Ockhi Cyclone and its Impact in the Kanyakumari District of Southern Tamilnadu, India: An Aftermath Analysis

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Abstract- **The origin of Ockhi can be tracked to an area of low pressure that formed in the eastern Andaman Sea on 21st November 2017. While traversing the southern part of the Bay of Bengal, favourable conditions established it to consolidate into a cyclonic storm on 29th December of 2017 and devastated parts of Srilanka and Kanyakumari district of Tamilnadu. On its track, Ockhi cast severe damages to structures, property and also claimed the lives of least 218 peoples in the Kanyakumari district. An integrated Remote sensing and GIS study has been conducted to estimate impact of Ockhi on Landuse and Landcover of Kanyakumari District. Landsat 8 imageries of Pre and Post Ockhi where compared and changes made by cyclone Ockhi has been estimated in the present study.**

Keywords: Ockhi-Cyclone, Landsat, Image Processing, SAGA and Disaster.

INTRODUCTION

Climate change in global scale expected to be worsening the situation by affecting the Coastal regions though they are more sensitive to cyclones, high precipitation, temperature increase in sea and sea level rise (Ghose et al 2015). Where the study area itself situated in the coastal zone is suffering from many natural catastrophes such as storms, cyclones, floods, tsunami and erosion. Recently the study area was struck by type 3rd strong OCKHI cyclone on 30th November 2017 which was formed during 28th November 2017 at southern part of the Bay of Bengal and dissipated on 6th December of 2017 near the south coast of Gujarat. The wind speed during the onshore impact of the cyclone is about 155km/h to 185km/h with a lowest pressure of 976 mbar. Cyclones are called as Hurricane when it formed in the North Atlantic or Eastern North Pacific Oceans and Typhoons in Western Pacific regions (Dhruvesh et al 2016). Cyclones are natural hazard as described by Wisner et al 2004, hazard a perilous event, essence, anthropogenic doings or state that causes livelihood loss, damage or other health impacts, property damage, loss of life and services, social and economic disruption, or environmental impacts. The onshore and offshore regions of the cyclonic path has been severely damaged due to the Storm Surge, high speed wind blowing and flood due to heavy rainfall. Figure 1 shows the path of Ockhi cyclone. Information derived from the precise and capable tools of remote sensing and spatial analysis is very much useful in every stage of cyclone disaster management (Hussain et al

2015, Rana et al 2010, Wang and Xu 2010). To reduce the future tropical cyclonic impacts, the remote sensing data integrated with spatial analyses are essential tools that may provides necessary information on changes in the condition of environment and infrastructure due to cyclonic impacts (Hoque et al 2016). This study is to analyse the pre & post impact of cyclone on the land classes with the help of remote sensing and GIS techniques. This also helps to assess the effectiveness, reliability and problems found during aftermath analysis using these geomatics technique.

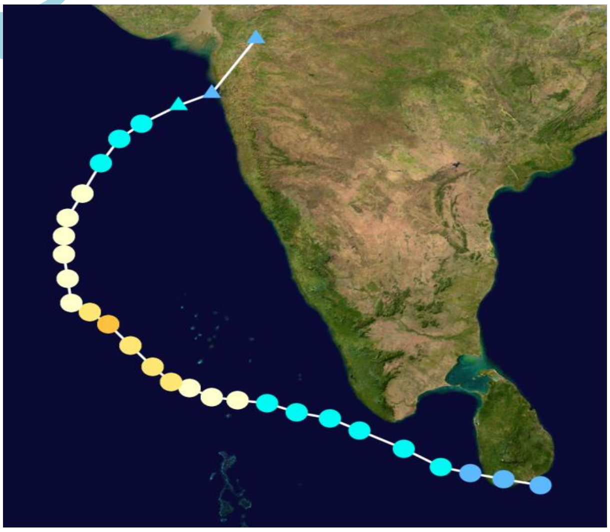

Fig 1. Track of Ockhi Cyclone by WikiProject Tropical cyclones/Tracks

STUDY AREA

The study area was located in the southernmost tip of the Indian subcontinent and lies between the latitude and longitude of 8.1° N to 8.5° N and 77.1° E to 77.6° E respectively. Kanyakumari is a coastal town in the state of Tamil Nadu and roughly covers an area around 25.89 km2. It has an elevation above 30m from the mean sea level (MSL). The major drainage system in this area is Tamiraparani river that originates from the Pothigai Hills from an elevation of 1,725 m above MSL on the south-western slopes of Western Ghats. Sub-tropical condition is the climate pattern that experienced by the study area with annual optimum temperature between 23° and 27° C and south-west monsoon during June to September and north-east monsoon during October to December is the monsoons that prevail over the area. The surface and sub-surface water bodies are being filled by monsoonal precipitation which is the main source of water and it ranges from 80 mm to 241 mm where the north-east monsoon (October and December) period contributes maximum rainfall to the study area. The Study area was shown in the Figure 2.

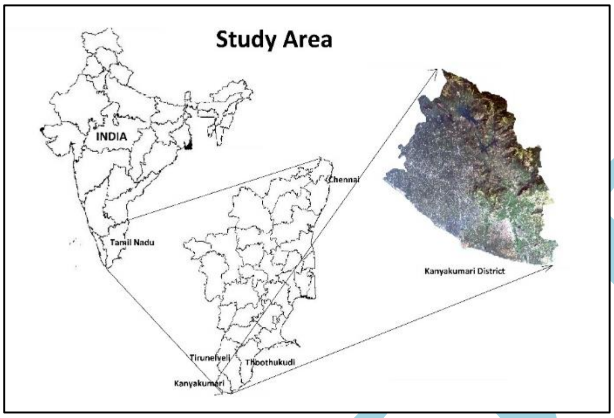

Fig 2. Map showing the study area

MATERIALS and METHOD

NASA's (National Aeronautics and Space Administration) Landsat 8 OLI – TIRS multispectral imageries of 30 m resolution (Sivakumar et al 2017, Ghosh et al 2015) were obtained from the USGS website namely EARTH EXPLORER, which are taken on 10th October of 2017 (before the Ockhi impact) and on 29th December 2017 (After the Ockhi impact). Below table 1 gives the spectral bands and their properties of Landsat 8 image. The obtained imageries are further registered in the Qgis environment to prepare the base map for the study area. Both the Landsat data sets loaded in to the Saga GIS (v2.1.2) to process the bands and get the land use classes for each image (Jayaprakash et al 2016, Jayaseelan et al 2014, Horvat 2013). By the RGB composite module in Saga GIS, the Nature colour composite maps (Fig3&4) were produced using the bands red, green and blue for each Landsat data set (Sharun et al 2011). Similarly false colour composite maps (Fig5&6) using the bands green, red and infrared were derived by the same module of RGB Composite (Hughes and Hayes 2014). Both the composite maps are used after the cluster analysis for grid process, which is used to derive the following land use classes 1. Urban – residential areas, industries and pavements; 2. Water - all the water logged areas; 3. Barren land - unused lands, waste lands, uncultivated lands, open scrubs, sandbars and beaches; 4. Agriculture – all the agriculture and irrigation fields; 5. Forest – bushes, scrubs and dense forest Based on NRSC

Table 1. Spectral band and their properties of Solar irradiance, Wavelength and Resolution

Spectral Band	Solar Irradiance	Wavelength	Resolution
Band 1 Coastal / Aerosol	2031 W/(m²µm)	0.443 – 0.453 µm	30 m
Band 2 Blue	1925 W/(m²µm)	0.450 – 0.515 µm	30 m
Band 3 Green	1826 W/(m²µm)	0.525 – 0.600 µm	30 m
Band 4 Red	1574 W/(m²µm)	0.630 – 0.680 µm	30 m
Band 5 Near Infrared	995 W/(m²µm)	0.845 – 0.885 µm	30 m
Band 6 Short Wavelength Infrared	242 W/(m²µm)	1.560 – 1.660 µm	30 m
Band 7 Short Wavelength Infrared	82.5 W/(m²µm)	2.100 – 2.300 µm	30 m
Band 8 Panchromatic	1739 W/(m²µm)	0.500 – 0.680 µm	15 m
Band 9 Cirrus	361 W/(m²µm)	0.1360 – 0.1390 µm	30 m

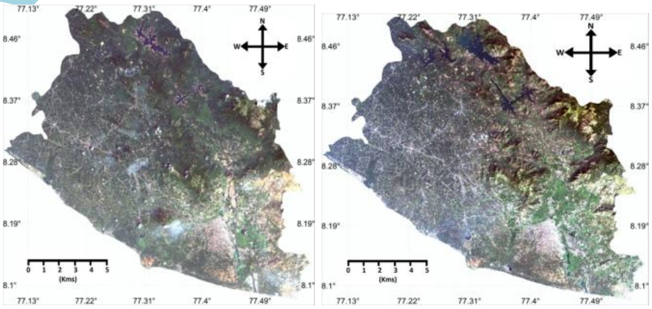

Fig 3 & 4. 10th October 2017 & 29th December 2017 Nature Colour Composite Maps

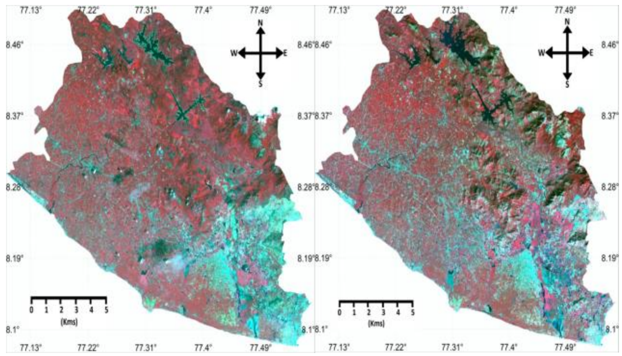

Fig 5 & 6. False Colour Composite Map of 10th October 2017 & 29th December 2017

Hill – Climbing method has been used in the cluster analysis of grid module by loading the visible and Infra red bands of both data sets (Rubin 1967) to derive unsupervised classification. Among the large number of classification methods supervised and unsupervised classification methods are commonly used method stated by Prabhakar and Tiwari (2015) in their studies. Totally 100 clusters are derived and overlayed on the nature colour and false colour composite maps of respective data set. Paine and Kiser in 2012 analysed and interpret the clusters using the tone or colour, shadow, pattern, texture, size, shape, location, convergence of evidence and its mutual relation, likewise the same technique is applied in this study. Respective class values are assigned using the module change grid values from Saga module library and the resulting maps are shown in the Figure 7 & 8. Using the field calculator tool the area of each land class is calculated for further analysis which is given in the results and discussions.

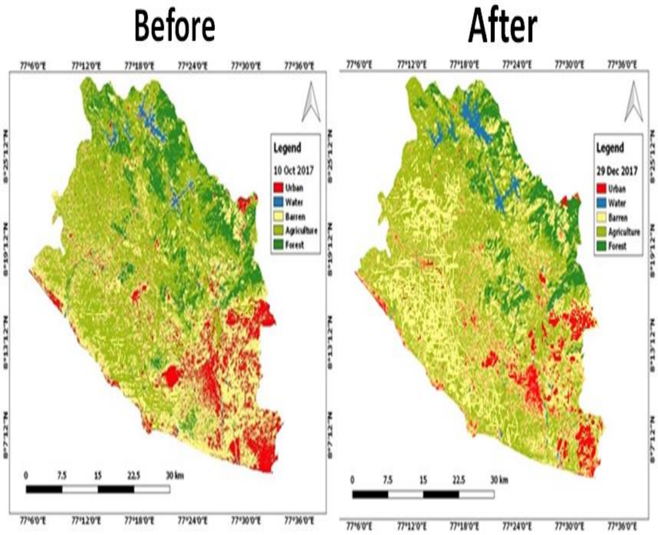

Fig 7 & 8. 10th October 2017 & 29th December 2017 Land Cover Classified Maps

RESULTS AND DISCUSSIONS

The results are given in the table 2 for the classification maps of before cyclone impact and after cyclone impact. On the 10th October 2017 the urban land area was 465.47 km2 which is reduced to 431.44 km2 on 29th December 2017 is seems to be that nearly 34.03 km2 of urban land was wiped out by the impact of cyclone. The high speed of wind produced by the cyclone Ockhi has destroyed small huts in the slum areas that present in and around the study area. The huts might be built by palm tree or coconut tree leaves, or by poor quality cement and asbestos sheets that were not withstand against the wind speed of the cyclone. As reported by the Tamil Nadu government in news print media that total of 4,501 houses in Cyclone Ockhi-hit Kanyakumari have suffered partial and full damage on which 1,687 houses had been damaged completely while 2,814 houses suffered partial damage(figure 9).

Fig 9. Cyclone Ockhi damaged house in Kanyakumari. courtesy: www.firstpost.Com

The heavy rainfall due to the cyclone is increased the water level of almost all the reservoirs, lakes and ponds in the study area that also reflected in the results. The average rainfall of 15 cm is increased the water storage up to 149 feet at Perunchani Dam in Kanyakumari where the dam's total water storage is 156 feet. Before the cyclone impact the water storage areas were 19.86 km2 and it is increased to 31.06 km2 after the impact of Ockhi cyclone. Even though the water logged area of about 11.2 km2 has been increased after the Ockhi impact in the study area, the cultivated land like paddy crops, coconut trees, rubber trees, banana trees etc., faced severe damage to the crops leads the irrigation land is decreased from 179.19 km2 to 170.17 km2. The bar chart of figure 10 illustrates the increase and decrease in the total area of land classes during before the cyclonic impact and after the cyclonic impact and the pie chart of figure 11 shows percentage of the same. The forest land area before the impact of Ockhi cyclone is about 846.37 km2 which holds 50.26% of total land mass of the study area and it is reduced to 745.12 km2 after the cyclone. The devastative cyclone has destroyed about 101.25 km2 of dense forest land and nearly 550 trees were uprooted by the impact of the cyclone. The barren, open scrub land area has increased from 173.1 km2 to 306.21 km2.

Table 2. Calculated Area for each class

S.NO	LAND CLASSES	LAND % BEFORE IMPACT	LAND % AFTER IMPACT	AREA in Km^2 BEFORE IMPACT	AREA in Km^2 AFTER IMPACT
1	*Urban*	27.64	25.62	465.47	431.44
2	*Water log*	1.18	1.84	19.86	31.06
3	*Barren Land*	10.28	18.18	173.1	306.21
4	*Agriculture*	10.64	10.11	179.19	170.17
5	*Forest*	50.26	44.25	846.37	745.12
TOTAL		100	100	1684	1684

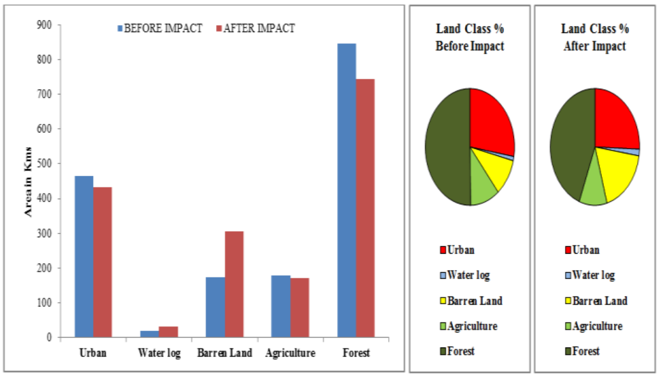

Fig 10. Bar-chart & Pie-charts shows the area of classes in Km2 & the percentage of total area of land classes

CONCLUSIONS

Even though the geomatics methods are simple and reliable, the demands of the cloud free satellite images are making the study to complicate. However in the case of Ockhi, the availability of Landsat 8 images with in the three month period before and after Ockhi impact made it possible. From the results and discussion it is concluded that water and barren land classes are increased and the forest, agriculture and urban lands are decreased. Due to the poor construction strategies, few urban land areas have been destroyed by the wind speed of the Ockhi cyclone. The increased water storage due to the cyclonic rainfall lets the irrigation possible and makes forest lands to be converted in to agriculture and also increased barren land. The Remote sensing and GIS techniques in aftermath analysis of cyclone disaster is purely depends upon the availability of required data set in specific period of time which have to be ensured and it also helps in the disaster management and planning.

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