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CASE STUDY

Ecological impact of Rohingya refugees on forest resources: remote sensing analysis of vegetation cover change in Teknaf Peninsula in Bangladesh

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Abstract – Satellite remote sensing technique has been used to assess the vegetation cover changes experienced by areas severely affected by Rohingya refugees in Teknaf peninsula of Bangladesh which is bordering Myanmar. Since 25 August, 2017, approximately 655,000 refugees settled in Bangladesh as of 11 December 2017. Majority of them are settled in the sub-districts of Teknaf and Ukhiya. Teknaf peninsula is an ecologically critical area. It includes the protected Teknaf Wildlife Sanctuary, one of the oldest reserved forests in Bangladesh. This vegetation at the southern coast of Bangladesh plays a vital role in the climate change adaptation and mitigation process in the region. Refugee camps and their practice of cutting trees to use as firewood for cooking cause significant deforestation. This study shows a major loss of vegetation cover following the refugee influx. The analysis of the remote sensed images provides quantitative data on the adverse impact of the refugee crisis on the natural resources and the ecosystem of the host community.

Keywords – forests, Rohingya refugees, ecology, climate change, vegetation, remote sensing

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Introduction

Impact of refugee crisis on the environment and natural resource of the host community has become an emerging issue in refugee research. Temporary shelters are often built near environmentally sensitive areas like national parks, reserve forests reserves, or agriculturally marginal areas (Shepherd, 1995). Refugees often stay in their host countries for long periods of time, having a prolonged impact on the environment (Shepherd, 1995). On 25 August 2017, massive violence broke out in Rakhine State, Myanmar. As of 11 December 2017, there were nearly 860,000 Rohingya refugees in Cox's Bazar district – of whom 655,000 have arrived since 25 August 2017 (UNOCHA, 2017). Rohingya refugees and asylum-seekers have arrived into Bangladesh from Myanmar in waves since at least the 1970s (Amnesty International, 2016). The Rohingyas, who have crossed the border from Myanmar into Bangladesh since August 25, 2017 outnumbered the local people in Ukhia and Teknaf sub-districts of Cox's Bazar district. According to the population census of 2011, the total population of Teknaf sub-district is 264,389 while that of Ukhia sub-district is 207,379 and the estimated Rohingya population stands at over 1 million, and increases continuously (UNB, 2017). The majority of people are settled in Teknaf and Ukhiya sub-districts of Cox's Bazar, a district bordering Myanmar identified as the main entry area for border crossing (IOM, 2017). Teknaf peninsula is an ecologically critical area. It includes the protected Teknaf Wildlife Sanctuary, one of the oldest reserved forests in Bangladesh (IUCN, 2011). This vegetation plays a vital role in the region's climate change adaptation and mitigation process. Movement of thousands of people and the establishment of refugee camps can have a serious impact on local ecology, as well as on the welfare of nearby communities (Lynch, 2002). Refugees collect wood as fuel for cooking and for warmth and fell trees to build shelters. As a result, land surrounding the refugee camps may be stripped of trees and vegetation (Lynch, 2002).

Objective

The objective of the study is to assess the impact of Rohingya refugee influx since August 25, 2017 on vegetation cover in Teknaf peninsula using satellite remote sensing technique.

Data and Methodology

1. Data

Multispectral satellite data (Landsat 08 with 30 m spatial resolution) were used in this research. Satellite images were collected from the same season (autumn) of four different years (2014, 2015, 2016, and 2017) to avoid seasonal variations.

Table 1. Data characteristics of satellite imageries

Satellite	Bands	Date of Acquisition
Landsat 8	1 to 7 and 9	28 December 2017
Landsat 8	1 to 7 and 9	23 November 2016
Landsat 8	1 to 7 and 9	07 December 2015
Landsat 8	1 to 7 and 9	04 December 2014

Source: U.S. Geological Survey Archive

2. Study Area

Teknaf sub-district (38,870 hectares) is the study area which is located at 20.8667°N 92.3000°E. Teknaf is a sub-district of Cox's Bazar district in the division of Chittagong, Bangladesh. It forms the southernmost point in mainland Bangladesh and shares the border with Myanmar. The study excludes St. Martin's Island, a part of Teknaf and the southernmost point of Bangladesh. The study includes Teknaf Wildlife Sanctuary (also called Teknaf Game Reserve), a reserved forest. It comprises an area of 11,615 hectares.

3. Methodology

The main goal of this study is to determine the vegetation cover change of Teknaf peninsula using Normalized Difference Vegetation Index (NDVI). Since Landsat-8 images were used in this study, band 5 was taken as Near Infrared (NIR) and band 4 was taken as Red. For calculations of the NDVI data we used the formula

NDVI= (Band 5-Band 4) / (Band 5+Band 4)

Due to lack of standardized vegetation cover classification system for remotely sense data in Bangladesh, the general classification scheme from the site of United States Geological Survey (USGS 2017) was adopted.

NDVI values range from -1.0 to 1.0. Areas of barren rock, sand, or snow usually show very low NDVI values (for example, 0.1 or less). Sparse vegetation such as shrubs and grasslands or senescing crops may result in moderate NDVI values (approximately 0.2 to 0.5). High NDVI values (approximately 0.6 to 0.9) correspond to dense vegetation such as that found in temperate and tropical forests or crops at their peak growth stage. (USGS 2017)

This technique is applied for comparison of vegetation cover changes from multiple dates of NDVI imageries. All the pixels with NDVI values above 0.1 were counted for calculating total areas of vegetation. The vegetation cover change analysis was done by determining the total area occupied by vegetation and comparing the quantities from different years.

Two study areas were assessed: 1) the whole administrative area of Teknaf sub-district and 2) the "Teknaf Wildlife Sanctuary" situated within the Teknaf sub-district. For digital image analysis remote sensed data and GIS based software (ERDAS Imagine 2014; developer: Hexagon Geospatial) and ArcGIS 10.5 (developer: Esri) were used. From multispectral satellite images of the area (Landsat-8; autumns of 2014, 2015, 2016, and 2017) two subsets of images ("Teknaf sub-district" and "Teknaf Wildlife Sanctuary" shapefiles) were created for each year. The subset images were converted to individual NDVI maps in order to calculate total areas of vegetation cover. These areas (expressed in hectares) were determined by multiplying the number of pixels by 0.09 (based on the 30 m x 30 m resolution of the Landsat 8 images). Total areas of vegetation for the different years were calculated, tabulated, and the yearly changes were evaluated.

Result and Discussion

Tables 2 and 3 represent the characteristics of vegetation cover change in Teknaf sub-district and Teknaf Wildlife Sanctuary, respectively. The changes of vegetation cover for each year is shown in the rightmost column of the tables.

Table 2. Total vegetation cover of Teknaf sub-district

Year	Number of pixels	Area (hectare)	Area change (hectare)
2014	290056	26105.04	-
2015	288712	25984.08	-120.96
2016	292206	26298.54	-314.46
2017	277934	25014.06	-1284.48

Table 3. Total vegetation cover of Teknaf Wildlife Sanctuary

Year	Number of pixels	Area (hectare)	Change (hectare)
2014	127200	11448.00	-
2015	127684	11491.56	43.56
2016	127417	11467.53	-24.03
2017	126274	11364.66	-102.87

This timeline analysis shows a drastic change in vegetation cover in the year 2017 in both of Teknaf sub-district and Teknaf Wild Life Sanctuary. Total vegetation cover decreased by 1284.48 hectares and 102.87 hectares in Teknaf sub-district and Teknaf Wildlife Sanctuary, respectively. In both cases total vegetation cover is less than any other year since 2014. These changes are significant because this impact assessment is done just after 3.5 months of massive Rohingya influx. This massive Rohingya influx started in Bangladesh on 25

August 2017. The satellite image of 2017 was acquired on 12 December just after 3 months and 17 days. So the Rohingya refugee influx has impact on this period of 3 months and 17 days only. If this trend continues, it will seriously threaten the coastal forestry and overall ecosystem.

An increase in vegetation covers in any of these years might be the result of Social afforestation projects or other initiatives taken in different places of Teknaf peninsula.

Teknaf Wildlife Sanctuary is an area of 11,615 hectares that contains 538 species of plants and 613 species of wildlife, including Asian elephants (Mannan, 2017). Forests and trees are important in supporting community resilience and decreasing their vulnerabilities to climate-related stresses in different ways (Fedele et al., 2016). So the current situation of deforestation is alarming for the coastal resilience of Teknaf peninsula. A recently published book entitled "Deforestation in the Teknaf Peninsula of Bangladesh: A Study of Political Ecology" by M. Tani and Md. A. Rahman (Tani and Rahman, 2017) attempts to explore elucidate social factors contributing to processes of deforestation, including poverty, migration of refugees, forest encroachment, and power relations entailed in forest management at Teknaf peninsula. In this book, the chapter titled "Livelihoods of Rohingyas and Their Impacts on Deforestation" written by M. Z. Rahman (Rahman, 2017) revealed the livelihood mechanisms of undocumented Rohingyas and their possible impacts on the forest and other natural resources, including the Teknaf Wildlife Sanctuary. Cutting woods from hills exerted enormous negative impacts on Teknaf Wildlife Sanctuary. Issues of concern for the Rohingyas could only be mitigated or effectively resolved through cordial talks held between Bangladesh and Myanmar on these issues (Rahman, 2017).

Recommendations

The findings suggest the following:

1) NGOs and GOs should be assigned at the refugee settlement areas only for taking care of the deforestation issues.

2) Immediate action is needed to relocate Rohingya refugees from protected forest area.

3) Alternative cooking technologies, such as LPG cylinder and improved cook-stoves should be distributed among refugees to reduce the pressure on firewood.

4) Social afforestation should be encouraged. Fast growing tree plantations are needed to produce firewood for Rohingyas and local communities.

5) New research must be conducted to address the critical ecological consequences.

6) A complete policy framework is needed to deal with natural resource management during a humanitarian crisis.

Conclusion

A large number of Rohingyas from Myanmar migrated to the forest areas in Teknaf imposing a great threat to its sustainable forest maintenance. The continuously increasing population also impacts the local resources and the ecosystem. Forest resources are linked to many other issues, such as biodiversity conservation, climate change adaptation and mitigation, as well as coastal resilience. The Rohingya influx of 2017 is a completely new type of shock for Bangladesh. A sustainable forest management plan must be incorporated with the Rohingya response strategy.

Open access statement

Public interest statement

This study used satellite remote sensing data to assess quantitatively the vegetation cover changes experienced by areas severely affected by the ca. half million Rohingya refugees in the Teknaf peninsula of Bangladesh. The practice of the inhabitants of refugee camps to cut trees for using it as firewood for cooking causes significant deforestation. Overall, the refugee crisis adversely impacts the natural resources and the ecosystem of the host community.

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