

# The role of remote sensing data in mitigation of the impact of establishment and development of refugee camps on the natural environment – examples from Bangladesh and Tanzania

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## Background

According to UNHCR, approximately 95 million people were forcibly displaced worldwide at the end of 2021. This includes 51.3 million internally displaced persons (IDP) and 21.3 million refugees. Diverse housing conditions, uncontrolled growth due to the constant influx of new migrants, water and cooking fuel supply issues, sanitation, hygiene and security are just some of the challenges facing the refugee/IDP camps inhabitants. Large-scale, in terms of temporal and/or spatial contexts, settlements often lead to environmental pollution and land degradation, where severe deforestation and surface water pollution are just pieces of a larger picture. Common management mechanism implemented for IDP/refugees camps, do not sufficiently respond to different environmental, cultural, social and economic background of both settlements and host community, pushing both of those groups to maladaptive strategies. Undoubtedly, in such complex areas as refugee/IDP camps, the monitoring of the situation and settlement's management require the joint efforts of humanitarian aid agencies and local authorities as well as interdisciplinary research support.

## Case study location



## Aim

To present the most common and essential refugee activities that lead to anthropogenic environmental changes in refugee camps and their surroundings.

## Methods

**Multi-temporal Geospatial Analysis:**  
- VHR Satellite Data  
- HR Satellite Data (Optical and Radar)  
- Ground Truth Data

**Socio-Geographical Analysis:**  
- literature review  
- micro level - interviews with refugees  
- meso level - interviews with key informants (e.g. relevant local authorities, non-state actors, NGOs)

\* This approach examines the change detection and trend analysis based on multi-source geospatial data.

\* This approach investigates the insiders' perspective of the mutual relations between the natural environment and human activity.

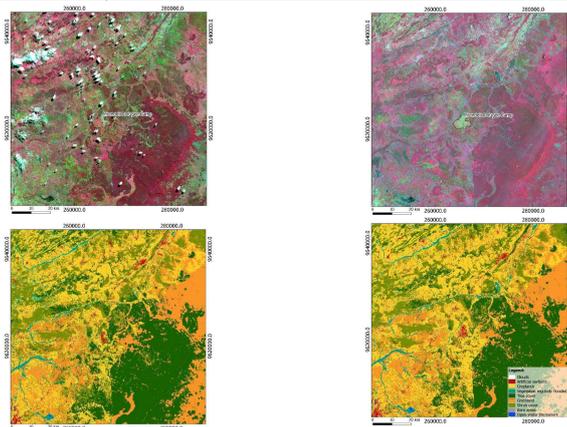
## Results

### Mtendeli refugee camp

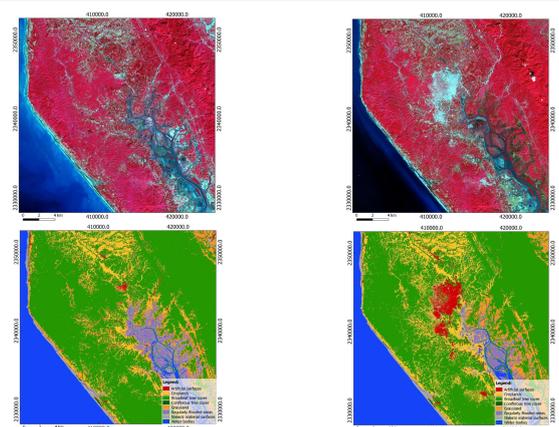
**Mtendeli refugee camp** was first opened in the 1990s, then closed in 2010, re-opened 6 km from its original location in 2016 and reclosed in 2021. It hosted mainly Burundians. Sudden overpopulation led to deforestation, soil degradation, a decrease in water quality and quantity, as well as depletion of wild food resources. **Deforestation** is the most significant challenge in the area. Before 1991, the woodland cover in Mtendeli was at 71% (Gwamagobe 2015). In 2009, the forest cover was at only 17.7%. Deforestation occurred in two ways. On the one hand, trees were felled to build camp infrastructure. On the other hand, up to 67.7% of all deforestation was caused by various sorts of illegal farming. In the 5th year after the first closure of Mtendeli refugee camp, most of the land was left uncultivated. Until 2016 the forest cover increased to 31%, suggesting the possibility of a complete recovery in the next 3 decades (Gwamagobe 2015). After the reopening of the camp, the problem returned. Remote sensing analysis (Gianvenuti & Vyamana 2018) confirmed that collecting firewood and clearing for agriculture were the main causes of forest degradation. **A decrease in water quantity and quality** is another challenge. The large population caused a quick depletion of water resources. Water also became a means of carrying disease. The necessity to continually combat food deficiency resulted in a significant **decrease in land productivity**. Crop expansion in the neighbourhood of first Mtendeli refugee camp accounted for 85% of soil degradation causes (REDES0 2003). This directly influenced decrease in land productivity and **soil erosion**. The analysis based on Sentinel-1 (radar, S1) and Sentinel-2 (optical, S2) HR satellite imagery of the neighbourhood of the camp over the years 2015 and 2020, showed that presence of refugees had an influence on the surrounding environment decreasing its quality through the loss of natural vegetation (Gromny et al. 2022).

### Kutupalong-Balukhali refugee camp

**Kutupalong-Balukhali refugee camp** has a population exceeding 700.000 inhabitants. One of the main environmental concerns is massive **deforestation** and conversion of forest and agricultural areas into settlements. Refugees living in the Kutupalong-Balukhali refugee camp consumed lots of wood as fuel for cooking and shelter construction material. With time, thanks to the usage of the LPG as a cooking fuel helped to limit consumption of firewood, but the problem was not solved. Despite limitation of the deforestation in recent years, the damage is done, and emergence of this huge refugee settlement prohibits to restore the natural landcover in the area. Moreover, resource consumption causes increasing **air pollution**, reduction of the capacity of forest biomass to store carbon, increased noise and has a negative impact on environmentally sensitive areas (Labib, Hossain, Patwary 2018). The effects of deforestation affects the whole Teknaf Peninsula, including the **degradation of marine resources** (Sills 2019). Rapid deforestation and hill cutting for sand extraction cause **soil erosion**. During the monsoon season, the situation is especially dangerous and leads to **landslides, flooding and pollution of existing water resources**. Moreover, the large usage of various types of plastic is one of the main sources of soil pollution and can cause flooding by blocking drainage systems (UNDP and UN WOMEN 2018). This type of contamination directly affects local population living in the proximity of the camp. Plastic waste pollute rice fields and limit access to the surface water. In the long run, wiping out of the vegetative cover directly connected with the soil conditions may result in further degradation of the regional environment.



Mtendeli refugee camp and its surrounding, presented on Sentinel-2 images in a) 2016 and b) 2020, and corresponding Land Cover classifications maps based on S1 and S2 for c) 2016 and d) 2020.



Kutupalong-Balukhali refugee camp and its surrounding, presented on Sentinel-2 images in a) 2016 and b) 2021, and corresponding S1/S2- Land Cover classifications maps for c) 2016 and d) 2021.

## Chosen recommendations to prevent degradation of the environment

### Camp establishment:

- Rapid creation of the crisis management group consisting of representatives of local and national authorities, interdisciplinary research incl. remote sensing as well as experts in development, logistics and environmental protection;
- Rapid preparation of environmental assessment, done before the choice of the place of the camp establishment – with a focus on the environmentally sensitive areas;
- The shelter should be constructed from environmentally friendly resources giving protection to inhabitants according to the different climatic conditions.

### Camp development:

- Mapping of camp area morphology and vegetation cover to maintain as much vegetation cover as possible to avoid landslides;
- Proper management and usage of materials to preserve local natural resources;
- Protecting water resources, including preventing contamination from latrines, garbage dumps and livestock;
- New drillings for water should not influence existing water sources of host community;
- Proper waste management (including recycling and composting) strategy need to be created and implemented.

### Camp closure:

- Monitoring of the development of the camp with consideration of its limits and possible creation of the relocation plan which should be consulted with inhabitants of the camp and the host community;
- Early creation of a rehabilitation plan in consultation with the local community.