SUMMARY REPORT

Natural Hazards Technical Working Group , Cox's Bazar | June, 2022

ISCG | Inter Sector Coordination Group

WHAT IS THIS REPORT ABOUT?

This report summarizes the current work of the Natural Hazards Technical Working Group (NatHaz TWG), a specialized sub-group bringing together the in-house capacities of key actors involved in the technical analysis of hazards through vulnerability analyses, GIS mapping and information management. More specifically, the report presents natural hazards products that are available and have been validated by NatHaz members, Sector Coordinators or the Heads of Sub-Office Group (HOSOG). All agencies involved with camp planning and implementation are advised to use them as part of their toolkits to strengthen informed risk reduction and mitigation activities.

Natural hazards mapping and risk analyses are not static activities. They are subject to change due to the constantly evolving situation, environment and available information. The products under the coordination of NatHaz TWG reflect the current status at the time of creation. Regular updates will be needed, depending on new findings and changing conditions. All actors are invited to pro-actively ensure they are using the latest information.

The inventory of previously developed products is tabulated in Annex 1. The products are delineated in a set of Info-sheets in Annex 2.

WHAT IS CURRENTLY AVAILABLE?

Hazard maps:

- Flood
- Landslide
- Wind
- Storm surge
- Cyclone[1]
- Fire[2]

Each map shows areas that could be affected by the respective hazard. All map products may be downloaded here. The maps are simplified representations derived from more complex data (available on request). The latter requires an appropriate level of GIS proficiency, as well as technical expertise to understand the methodologies and interpret the results. The maps have indicative value; they are not ground-proofed products and entail limitations. The identified zones do not necessarily imply exposure and, similarly, the remaining zones are not necessarily free from any danger. These maps provide general overview of the hazards distribution in the camp area, and support camp scale site development and preparedness activities. They are NOT designed for detailed site planning and should therefore not be used as a decision-making tool at this level. Site planning decisions need specific on-site evaluations and appropriate technical expertise.

Other products:

• 2021 Hydrometeorological - SMSD Incident Database: Meteorological data, such as precipitation, wind, humidity, temperature etc., from the Bangladesh Meteorological Department (BMD) and the yearly incidence database from the camps compiled by the site management sector (SMSD) were merged allowing (weather related) incidents to be directly linked to weather data. This database also serves to document available field instrumentation over time. More details on field instrumentation is available below. The database is available here.

• 2020 Hydrometeorological - SMSD Incident Database: based partner feedback, the 2019 database and an updated database was created for 2020. The database is available here.

• 2019 Hydrometeorological - SMSD Incident Database: Data from a variety of rain, weather, and hydrological field instrumentation was merged with the SMSD incident database allowing incidents to be directly linked to field-measured weather data. This database also serves to document available field instrumentation over time. More details on field instrumentation is available below. The database is available upon request.

• Technical note on landslide classification, specifically adapted to the context of the camps, based on field observations and analysis.

• Infosheet about key terminologies and definitions related to natural hazards and risk.

[1] New since previous update
[2] New since previous update

WHAT IS ON-GOING?

In the past year, the NatHaz TWG published new outputs with a focus on sub-block level flood, fire and cyclone hazard maps to provide a general overview of the hazard distribution in the camp area, and support camp scale site development and preparedness activities.
Through its work and common overarching objectives, the NatHaz TWG strengthened its collaboration with the Emergency Preparedness and Response Working Group (EPRWG) and Energy and Environment Technical Working Group (EETWG). NatHaz is looking for new leadership to establish it as a core group of EPRWG and EETWG and better link technical early warning systems with anticipatory action.

For inquiries please contact naim@iscgcxb.org.

CONTACT

All general inquiries to be submitted to filip@iscgcxb.org and naim@iscgcxb.org.

ANNEX 1: PRODUCT INVENTORY

The table below shows the main natural hazard products investigated and endorsed by the NatHaz TWG. Greyed out items are either not being used or have been phased out by improved products. Minor version iterations which have been phased out are not included.

	Landslide	Last Release	Extent	Status
1	COMPAS/NASA/UNDP/REACH – landslide inventory (request form), landslide susceptibility maps, and online dynamic landslide hazard and exposure model	Nov 2019	All camps	Not used
2	Landslide definition and classification info sheet & key natural hazard terminologies info sheet	Aug 2019	All camps	In use
3	COMPAS/NASA/UNDP – landslide runout impact map (and buildings exposure map)	Nov 2019	Kutupalong-Balukhali Expansion	Not used
4	UNHCR/ADPC (V3) – early 2018: slope stability equation	Feb.2018	Mega camp	Phased out
5	REACH/MapAction/UK Met office – early 2018: landslide susceptibility	Mar 2018	All camps	Phased out
6	IOM/UNHCR - slope and slope impact analysis	Jan.2018	Mega camp	Phased out
7	REACH – slope analysis	Aug. 2018	All camps	Phased out
8	UNHCR/ADPC (V1) – early 2018: slope analysis	Jan.2018	Mega camp	Phased out
9	UNHCR/ADPC (V2) – early 2018: combination of factor maps	Feb.2018	Mega camp	Phased out
	Flood			
10	Arup / REACH / IOM – Hydrodynamic flood modelling and Analysis v1.0	Dec. 2019	Camps 21-27	In use
11	Deltares / WFP/ REACH – Hydrodynamic flood modelling and Analysis v2.1	Nov 2019	Kutupalong-Balukhali Expansion	In use
12	Deltares / WFP – Flood vulnerability Atlas	July 2019	Kutupalong-Balukhali Expansion	On-going
13	REACH - Standing water extend All camps	Mar. 2019	All camps	Phased out
14	UNOSAT - Standing water extend	2018/19	All camps	Not used
15	UNHCR / ADPC – (V1) Flood Risk Assessment in Kutupalong	May 2018	Mega camp	Phased out
16	UNHCR / ADPC – (V2) Flash flood and riverine flood risk assessment in Kutupalong	May 2018	Mega camp	Phased out
17	COMPAS/NASA - Regional dynamic flood warning model	n/a	All camps	Not used
	Storm Surge			
18	Arup / REACH / IOM / UNHCR – Storm surge modelling	May 2020	Coastal camps	In use
19	REACH – Storm surge analysis	Mar 2019	Coastal camps	Phased out
20	UNIDSR/CIMNE – Global model of storm surge hazard	Jan 2015	All camps	Not used

Wind				
21	Sander+Partner / UNDP/REACH – Wind assessment and modelling	May 2020	Kutupalong- Balukhali Expansion	In use
22	Tonkin+Taylor / UNDP – Cyclone Impact Modelling Project	2020	Kutupalong- Balukhali Expansion	In use
23	REACH – Wind hazard susceptibility	Mid 2018	All camps	Phased out
24	REACH - Wind Flow Analysis – WindNinja	Mar. 2019	Kutupalong- Balukhali Expansion	Phased out
25	UNIDSR/CIMNE – Global model of cyclone wind	Jan 2015	All camps	Not used
Fire				
26	Fire Hazard Model- REACH	Feb 2022	All camps	In use
27	Factsheet - Rapid Infrastructure Damage Overview from Fires- REACH	Mar 2021	Camps 8E & 8W and Camp 9	Not used
28	Factsheet - Fire Damage Overview - REACH	Apr 2021	Camps 8E & 8W and Camp 9	Not used

HYDRODYNAMIC FLOOD MODEL
WFP, IOM & REACH COX'S BAZAR | 2019

ISCG | Inter Sector Coordination Group

PRODUCT DESCRIPTION

This product was conducted under the NatHaz framework with the collaboration of WFP, IOM and REACH, and with the support of two independent consultants – Arup and Deltares. It consists of two models: the first one based on TUFLOW (by Arup) and the second one based on D-Flow FM (by Deltares). The D-Flow FM was implemented in the Kutupalong area with special emphasis on the effects of floods on the accessibility of roads. The model consists of 10 different scenarios based on the probability (return period), rainfall (duration and intensity), hydraulic structures (culverts and bridges in particular), and external conditions (inflow/outflow). The model can easily accommodate new/planned hydraulic structures to test their effect on the outputs. It is available with WFP.
The second model was implemented for the camps in Teknaf. The model simulates three different probability defined rainfalls events: 1, 5, and 10-year Average Reoccurrence Interval (ARI) storms. The maximum of two different rainfall duration/intensity scenarios for each storm (3 & 24 hr. max precipitation) is modelled. These scenarios were chosen to ensure comparability with the flood modelling work mentioned above, performed earlier by Deltares/WFP in the Kutupalong camp. Both models are required to be updated with the most recent available data, in order to provide better outputs that reflect the changed environmental conditions during the past years.

WHAT IS IT MEANT FOR?

The model output provides information about expected flooded areas, water depth and speed of water flow for the various scenarios. It is primarily designed as a macro- level site planning tool. The product can be used to quickly identify areas which may be at higher risk. All insights gained from the product must be investigated in the field.

LIMITATIONS

The model is based on assumptions that need to be verified with on-ground data collection (i.e. water level in rivers). The results of the model entail a degree of uncertainties and artefacts. Site planning decisions should not solely rely on the results, but need a sound on-site evaluation.

METHODOLOGY IN SHORT

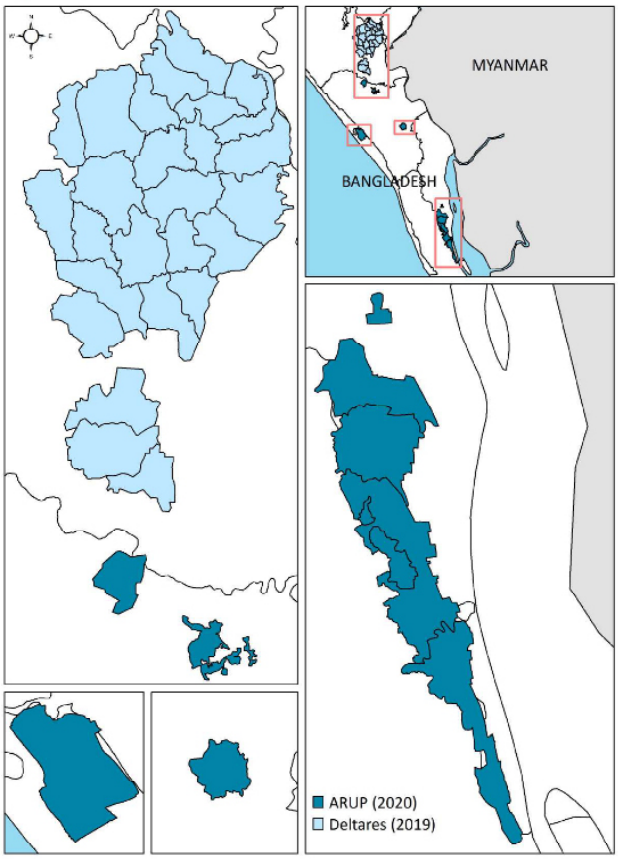
The TUFLOW model simulates three different storm events based on probability (1, 5, and 10-year average reoccurrence interval) based on the maximum of two different rainfall duration/intensity scenarios for each storm (3 & 24 hr. max precipitation). After hydrologic correction of input terrain data, a direct rainfall (TUFLOW) model applied to extract all major/minor flow paths and simulate a pluvial flooding. The D-FLOW FM model implements 2- and 10- year return Period; 3hr. and 24 hr. precipitation; hydraulic structures, Functional/non-functional and with/without boundary conditions.

MAIN INPUT DATA

- 0.5 m resolution Digital Elevation Model (DEM) from UAV drone survey (IOM-NPM; January 2019)
- Building footprint (REACH-UNOSAT, Jan 2019)
- Precipitation data (BMD/Deltares)
- Road network (existing and planned)
- Hydraulic structures

EXTENT

Hydrodynamic Flood Modelling Coverage



FLOOD HAZARD – SHELTERS EXPOSED TO FLOODS ALL CAMPS - REACH | COX'S BAZAR | APR 2021

ISCG | Inter Sector Coordination Group

PRODUCT DESCRIPTION

This product includes a series of 35 maps for all camps in Cox's Bazar, based on the outputs from the hydrodynamic model and shows modelled water depths from a 10-year average return interval (ARI) pluvial flood event from 24hrs of sustained rainfall. The maps show the extent of the flood (in terms of the depth of the flood water), the affected shelters (partial or full damage based on the depth of the flood waters) and the exposed numbers of shelters aggregated based on 50m×50m imaginary grid. The maps also indicate the maximum flood depths within structures. There are also higher resolution maps showing single camps.

The maps were published in April 2021 and can be found in the following link.

WHAT IS IT MEANT FOR?

This map is designed to assist planners and decision makers identify priority areas impacted by flooding for interventions at camp level. It is NOT designed as a stand-alone tool for detailed site planning decisions.

METHODOLOGY IN SHORT

The outputs from the hydrodynamic model are used to show the depths and extent of the flood waters in the scenario described above. The structure footprint data is used to extract the shelters which would get submerged in two scenarios: a flood up to 1m and another with greater than 1m water depth.

MAIN INPUT DATA

- Background: Hillshade derived from NPM - UAV Orthographic DEM, January 2019Block and Sub-block Boundary (ISCG, 2021)
- Drone Imagery (IOM NPM, January 2019)
- Structure Footprint (UNOSAT-REACH, 2019)
- Hydrodynamic Modelling (Arup, 2019)
- Camp Boundary (ISCG, 2020)
- Camp Footpaths (ISCG, 2019)

LIMITATIONS

The map does not provide any information about the flow speed or directions. Results are derived from remote sensing data and computational modelling; they are not ground proofed and are inherently limited by the quality of the input data and/or model assumptions and therefore hold a degree of uncertainty. The areas shown in the maps that are outside the flood zones are not necessarily free from any danger.

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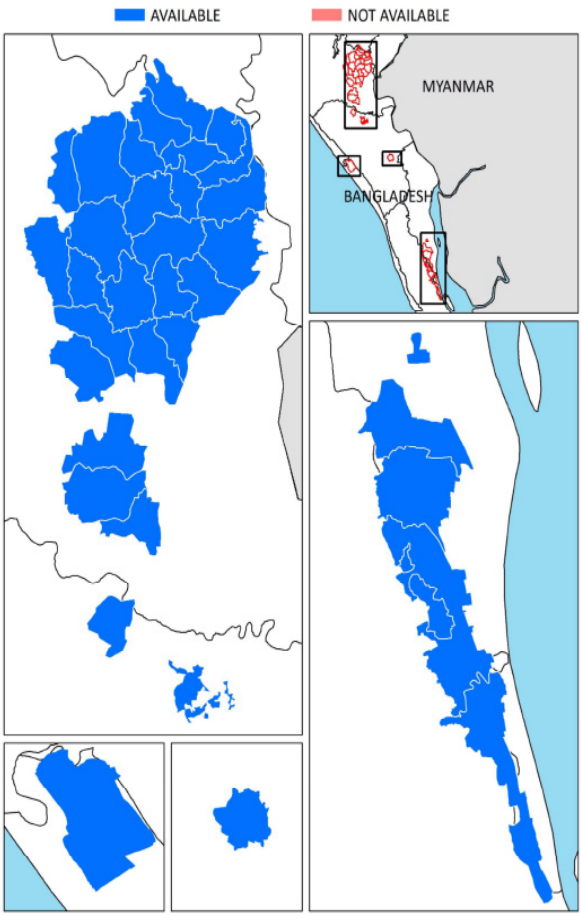

MODELLED FLOOD HAZARD – FLOOD VOLUME, EXTENT, COUNT AND AREA OF FLOODED STRUCTURES REACH | COX'S BAZAR | NOV 2021

ISCG | Inter Sector Coordination Group

PRODUCT DESCRIPTION

This product consists of four flood related maps developed based on the outputs from the hydrodynamic model. These maps show the volume of the flood waters, the extent of the floods, the number of structures which would get inundated and the area of the inundated structures in the event of a 10-year average return interval (ARI) rainfall. The counts and area of the structures are based on REACH/UNOSAT 2021 Structure Footprint data used in the model. To create the maps, camp and geographic boundaries are used in addition to the model. The maps cover the Kutupalang and Teknaf camps.

The map was published in April 2021 and can be found in the following link.

WHAT IS IT MEANT FOR?

The aim of these maps is to help planners and decision makers identify priority areas for interventions at camp sub-block level. They are not designed as a standard tool for detailed site planning decisions. Map results need to be ground verified and decisions combined with specific on-site evaluation and appropriate technical expertise. The map does not provide any information on water flow.

METHODOLOGY IN SHORT

The flood volume, extend, count of structures and the area of flooded structures are estimated based on the hydrodynamic model output. These outputs are aggregated to the sub-block level using the Aggregate Function in the GIS. The sub-block level values of the four categories are mapped as choropleth maps.

MAIN INPUT DATA

- Camp boundary (ISCG, 2020)
- Block and subblock boundary (ISCG, 2021)
- Hydrodynamic modelling (Arup, 2019, Teknaf)
- Hydrodynamic modelling (Deltares, 2019, Kutupalong)
- Structure footprint(REACH/UNOSAT, 2021)

LIMITATIONS

Results are derived from remote sensing and computational modelling; they are not ground proofed and inherently limited by the quality of the input data/ or model assumptions. The flood zones do not necessarily imply exposure and, similarly, the areas outside the flood extents are not necessarily free from any danger. In all four scenarios, water depths that are less than 0.05m are not considered.

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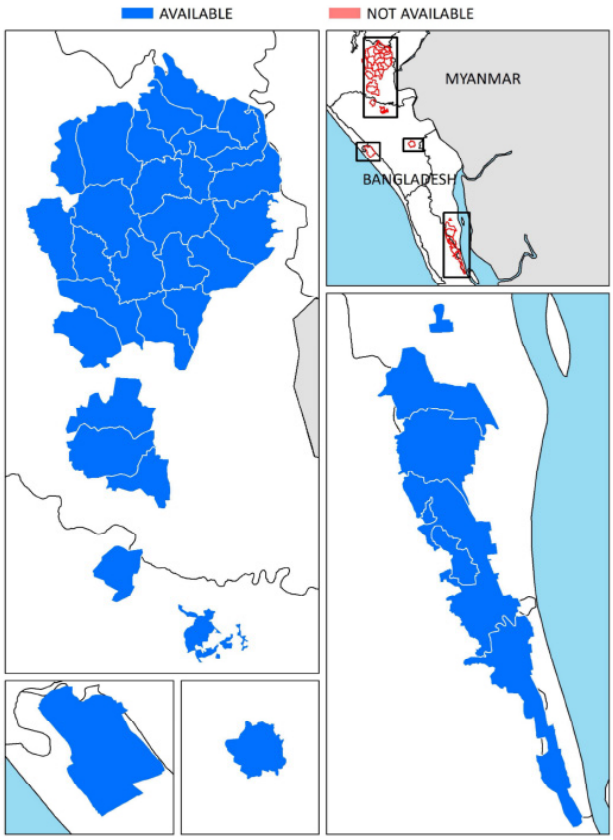


FIRE HAZARD SUSCEPTIBILITY
REACH | COX'S BAZAR | FEBRUARY 2022

ISCG | Inter Sector Coordination Group

PRODUCT DESCRIPTION

This product consist of a fire susceptibility map for Kuthupalong and Teknaf camp sites. The density of the shelters in the camps was the basis of assessment of the fire hazard – the higher the density of the shelters, the greater the fire hazard. A distance of 2 meters was considered as critical, as a fire in the camp would jump to the adjacent shelters if they are closer than or equal to 2 meters. Depending on the potential fire-spread area in different localities in the camp, shelters were grouped as low, medium and high susceptibility areas. This is a preliminary assessment based on the basic available data with room for further improvements in the future.

The map was published in March 2022 and can be found in the following link.

WHAT IS IT MEANT FOR?

The map is meant to shows the degree of fire hazard distribution based on the density of shelters. This map can be used as a primary tool while implementing any programs for fire hazard reduction; the maps gives an overview of the suitability of locations at an instant.

LIMITATIONS

There are several other factors that determine the fire hazard potential of the area other than the density of the shelters. Factors such as wind direction, velocity, existence of firefighting systems or presence of natural water bodies could influence the fire spread and fire hazard. These factors were not covered in the analysis. The critical distance used is not tested and needs further validation in the camp situation.

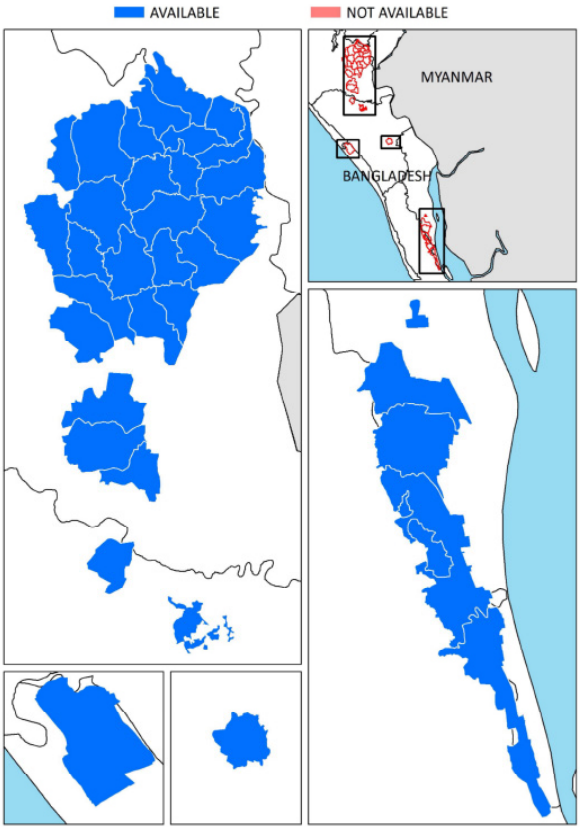
METHODOLOGY IN SHORT

The fire hazard potential was assessed for the camps based on the shelter density. The closer the shelters with the adjacent ones, the higher the fire hazard. In addition to the density of the shelters, features such as roads and paths were also part of the analysis as they could act as fire lines in the event of a fire. The width of the roads were also factored in the analysis. The region was classified into Low, Medium and High fire hazard areas depending on the extent of a theoretical fire spread area.

MAIN INPUT DATA

- REACH-UNOSAT Structure Footprints (2021)
- Camp boundaries (2022)
- Roads/Paths (Logistics Sector, 2020)

EXTENT



FACTSHEET - RAPID INFRASTRUCTURE DAMAGE OVERVIEW FROM FIRES REACH | MARCH 2021

ISCG | Inter Sector Coordination Group

PRODUCT DESCRIPTION

This product is the result of a rapid assessment conducted following the devastating fire that broke out in Kutupalang Refugee camps, Cox's Bazar, Bangladesh on 22 March 2021. The fire-spread over approximately 75 hectares and caused significant damage to Camps 8E & 8W and Camp 9. The rapid infrastructure damage overview provides analysis of the potential impact of the fire on the number of shelters, camps, facilities, and WASH infrastructure. A Burned Area Index (BAI) analysis was conducted using Sentinel-2 satellite imagery to define the most severely impacted area within the fire zone.

The map was published on 24 March 2021 and is available here.

WHAT IS IT MEANT FOR?

The aim of the rapid assessment is to provide an overview of the estimated proportion of the camps that were burned in the fire and to apply these ratios to estimate the number of individuals directly affected. The assessment also includes an assessment of damaged facilities including shelters, education, health and WASH facilities.

METHODOLOGY IN SHORT

To create the map, the burnt area was extracted from the Burnt Area Index (BAI) using the Sentinel-2 satellite imagery. This process demarcated the most severely impacted area within the fire zone. All the infrastructure details within this zone were calculated to estimate the probable damage to those infrastructures due to the fire.

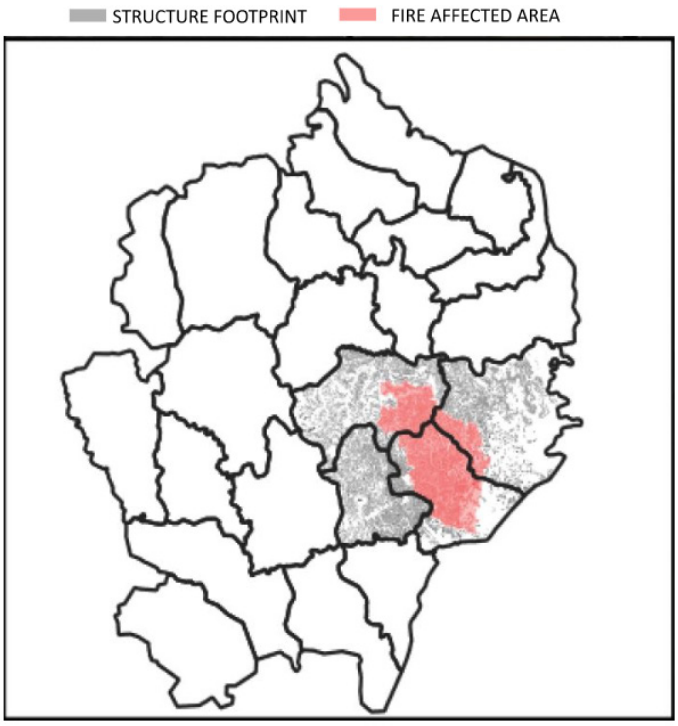
MAIN INPUT DATA

- Structure Footprints(REACH Initiative, 2020)
- Cox's Bazar – Common facility mapping dataset
- WASH Infrastructure (REACH, UNICEF, 2019)
- Sentinel-2 Imagery (Sentinel-hub, 24 March 2021)
- Satellite data (BlackSky)

LIMITATIONS

The number of shelters damaged is used as a proxy to the number of affected population. The population living within the fire footprint is calculated using the population of each camp and the proportion of structures within the fire affected area. All structures within this area are assumed to be affected.

EXTENT



FACTSHEET - FIRE DAMAGE OVERVIEW - REACH COX'S BAZAR | APRIL 2021

ISCG | Inter Sector Coordination Group

PRODUCT DESCRIPTION

This product consists of a map and factsheet prepared in the aftermath of the devastating fire that broke out in Kutupalang Refugee camps, Cox's Bazar, Bangladesh on 22 March 2021. The fire-spread over approximately 75 hectares and caused significant damage to Camps 8E & 8W and Camp 9. The purpose of the factsheet was to show the extent of the fires in these camps and the percentages of structures and the populations that are affected by the fire. Comparable estimates based on key informant interviews can be found in the Joint Humanitarian Response report. Data inputs to this model include the drone imagery (IOM NPM, 24 March 2021), drone imagery (IOM NPM, March 2020) and the structure footprint processed by REACH from IOM NPM drone imagery (March 2020).

The map was published on April 2021 and can be found in the following link.

WHAT IS IT MEANT FOR?

The aim of this map is to provide an overview of the estimated proportion of the camps that were burned in the fire and applies these ratios to estimate the number of individuals directly affected.

The figures and the map in the factsheet are to help the Site Management sector to facilitate the relief operations in terms of reconstruction and rehabilitation.

METHODOLOGY IN SHORT

This factsheet uses the March 2020 structure footprint to estimate the proportion of the camps that were burned in the fire and applies these ratios to estimate the number of individuals directly affected. Comparable estimates based on key informant interviews can be found in the Joint Humanitarian Response report.

MAIN INPUT DATA

Mapped and Data

• Drone imagery (IOM NPM, 24th March 2021)

• Drone imagery (IOM NPM, March 2020)

• Structure footprint processed by REACH from IOM NPM drone imagery (March 2020)

Main Analysis Inputs

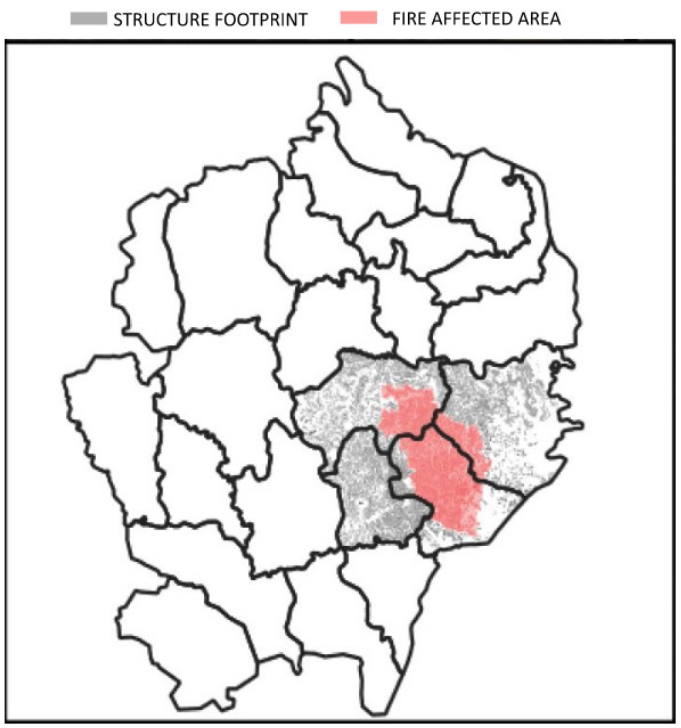
• Age and Disability Inclusion Needs Assessment, Cox's Bazar (REACH, 2021)

• Rohingya Refugees Population by Location at Camp and Union Level - Cox's Bazar (UNHCR, March 2021)

LIMITATIONS

The number of shelters damaged is used as a proxy for the number of affected population. The population living within the fire footprint is calculated using the population of each camp and the proportion of structures within the fire affected area. All structures within this area are assumed to be affected.

EXTENT



DIGITAL ELEVATION MODEL (DEM)
NPM - IOM | COX'S BAZAR | NOVEMBER 2021

ISCG | Inter Sector Coordination Group

PRODUCT DESCRIPTION

This Digital Elevation Model (DEM) is a 3-D representation of the terrain over the two camp settlements; Kutupalang and Teknaf. It has a spatial resolution of 0.5m and is derived from aerial pictures using UAV (drone) surveys. The DEM is updated on a regular basis. The first product was released in December 2017 and the release in January 2019 is currently in use. The most recent version (for November 2021 survey) will be released in mid July 2022.

Product accessible on request: npmbangladesh@iom.int

WHAT IS IT MEANT FOR?

The DEM is used in geographical information systems (GIS) visualizing the terrain surface and for input data for modelling geographic phenomena. Hill shade, slope, contour lines, aspects, catchment areas etc., are some of the parameters that could be developed from a DEM.

METHODOLOGY IN SHORT

Stereo aerial imageries are used to derive a digital surface model (DSM). The model is further processed in order to filter surface elements such as buildings, vegetation etc. and ultimately provide a terrain model representing the elevation of the bare earth.

MAIN INPUT DATA

Stereo aerial photography at 0.5m resolution obtained from UAV surveys.

LIMITATIONS

• Shelters and building are not always properly identified and are partially integrated into the DEM instead of getting filtered out.

• Smoothing effects, especially on hill crests, tend to produce slope angles lower than the real values.

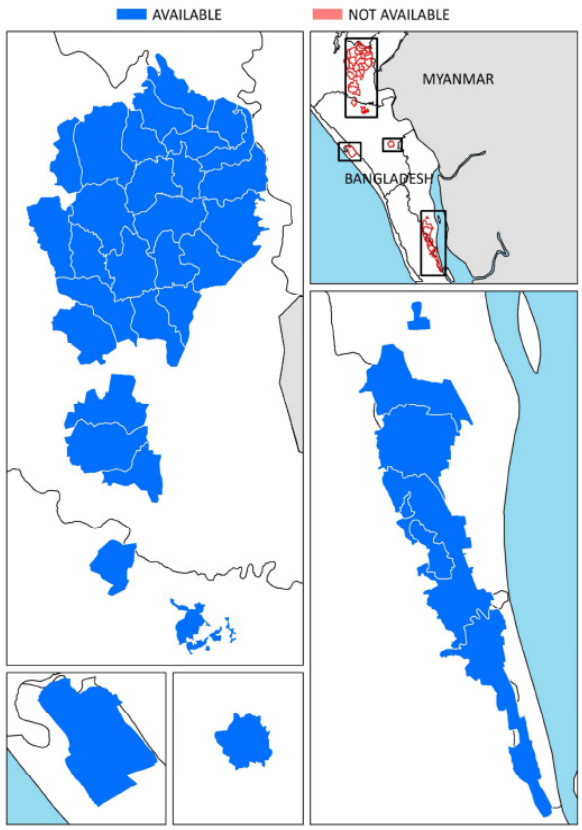
• Large interferences under tree covers (poor terrain representation due to interpolation effects)

• Poor representation of water bodies (lakes and ponds)

• Small scale linear artefacts that do not reflect the reality

• Accuracy issues in absolute positon of the DEM.

EXTENT



LANDSLIDE SUSCEPTIBILITY AND WARNING MODEL COMPAS | COX'S BAZAR | MARCH 2019

ISCG | Inter Sector Coordination Group

PRODUCT DESCRIPTION

The model is developed by NASA through the NASA/IRI Columbia University led COMPAS project (Connecting Earth Observations to Decision Makers for Preparedness Actions). It consists of two modules; the first one integrates various input data to generate a landslide susceptibility map; the second model integrates a near real-time rainfall data to produce warning events for landslide occurrence. The first part utilizes machine learning technology and both are highly flexible in terms of parametrization and input sources. The models are designed to evolve with the availability of new data and integrate lessons learnt from previous events. The resolution of the model is 0.5m in the Kutupalong mega camp and 10m for the wider Cox's Bazar district. Currently only the susceptibility maps are available. The maps categorizes the landscape into three categories, Low, Moderate and High, based on the likelihood of occurrence of landslides (susceptibility). Practically, Low areas have a probability of isolated landslides, Moderate and High areas have probability of infrastructure and population are at risk due to landslides.The maps for Teknaf and Kutapalong are available for download from the Humanitarian Response website. This model is also under consideration for upgradation using the latest data.

METHODOLOGY IN SHORT

Susceptibility module: data of both continuous and categorical type are used as input and evaluated as part of a random forest classifier, where the classifier determines likely presence or absence of landslides. This is calibrated using the mapped landslide inventory.

Dynamic module methodology uses daily rainfall over last 7 days; if rainfall exceeds historical thresholds (2000 – 2015) then a warning is issued. Will be hosted on GIS webpages (in progress).

MAIN INPUT DATA

• DEM Vricon 10m resolution (Cox's Bazar district); DEM IOM-NPM Jan 2019, 0.5m resolution (Kutupalong mega camp)

• Soil thickness (ORNL DAAC, 1km res); land cover: MODIS/Terra and Aqua (500m res)

• Settlement extent (HBASE, Landsat 2010); Hot OSM buildings Cox's Bazar

• Global Forest Change 2000 – 2017

• FAO Land Use Classification (in Camps)

• Near-Real precipitation (NASA IMERG)

LIMITATIONS

The landslide susceptibility map highlights the potential rupture zones, but does not reflect the propagation of the landslide. The input data (e.g DEM) have their own limitations, which will affect the results adversely. Calibration of the model uses a catalog of mapped landslides, many of which are not validated by local observations. The map is not designed for a detailed site planning. Such activities need to be supported with on-site technical investigations.

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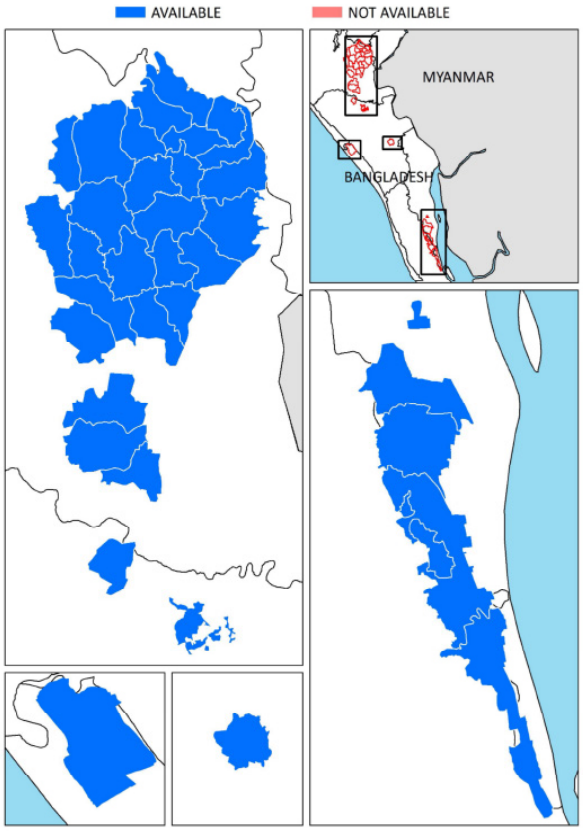

CYCLONE IMPACT MODELLING PROJECT
UNDP | COX'S BAZAR | 2020

ISCG | Inter Sector Coordination Group

PRODUCT DESCRIPTION

The Tropical Cyclone Disaster Impact Modelling (DIM) study involves simulating the impacts of two cyclone scenarios on the populations of the Rohyingya Refugee Camps and the surrounding Host Communities. The first scenario is a Category 1 cyclone incident with a high tide, representing the most probable severe weather event. The second scenario considers a Category 4 cyclone occurring during a king tide, representing a much higher impact event. The study area is the Cox's Bazar district, where the camps are located. Disaster impacts have been modelled under each impact scenario, using a risk assessment approach to understand the exposure and vulnerability of both the Rohingya Refugees and the Host Communities.

The map was published in May 2020 and can be found in the following link.

WHAT IS IT MEANT FOR?

The main purpose of this study is to support contingency planning for the Rohingya Refugees and the Host Communities. Model outputs from a Category 1 cyclone and a Synthetic Category 4 cyclone provide estimates of the impacts of wind and coastal inundation associated with a cyclone on population and buildings.

METHODOLOGY IN SHORT

Risk and impact were modelled as a function of hazard, exposure and vulnerability. The DIM study uses geospatial analysis and planning tools to simulate impacts on the coast. Buildings are counted using maps of the camps and publicly available satellite imagery and assigned to one of three categories: Shelters (residential structures in a refugee camp); Host Buildings (residential structures in a Host Community); and Significant Buildings (public and private infrastructure such as government buildings, health clinics, etc.). The exposure and vulnerability of these building types were modelled for each hazard. The impact on the Refugee and Host Community populations was estimated by assigning an average number of persons per building (Household size) for each category of building.

MAIN INPUT DATA

• 1m DEM were used to determine any slopes with an angle greater than 35°.

• Building footprints from the OSM

• Building footprints of the camp area from UNOSAT

LIMITATIONS

The number of shelters damaged is used as a proxy for the number of affected population. The population living within the cyclone footprint is calculated using the population of each camp and the proportion of structures within the fire affected area. All structures within this area are assumed to be affected.

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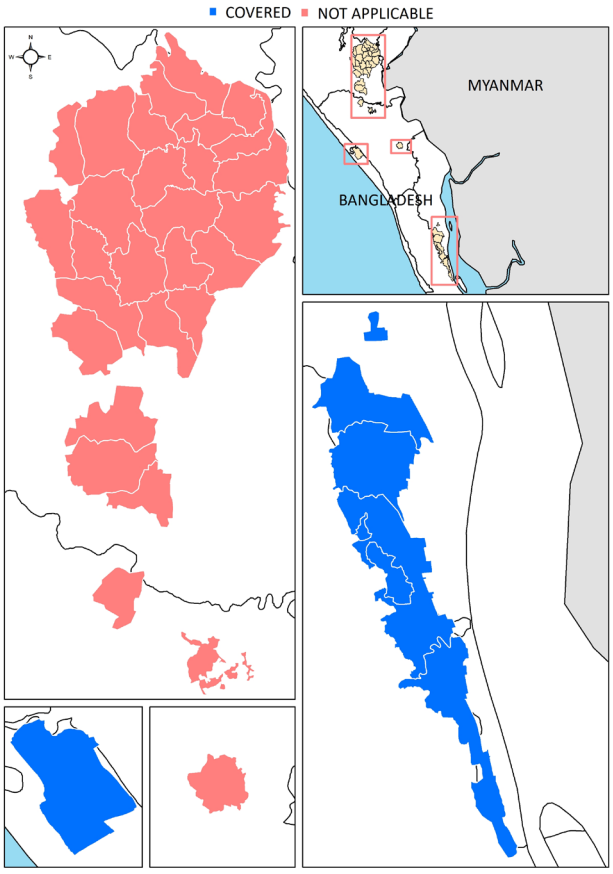

AUTOMATED RAIN GAUGES (UNDP)
BMD WEATHER STATIONS
UNDP I COX'S BAZAR I JULY 2021

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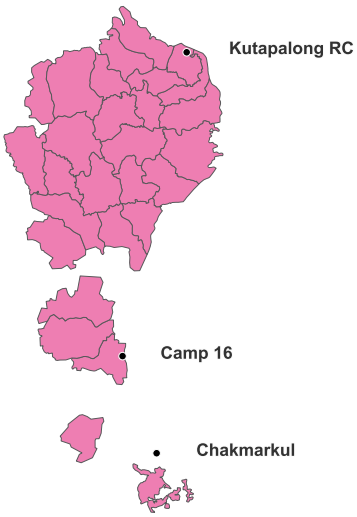
The United Nations Development Programme (UNDP) in partnership with UNHCR, the UN refugee agency, the Geological Survey of Bangladesh (GSB) and the Norwegian Geotechnical Institute (NGI) have installed state of the art rain gauges in three landslide-prone areas around the Rohingya refugee sites in Cox's Bazar, Bangladesh. The rain gauges will enable decision-makers to monitor the weather situation in the areas around the camps, and send alerts when high- intensity rainfall is significantly increasing the risk of landslides.

The automated rain gauges in the Rohingya Camps are located at

Gauge ID: 1279	Kutupalong RC	Roof of magistrate's house in CiC compound
Gauge ID: 1260	Camp 16	Outside of CiC office
Gauge ID: 1278	Chakmarkul	Inside the SCI clinic compound

The automated rain gauges in other locations in the district are located at:

Gauge ID: 1227	Cox's Bazar Sadar	Roof of Public Works Department building
Gauge ID: 1226	Teknaf	Roof of UNO office



While the whole of Bangladesh is highly prone to floods, Cox's Bazar district and the Chittagong Hill Tracts are also particularly vulnerable to flash floods and landslides. In the past, GSB and NGI installed four automated rain gauges in Chittagong, Cox's Bazar town and Teknaf town. Equipped with solar panels and a SIM card, the rain gauges were programmed to register and upload rainfall values to the web every 15 minutes, as well as send alert SMS/text messages to relevant government agencies when rainfall levels were intense enough to significantly increase the general risk of landslides. When the recorded rainfall values exceed a pre-determined risk threshold, the rain gauge alert system sends SMS/text messages to 20 designated Government of Bangladesh and UN agencies located in Cox's Bazar and Dhaka. Owing to some technical issues, these rain gauges did not function properly during the year 2021. For the purpose of the obtaining the precipitation data, the data from the BMD weather stations near the two refugee camps were used instead of the UNDP installed gauges.

The BMD weather data provide daily weather data that includes the temperature, rainfall, wind direction/speed and relative humidity values. The data is available from March through October 2021 from the two stations located in Cox's Bazar and Teknaf.

In combination with the incident reports compiled by the ISCG Site Management sector, the rainfall data would enable the GSB, UNDP and humanitarian actors to gain a better understanding of how vulnerable the camp and settlement areas are to rainfall- triggered landslides, especially during the monsoons. The NatHaz TWG compiles hydro-meteorological data that concaternates incident and weather-related data (the 2021 data is available here). UNDP is working together with GSB, NGI and the Inter-Sectoral Coordination Group (ISCG) secretariat to analyse the data and improve risk analysis for the camps.

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UNHCR
The UN Refugee Agency