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Analysis of Changes in LULC of Western Ghat by Comparing NDVI and NDWI

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Abstract

1,50,000 km² of the area contains dense forest in Indian Western Ghats. Western Ghats is one of the world's ten "hottest biodiversity hotspot" which spread over six states. There is a gradual change in land and in water bodies of Western Ghats which is affecting the surrounding.

The research aims to compare and analyze the changes in land and in wet bodies by using Landsat series for the year 1988-2018. The Landsat data received for 1988, 1998, 2008 and 2018 is showing numerous differences in forest and water resources. The changes are studied by using software and by using Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) and also impact of forest changes on Western flowing rivers.

The overall per cent change in vegetation is found to be 14.19. Majority of change is observed in Tamil Nadu state by 21.90%. For water bodies the change is observed as 3.361% overall. Maximum changes are observed in Tamil Nadu state by 12.90%.

The changes from past and present of land can be used to predict the future changes in land and in water bodies and the impact of the same on the surrounding. This will be the contribution to nature for the conservation.

Keywords: Landsat; LULC; NDVI; NDWI

Introduction

Present scenario

There is a huge transformation in Western Ghats land due to natural substance or other substances like increase in cattle population, widespread rural poverty, and increase in human, increases in demands are affecting the nature's beauty which results in deforestation which further affects the water streams [1]. Noticeable changes have taken place in land use and land cover which further affects the atmospheric conditions due to reciprocity between water and forest [2]. As a result of infrastructure development project and agricultural changes a very severe land cover changes has taken place [3]. Quick changes and monitoring is might be difficult in some region of the Western Ghats. It is next to impossible to study areas with huge amount of changes and with large spatial scales with time consuming ground survey. Qualitative and quantitative availability of the resources are required with detailed study for the conservation and preservation of environmental grade [4]. But in this case RS and GIS play an important role. RS and GIS are progressively valued for providing relevant knowledge on land characteristics [5]. To study the differences and similarity in result and methodology of land use and land cover data is the objective of the thesis [6].

Need of study

Water is a meaningful part of each and every individual living on this earth. Forest is what beauty of the nature. Both should get priority for the conservation. Indian Western Ghats is known as an India's top ten "hottest biodiversity hotspot". Different species of flowering plants, non-flowering plants, bird species, mammal species, insects species, and river system is also originated in Western Ghats are Godavari, Krishna, Tungabhadra. For such an extravagant range it seems difficult to take some actions regarding conservation or to find out solution on negative changes. Changes in Western Ghats have been a trouble from varying years [7]. The extradited rate at which climate is changing it is becoming a serious portent for entire ecosystem and biodiversity [8]. Land use changes have imaginably large brunt on water resources [9].While production of resources which are essential for living beings the LC changes distribution, negative consequence curtailing, location monitoring, becomes a major challenge for decisions of forest officers, management of land and economic planning and it is necessary to stabilize the link between decisions of forest officers and subsequent for land management [10]. With a large enhancing ability of remote sensing to capture the discrepancy it is achievable to distinguish the changes in Western Ghats (WG) [11]. Development and Evaluation of vegetation and water index requires unmistakable measurement of the present and past land cover and land use parameters as changes in these parameters can be used to determine the ecological changes existing in a vegetation and water index [12]. RS and GIS help to provide info about land use and land cover and also detection of land changes. Statistically analyses of RS data to judge changes in resources, for water bodies and forests, over time has been in practice for decades [13].The relationship between vegetation and water index may be further utilized for detailed study of forest variety [14]. By using long term data also changes can be detected.

Study Area and Methodology

Biogeographically and biologically unique Western Ghats which is spread over 150000 km2 is the research area which is also known as Benevolent Mountains and which is older than Himalayas. The India's Great Escarpment is originating out proportion of the country's fauna and flora, most of them are only observed in India. The mountain range that spread over the six states that is Tamil Nadu, Kerala, Gujarat, Karnataka, Goa and Maharashtra covers the part of the Indian peninsula of about 140,000 square kilometers (54,000 sq mi) in a stretch of 1,600 kilometers (990 mi) parallel to the western coast .It is known as a one of the four watersheds which creates feeding the perennial rivers of India. The Kaveri, Krishna, Tungabhadra, Thamirabarani and Godavari are the rivers which originating in the Benevolent Mountains. In rainy season it contains large amount of water from most of the streams of Benevolent Mountains they connect with the rivers and forms large amount of water. Streams originating in Benevolent Mountains are the major source of generation of electricity, water for drinking and irrigation. The study area includes six states which is located on Benevolent Mountains which are rich in different species of plants (Figure 1). As per figure it is clearly observe that the large part of Goa and Kerala is occupied by Indian Western Ghats and very less part of Gujarat and Tamil Nadu is occupied by Western Ghats. The area of Maharashtra, Gujarat, Goa, Karnataka, Tamil Nadu and Kerala is 4736500, 758943, 342640, 3835914, 1460247 and 3714275 km2 respectively.

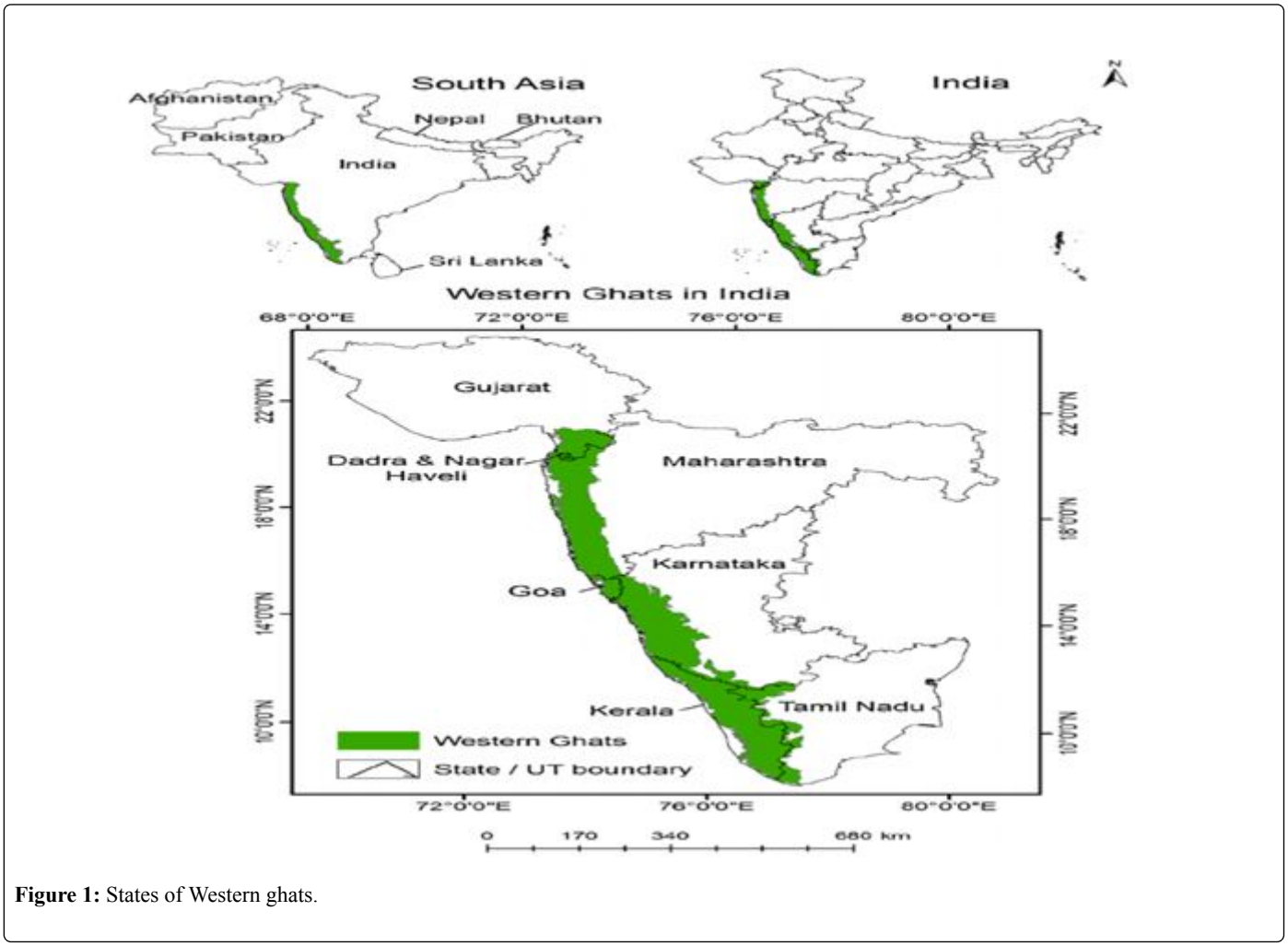

Figure 1: States of Western ghats.

LANDSAT data downloaded from USGS for the year 1988, 1998, 2008 and 2018 for 1, 50,000 km2 area of Western Ghats for the calculation of NDVI and NDWI .For the month September to December by using arc GIS software image were processed for further calculations. The start of the calculation is consider from September of the years and December is considered as its peak .as this are the end months of a year the changes will be clearly understand by using the changes occurred at the end of the year [11] also this months will be helpful regarding cloud free data. Captured images for these months show annual variations for NDWI and NDVI [15]. The calculation of NDVI and Band combination of downloaded date is calculated by using Arc GIS software by using red, infrared, and green band as these are the bands used to calculate NDVI and NDWI. Band combination further processed with mosaicking of different tiles of Western Ghats. So different tiles are downloaded by Landsat to form one complete tile of Western Ghats for the four different years. After that shape files for 6 different states was created by using arc GIS software for create simplicity to the work as it is difficult to work for such a large area of Western Ghats so for simplicity of work the Western Ghats is divided into six states that is Gujarat, Goa, Tamil Nadu, Karnataka, Kerala, and Maharashtra. Mapping can be used to get general idea of distributed forest variety [16].

The NDWI and NDVI for the images was calculated by using formula which is termed as NDWI=(G-NIR)/(G+NIR) and NDVI=(NIR-R)/(NIR+R) where G=Green Band, NIR=Near Infra-Red band, R=Red Band. After calculation of the vegetation and water index the percent calculation of changes is calculated by using the formula (New year changes − Previous changes)/Previous Changes*100 for each and every year percentage changes is calculated addressed classes found are deciduous broadleaf forest, evergreen broadleaf forest, mixed forest, and shrub land. Vegetation and water index is playing a major role in forming of composition and characteristics of the land surface [17] and in case of water two layers are found which are termed as Water Bodies and Permanent Wetlands. They showed numerous differences in percentage change calculations and are categorized in different cell the prediction of vegetation index and water index (Figure 2).

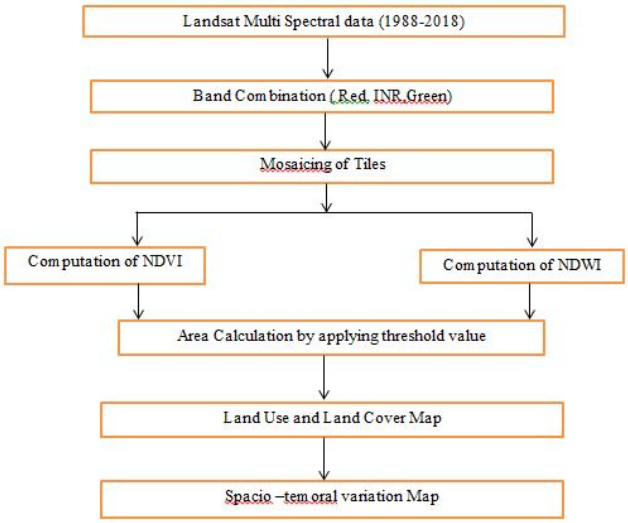

Figure 2: Methodology chart.

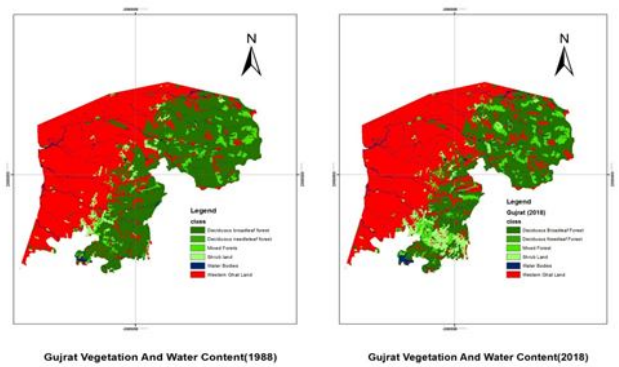

Figure 3: Gujarat Vegetation and Water Index.

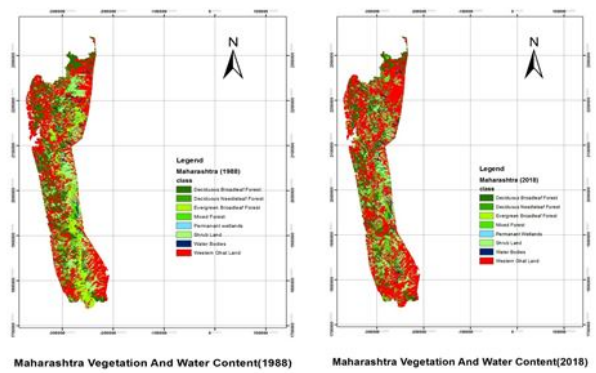

Figure 4: Goa Vegetation and Water Index.

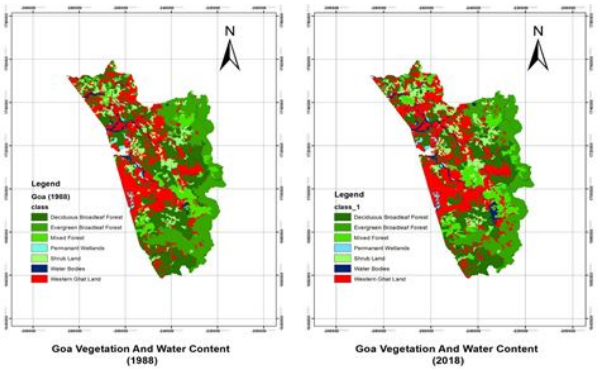

Figure 5: Goa Vegetation and Water Index.

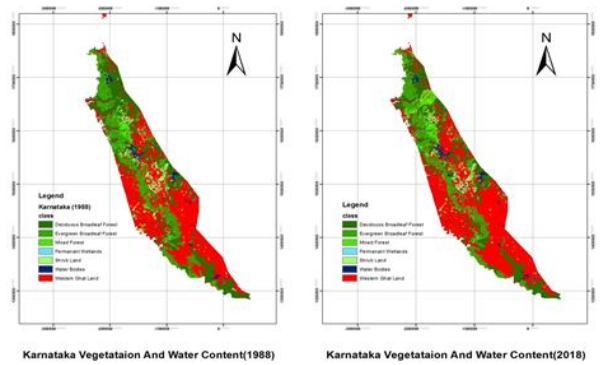

Figure 6: Karnataka Vegetation and Water Index.

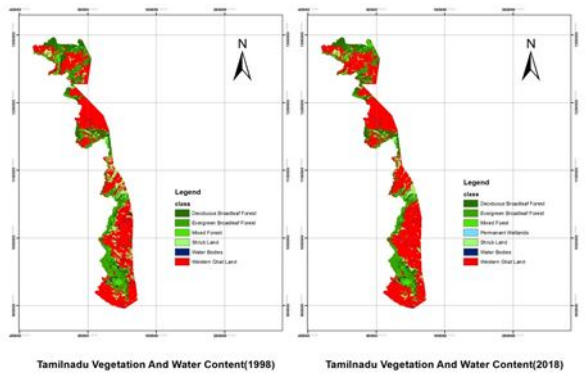

Figure 7: Tamil Nadu Vegetation and Water Index.

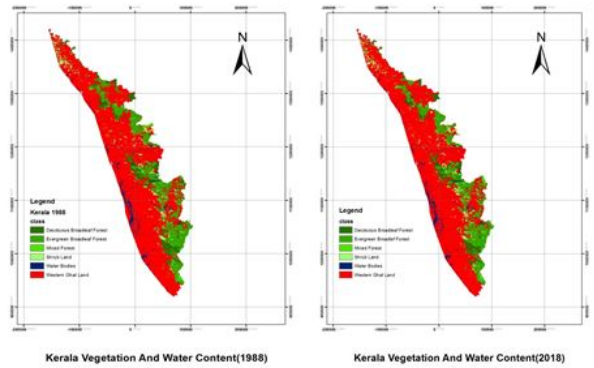

Figure 8: Kerala Vegetation and Water Index.

Area	Gujarat	Maharashtra	Goa	Karnataka	Tamil Nadu	Kerala
	308967	986035	105238	931202	200066	227299
	31331	260093	26224	112362	61953	60220
	19373	973384	30411	211562	176755	139007
		314108	76316	755013	246014	635467
	293	44391	0	0	0	0
	359934	1506887	238189	2010139	684770	1061993
	23925	158010	10011	116535	27341	142885
		6325	3476	751	0	0
	23925	164335	13487	117286	27341	142885

Table 1: Changes in Vegetation and Water Spread Area for the Year 1988.

Area	Gujarat	Maharashtra	Goa	Karnataka	Tamil Nadu	Kerala
	281038	863496	97754	828320	198240	199929
	37297	253845	23043	119968	67245	67375
	35531	920737	33548	186335	135341	142384
	0	316028	74820	739077	237277	617515
	292	44390	0	0	0	0
	354158	2398496	229165	1873700	638103	1027203
	25756	188785	12868	132992	34470	146625
	0	4807	2558	634	0	0
	25756	193592	15426	133626	34470	146625

Table 2: Changes in Vegetation and Water Spread Area for the Year 1998.

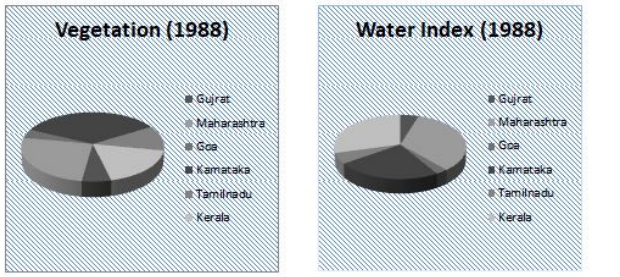

Figure 9: Vegetation and Water Index for Year 1988.

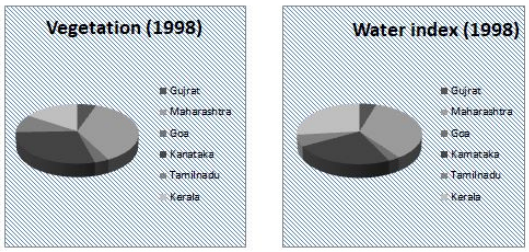

Figure 10: Vegetation and Water Index for Year 1998.

Area	Gujarat	Maharashtra	Goa	Karnataka	Tamil Nadu	Kerala
	270120	780866	86817	761045	182932	194005
	37203	306387	30969	199218	70924	66017
	35654	959569	35202	171748	99103	149387
	0	297234	74242	691028	229237	592368
	290	44069	0	0	0	0
	343267	2388125	227230	1823039	582196	1001777
	25332	170468	11784	129908	28169	139525
	0	4809	2766	743	82	0
	25332	175277	14550	130651	28251	139525

Table 3: Changes in Vegetation and Water Spread Area for the Year 2008.

Area	Gujarat	Maharashtra	Goa	Karnataka	Tamil Nadu	Kerala
	261208	699458	84237	692394	169062	173294
	37001	295436	28757	218362	76358	65327
	36016	951054	25892	14351	79985	153208
	0	301547	69941	642139	209389	556253
	289	44023	0	0	0	0
	334514	2291518	208827	1567246	534794	948082
	24756	167074	10595	104503	23773	128346
	0	4852	2432	594	39	0
	24756	171926	13027	105097	23812	128346

Table 4: Changes in Vegetation and Water Spread Area for the Year 2008.

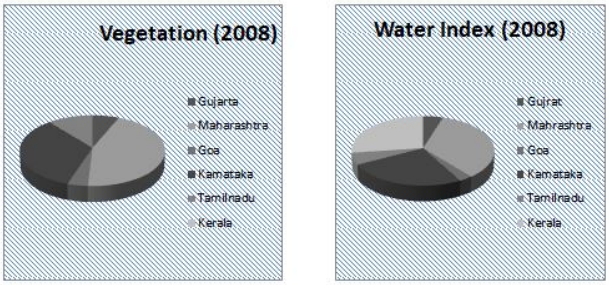

Figure 11: Vegetation and Water Index for Year 2008.

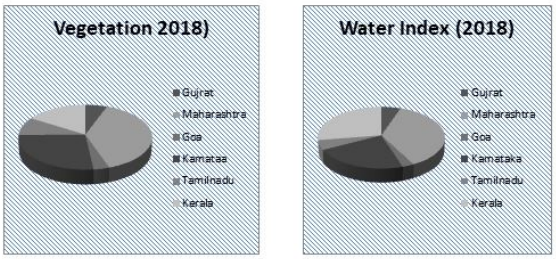

Figure 12: Vegetation and Water Index for Year 2018.

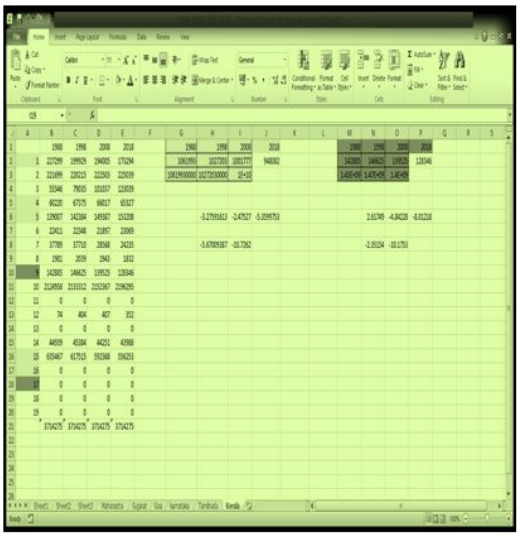

Figure 13: Attribute Table Calculation on word.

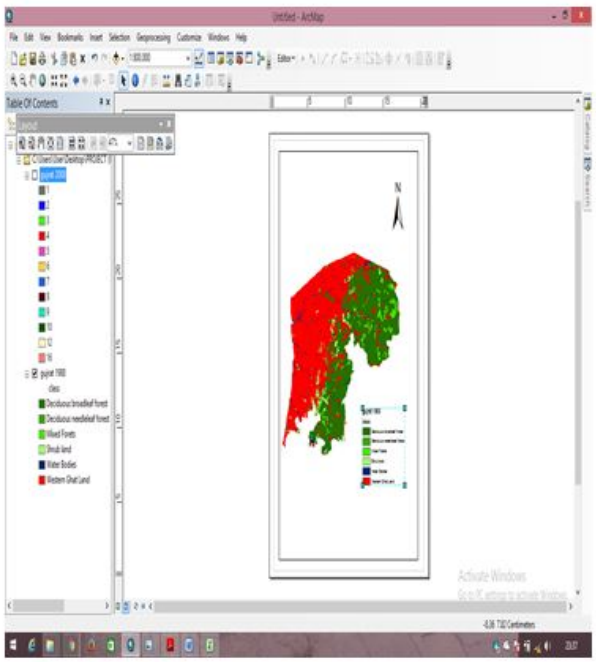

Figure 14: Arc GIS Mapping.

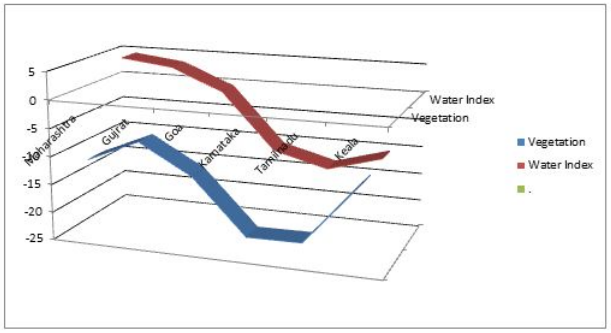

Figure 15: Comparison between Vegetation and Water Index.

Results and Discussion

There are 22% changes observed in forest area of Karnataka which is actually a large number of transformation and also large no of changes in water spread area i.e. 12.90% is observed in Tamil Nadu which indicates it's a high time for the state to take some action for the conservation of nature for the secured future of Green land (vegetation) and blue land (water spread area).As per the map observation large amount of Deciduous Broadleaf Forest land is converted into shrub land and mixed forest for the state Gujarat (Figure 3) and Maharashtra for Goa (Figures 4 and 5) the most of the Mixed forest area is converted into shrub land for Karnataka (Figure 6) Tamil Nadu (Figure 7) and Kerala (Figure 8) most of the part of vegetation index is actually converted into other Western Ghats land (Tables 1-4) (Figures 9-14) similarly in case of water content part of

the states other than Kerala indicating slight increment for the year 1988 to 1998 but again from 1988 the water spread area is converted into other land of Western Ghats. In case of Kerala the water spread area shows a negative change from 1988 there is complete decrement in maps of Kerala for the water spread area. The Main focus is on the states of the Western Ghats. It will become easy to pay attention to individual state economically and area wise also it is beneficial. For Urban and rural development one must take reference of vegetation and water spread area changes in past 30 years (Figure 15).

Conclusion

The new lifestyle, increase in population, infrastructure development may affect the more in future for vegetation and water index over Western Ghats. The high chances of flood, effect of biodiversity changes on monsoon pattern, the changes of hydropower project on marine life ,the danger of high rises on steep slopes of Western Ghats this are the effects we are observing now but there are lots of chances to increase the effects in future. The results we obtained may help to analyze, study the future changes and find a solution to overcome the future problems.

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