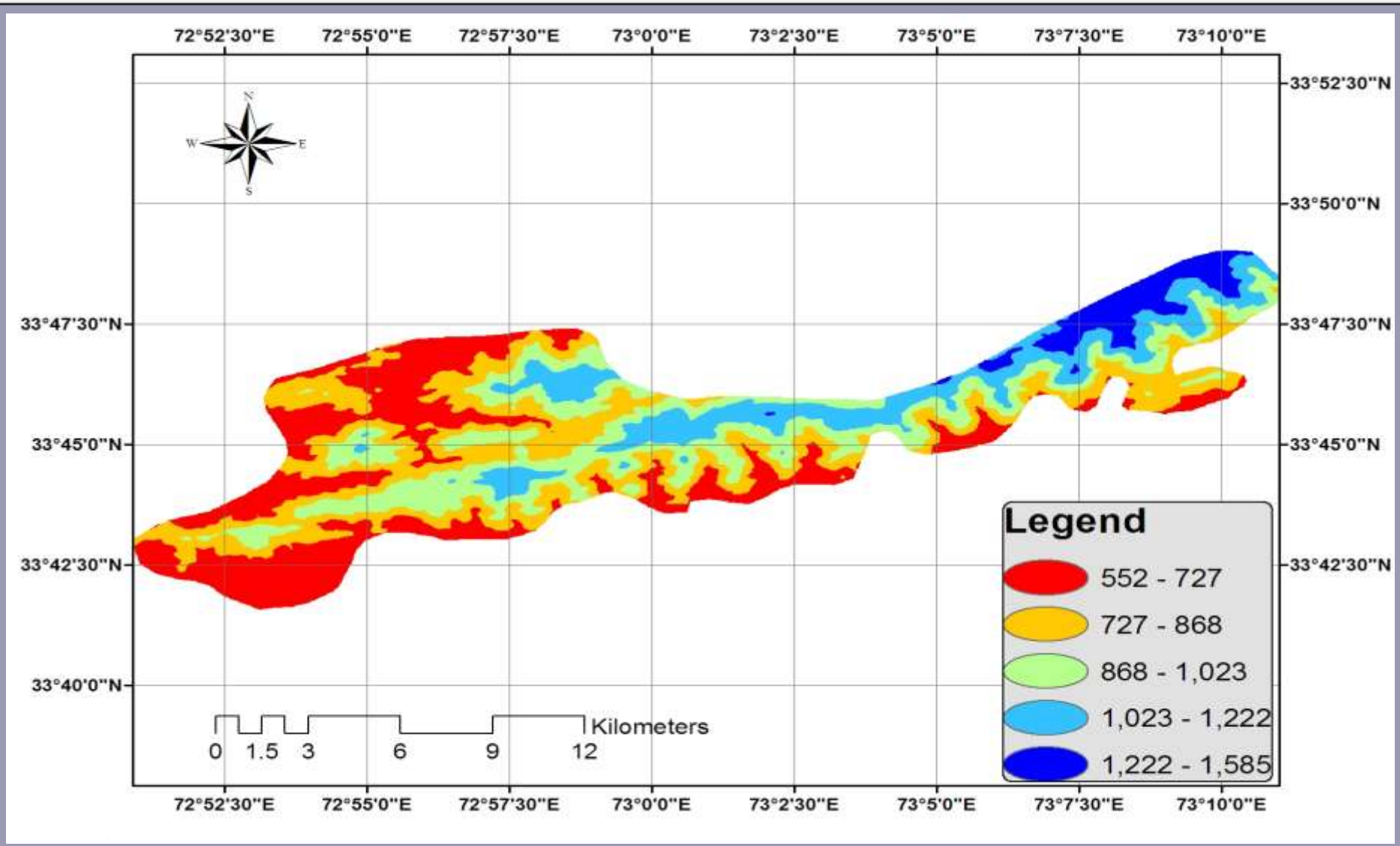
C_1 (coefficient) = 6

C_2 (coefficient) = 7.5

G (gain factor) = 2.5

L (canopy background adjustment term) = 1

Results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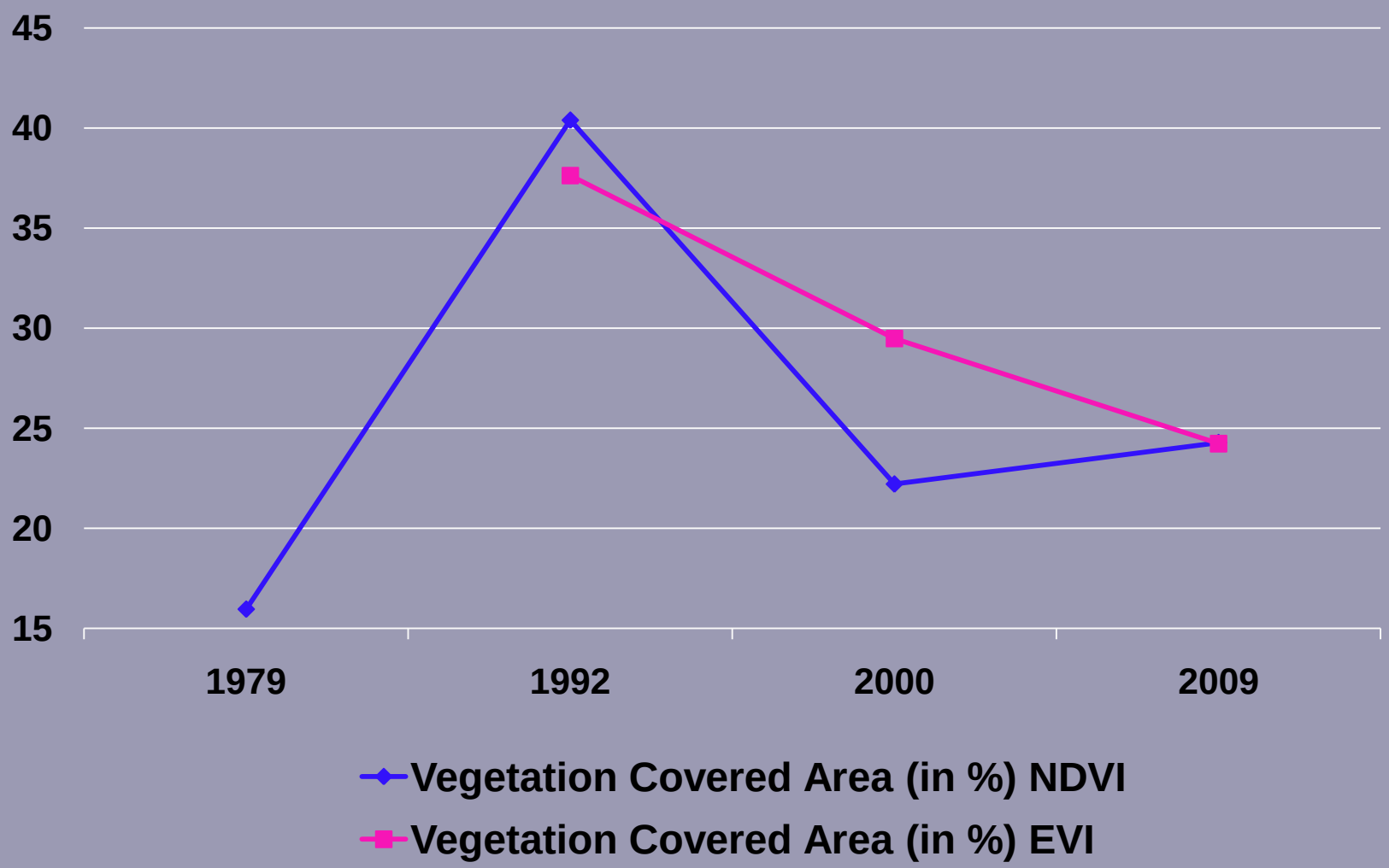
33°52'30"N
33°50'0"N
33°47'30"N
33°45'0"N
33°42'30"N
33°40'0"N
N
W
E
S
Kilometers
0 1.5 3 6 9 12
Legend
552 - 727
727 - 868
868 - 1,023
1,023 - 1,222
1,222 - 1,585

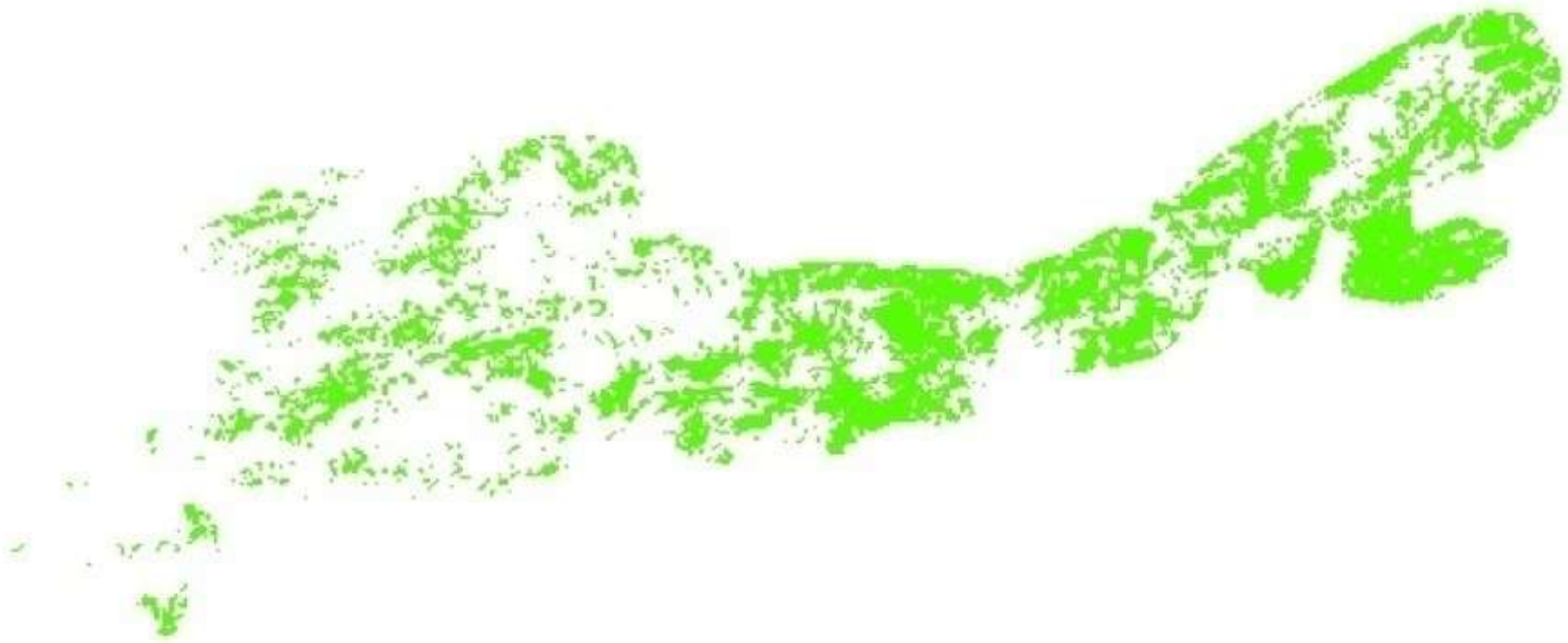
Results

Years	Vegetation Covered Area (in %) using NDVI	Vegetation Covered Area (in %) using EVI	Changes in NDVI per annum (in %)	Changes in EVI per annum (in %)
1979	15.96	-	-	-
1992	40.39	37.62	01.88 increased	-
2000	22.21	29.48	02.27 decreased	01.02 decreased
2009	24.28	24.23	00.23 increased	00.58 decreased

Results

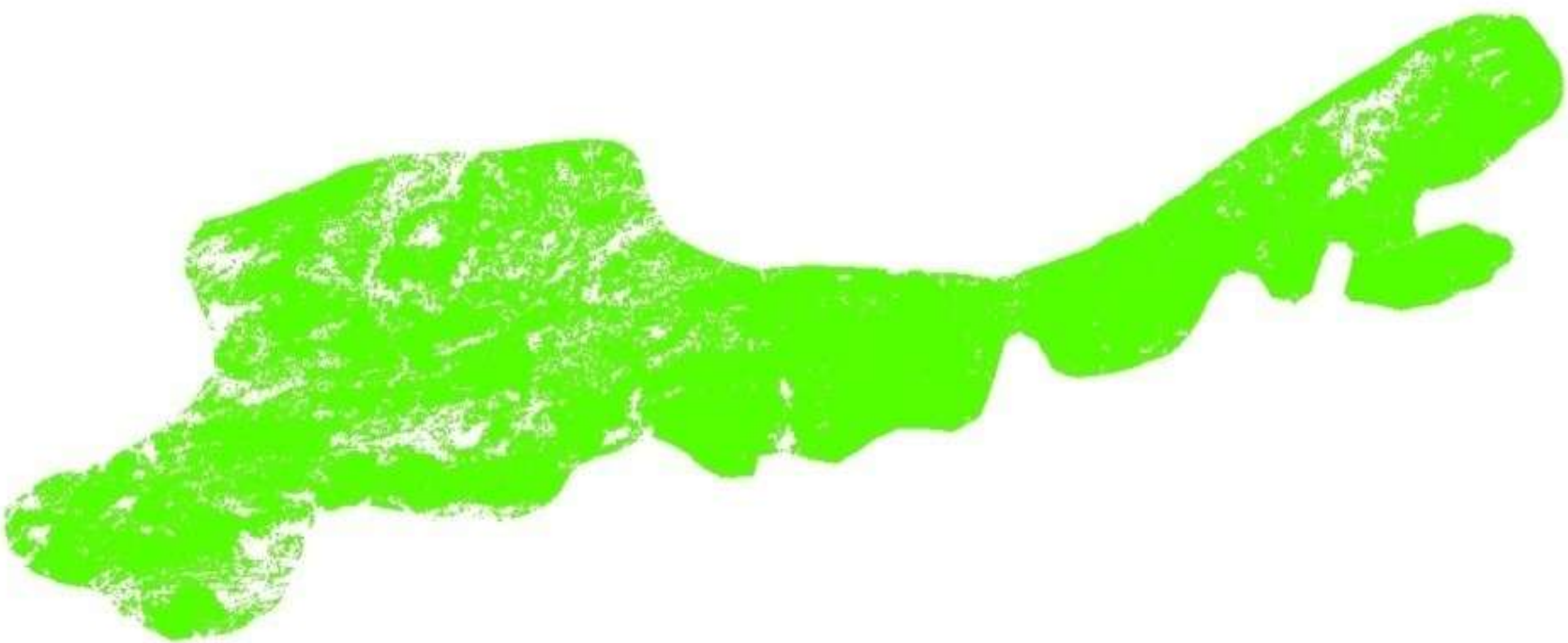

45
40
35
30
25
20
15
1979
1992
2000
2009
Vegetation Covered Area (in %) NDVI
Vegetation Covered Area (in %) EVI

Results (NDVI)



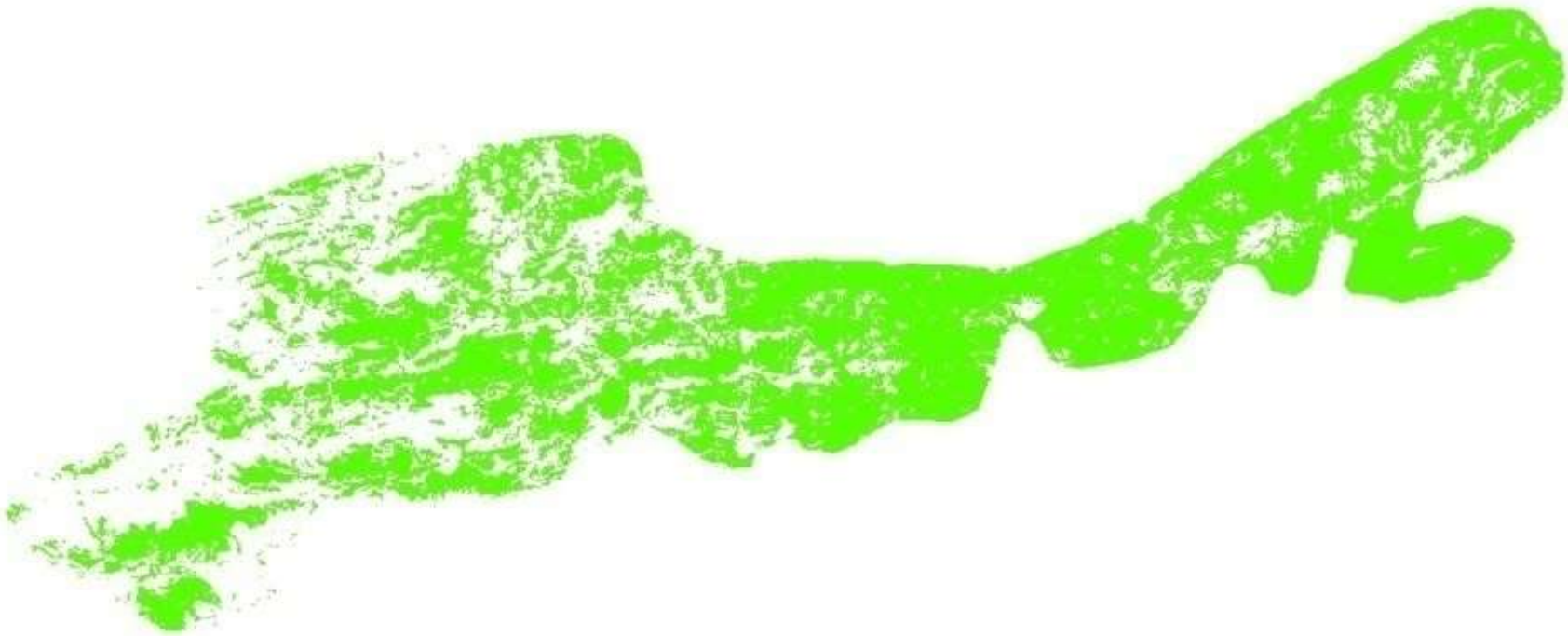
1979

Results (NDVI)



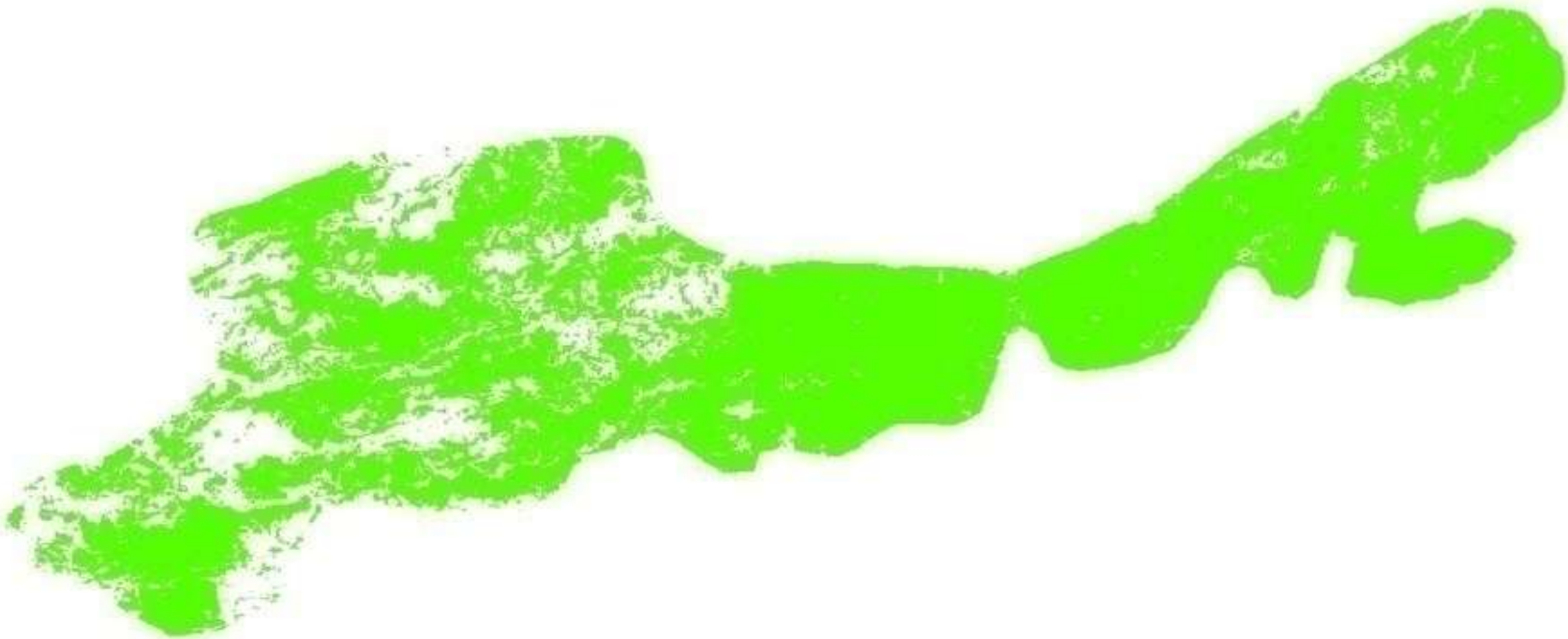
1992

Results (NDVI)



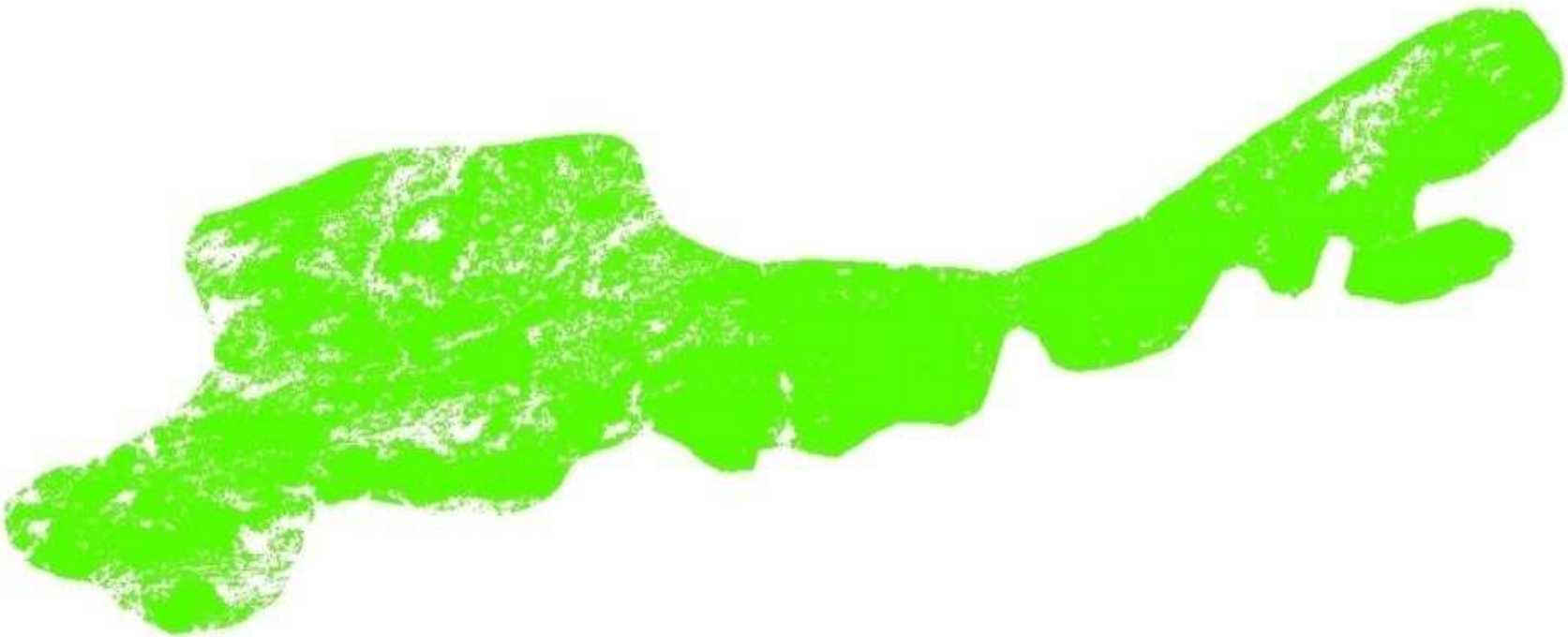
2000

Results (NDVI)



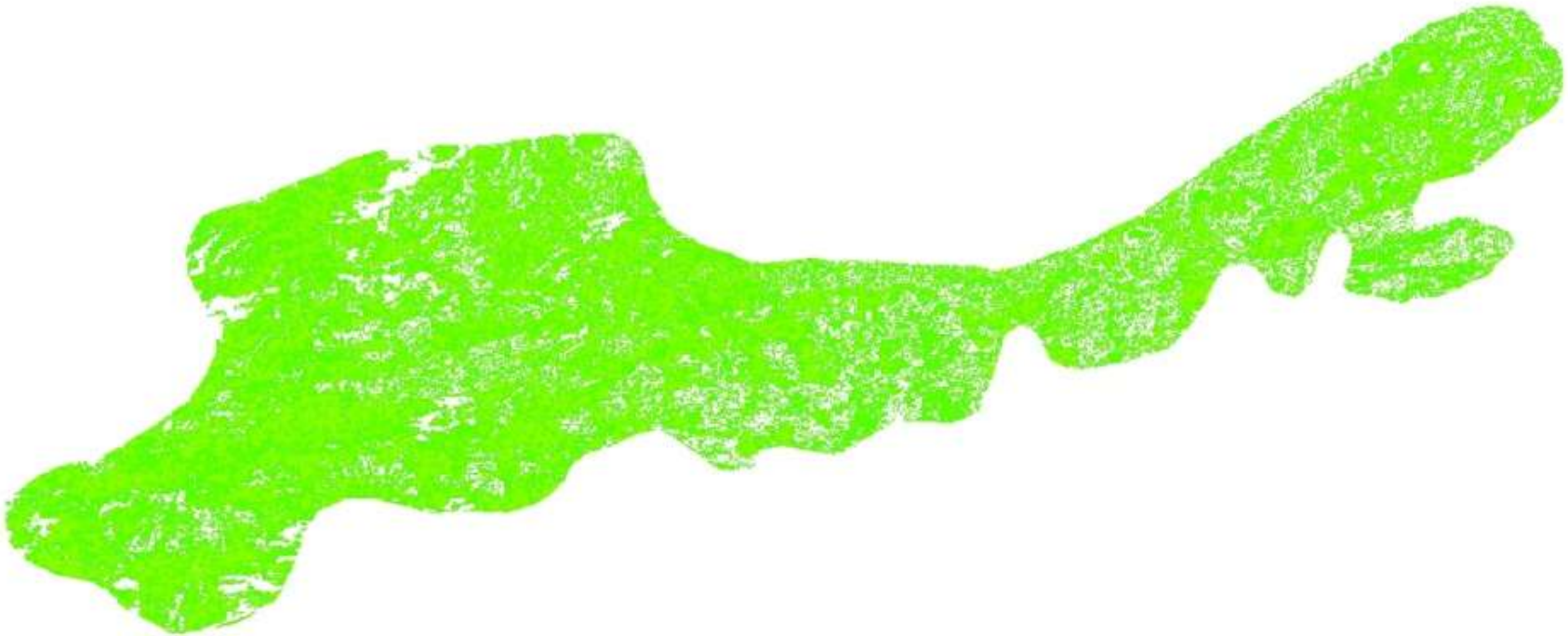
2009

Results (EVI)



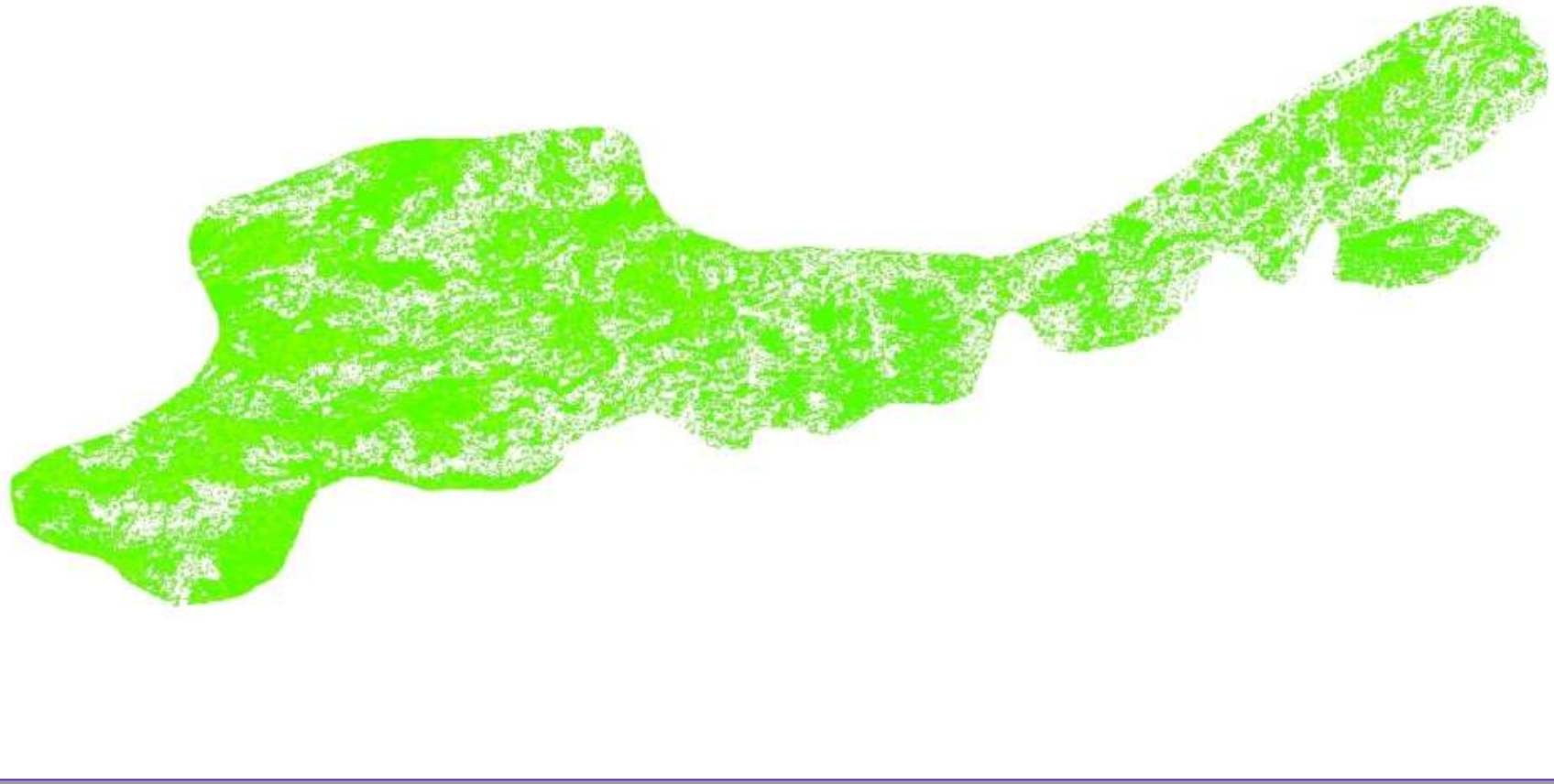
1992

Results (EVI)



2000

Results (EVI)



2009

Results

- EVI reduces both atmospheric and soil background noise simultaneously
- Thus performs better than does the NDVI in many applications related to vegetation indices
- EVI is proved to be more sensitive to topographic conditions as compared to NDVI.
- Correlation has been created of topography, rainfall, temperature, and population with vegetation and environment
- Vegetation is decreasing due to various factors including extraction of fuel wood, fire etc. and due to high topography, erosion is resulted to reduce the vegetation on the MHNP.

Results

- Vegetation covered area estimated on 2nd September 1979 using NDVI was 15.96%, before the establishment of MHNP was very low due to no restrictions to cut the vegetation and forest wood.
- Once Margalla Hills got named as MHNP, then we found maximum vegetation on 9th September 1992 was 40.39% using NDVI algorithm and 37.62% using EVI algorithm, though heavy rainfall was also recorded prior to obtaining the image.
- On 21st May 2000, vegetation covered area estimated was 22.21% using NDVI and 29.48% using EVI and low rainfall was recorded in this month.
- However, once again on 30th May 2009, vegetation covered area estimated was 24.28% using NDVI which

Results

- From 1979 to 1992, the vegetation covered area increased 01.88% per year, from 1992 to 2000 vegetation covered area decreased to 02.27 % per year using NDVI and increased 01.02% per year using EVI and where from 2000 to 2009 vegetation covered area increased 00.23% per year using NDVI and decreased 00.58% per year using EVI algorithm.
- This indicates that these forests, vegetation and woodland could be affected by air pollution damages, forest fires, forest operations, clear cut areas, grazing and some other factors as well.
- We have estimated from the simple change detection procedure that the total forest fire areas during the period 1979–2009 in MHNP was 12 km^2, which comprised only

Results

- Forests in Pakistan in 1990 were estimated to cover about 3% of total land area and today, forest cover is less than 2%.
- Even with irrigated plantations and other wooded areas, forest land was estimated to be no more than 4.3% of the Pakistan territory, however, there is a great controversy about this estimate because government sources suggest that forested areas are about 5% of Pakistan territory and growing.

Conclusion

- It is not possible to monitor and estimate the vegetation covered area effectively for the past years without remote sensing techniques.
- Vegetation covered area help us to find the impact of increasing and decreasing trend on the environment of MHNP.
- Analysis presented in this work gives a reliable indication of the vegetation cover changes from 1979 to 2009 in the MHNP.
- After establishment of MHNP the vegetation covered area increased 01.88% per annum and during the period 1992 to 2000 it decreased 02.27% per annum.
- Vegetation covered area once again increased to 00.23% per annum during 2000 to 2009 using NDVI techniques

Conclusion

- Pollution, deforestation, forest fire, timber and non-timber products, recreational and tourism spots are playing a vital role in the change of vegetation covered area.
- It has also been noticed that hunting and poaching is common in this area even after declaring the study area as MHNP.
- Excessive exploitation depleted the vegetation, degraded wildlife habitat and adversely affected the wild fauna.
- Vegetation has been affected by fuel wood cutting and livestock grazing.
- Dense vegetation cover is a critical element of barking deer habitat which is used for hiding against predators and harsh weather conditions.

Conclusion

- Wildlife has been protected since the establishment of Margalla Hills as a National Park, however, due to illiteracy, most villagers are unaware of the importance of wildlife in the ecosystem and in our daily life.
- A strong awareness campaign is needed to educate the people in and around the MHNP, about the natural resources and involve them in the management of these resources.

Thank you for your attention

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Years	1979		1992		2000		2009	
Sr. No.	Rainfall	Temperature	Rainfall	Temperature	Rainfall	Temperature	Rainfall	Temperature
	August/September		August/September		April/May		April/May	
1	11.1	28	0	33.9	2	38.1	0	38
2	55.7	33	0	34.7	0	32.7	0	34
3	Trace	31	0	35.8	0	34.9	Trace	33.5
4	0	33	0	36	0	36.7	0	35
5	0	36	0	35	0	37.8	3	34.8
6	0	38	0	36.1	0	36.1	0	33.1
7	1.3	34	3.6	32.8	0	30.5	0	32
8	0	34	111.6	29.2	0	34.7	0	33
9	0	32	5.1	29.2	0	35	0	34.5
10	51.1	34	1	33.1	***	***	Trace	34
11	0	34	0	34.2	0	36.9	2	35
12	16.8	35	0	33.3	0	38.8	0	38
13	0	36	2	35	0	41.1	5	42
14	20.6	36	0	35.8	0	41.6	53	40
15	0	34	0	35.8	0	35.8	0	34
16	0	36	0	34.2	0	39.4	0	37
17	0	32	0	32.2	0	36.6	0	38
18	17.5	33	4	32.2	0	35.5	0	36
19	Trace	31	25.3	32.8	0	36.1	0	37
20	0	32	0	34.7	0	38.8	0	38.9
21	0	31	0	36.1	0	41.1	0	38
22	11.4	27	0	33.3	0	40	0	39
23	0	33	0	36.7	6	40.8	Trace	36
24	0	34	0	37.5	0	34.5	5	33
25	0	36	10	32.8	0	38.3	0	37
26	0	36	0.6	33.3	0	40.5	0	38
27	26.7	34	0	31.1	0	39.4	0	40
28	0	34	0	33.3	0	41.6	0	40
29	0	36	Trace	31.4	5	39.9	0	38
30	0	37	0.9	27.2	0	40	0	39.1
31	0	37	74.3	28.3	0	42.2	Trace	39