LEBANON – BUILDING DESTRUCTION AND DEBRIS QUANTITIES ASSESSMENT

South and Nabatiyeh Governorates

Satelite imagery: 5 November 2024 | Published: 29 November 2024

UN-HABITAT

CREEMO
Centre de Recherche en Environnement-Espace Méditerranée Orientale
Notre ESPACE
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This publication presents the findings of a remote assessment of building destruction and debris quantities in areas affected by the Israel–Hezbollah conflict, conducted by the United Nations Human Settlements Programme (Lebanon) and the Center for Environmental Research of the Eastern Mediterranean (CREEMO) at Saint Joseph University. It covers seven districts in two governorates, as follows:

- South Governorate: Sour, Saida and Jezzine districts
- Nabatiyeh Governorate: Nabatiyeh, Marjaayoun, Bent Jbeil and Hasbaiya districts

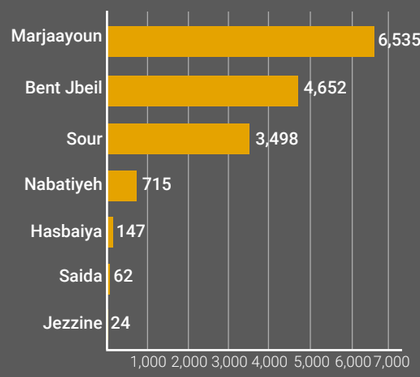
Building destruction

Number of totally and partially destroyed buildings

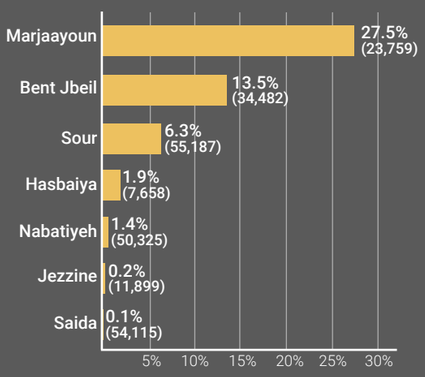
15,633

Percentage out of the total number of 237,425 pre-conflict buildings

6.6%



Number of totally and partially destroyed buildings per district



Percentage of totally and partially destroyed buildings out of the total number of pre-conflict buildings (indicated in parentheses above) per district

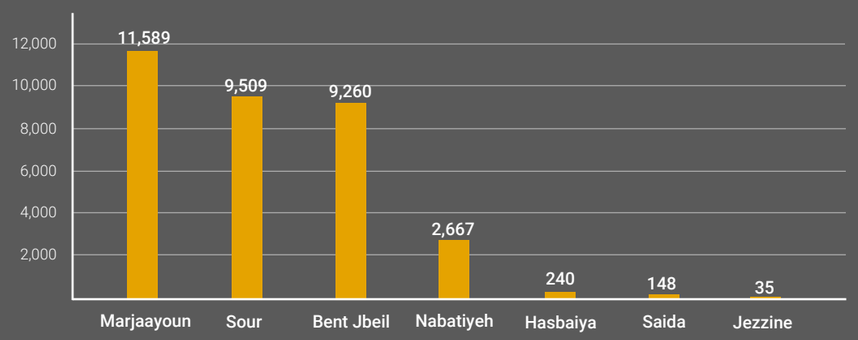
Unit destruction

Number of totally and partially destroyed units

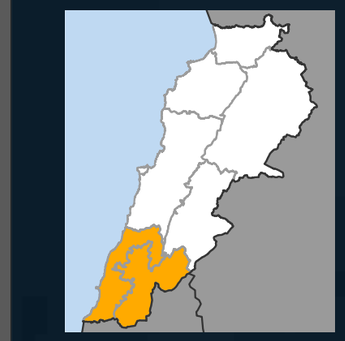
33,448

9,692 in South Governorate

23,756 in Nabatiyeh Governorate



Number of totally and partially destroyed units per district



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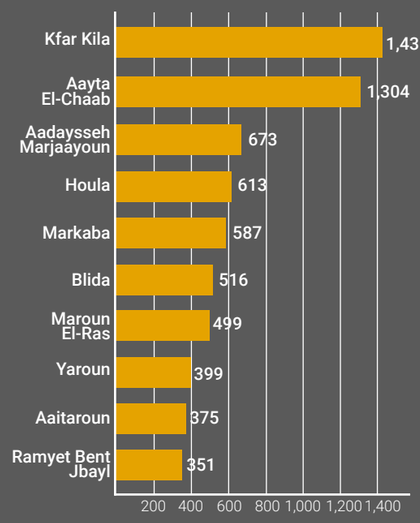
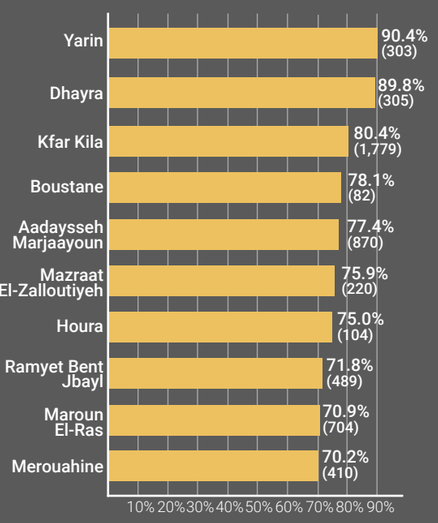
Affected cadastres

Number of cadastres with totally or partially destroyed buildings
191

Percentage out of the total number of 376 cadastres in South and Nabatiyeh governorates
50.8%



Number of totally and partially destroyed buildings per cadastre (top 10)



Percentage of totally and partially destroyed buildings out of the total number of pre-conflict buildings (indicated in parentheses above) per cadastre (top 10)

Debris quantification

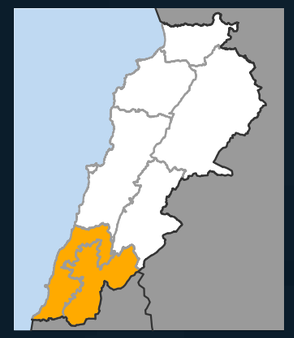
Tonnes of debris generated from destroyed buildings
8,029,658

2,303,659 in South Governorate

5,725,999 in Nabatiyeh Governorate

Sum of tonnes of debris generated per district	
Marjaayoun	2,773,675
Bent Jbeil	2,302,557
Sour	2,257,507
Nabatiyeh	607,208
Hasbaiya	42,559
Saida	37,259
Jezzine	8,893

Sum of tonnes of debris generated per cadastre (top 10)	
Aayta El-Chaab	656,942
Kfar Kila	621,046
Meiss El-Jabal	591,294
Sour	327,155
Aadaysseh Marjaayoun	270,922
Markaba	241,637
Borj El-Chemali	225,654
Houla	209,811
Blida	200,070
Maroun El-Ras	192,900



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Aayta El-Shaab – 8 September 2023

Aayta El-Shaab – 5 November 2024

Yarin – 8 September 2023

Yarin – 5 November 2024

Methodology

To detect areas with building destruction, a visual change detection analysis of pre-conflict and recent PlanetScope satellite images (downloaded from Planet Labs), dated 8, 10, 14 and 15 September 2023 and 5 November 2024, respectively, was conducted. The mid-range spatial resolution of 3 to 5 metres of the PlanetScope satellite images allowed for the detection of totally and partially destroyed buildings.

The areas where building destruction was detected were then overlaid with the pre-conflict building footprint layer from Microsoft Bing, downloaded on 25 September 2024 from GitHub. Consequently, the number and percentage of totally and partially destroyed buildings were calculated.

The number of units (or apartments)[1] per floor for each building was calculated based on an assumption that, in the Lebanese context, the surface area of an apartment is up to 150 square metres in urban (relatively densely populated) areas and is up to 250 square metres in rural areas. Urban and rural areas were identified using the application of the Degree of Urbanization (DEGURBA) methodology in Lebanon. Afterwards, the population density from WorldPop was superimposed over the urban/rural areas for cross-validation. The data on pre-conflict building heights was downloaded in June 2024 from the World Settlement Footprint 3D (WSF3D) layer available from the German Space Agency. The number of floors was calculated using the buildings' height, based on an assumption that the normal floor height is up to 3 metres. Therefore, the number of units per building was calculated as follows:

Number of units per building = Number of units per floor x Number of floors

The debris volume was calculated in cubic metres (m^3) using the below formula used by Tamraz, Srour and Chehab (2012):

Debris volume (m^3) = Number of buildings x Average built-up area (m^2)[2] x Volume of debris per every square metre (m^3/m^2)[3]

Then, the debris weight in tonnes was obtained by multiplying the volume (m^3) by a density of 2.25 t/m^3,[4] as tested – for the study of Tamraz, Srour and Chehab (2012) – by the Materials Lab of the American University of Beirut:

Debris weight (tonnes) = Debris volume (m^3) x Debris density (t/m^3)

Limitations and caveats

- This is a preliminary analysis and has not yet been validated in the field.
- The top-down satellite imagery view and mid-range resolution hindered the detection of minor and major damages, as well as some instances of total or partial destruction, particularly when roofs have retained their original shape. This also applies to destroyed facades.
- The Microsoft Bing building footprint layer requires refinement. Its inaccuracies regarding the location and shape of the footprints have affected the count and surface area of buildings, thus impacting also the accuracy of debris quantification. UN-Habitat has already started a manual refinement of this layer, which is expected to be completed in the future.
- Due to the lack of building use data, the analysis could not differentiate between residential, commercial, religious or other types of buildings.
- There might be some errors in the building heights due to the WSF3D layer's low spatial resolution (90 metres). Moreover, the above-mentioned Microsoft Bing building footprint layer's inaccuracies have affected the accuracy of building heights.
- Debris is calculated for both partially and totally destroyed buildings (considering that partially destroyed will be demolished at a later stage).
- Underground basements could not be detected through satellite imagery and were not considered in debris quantification.

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[1] A unit/apartment could include a residential unit, commercial unit/office, etc.

[2] Average built-up area = Average of the total [Surface area of each building (m^2) x Number of floors of each building].

[3] According to the Tamraz, Srour and Chehab (2012)'s study on construction demolition waste (CDW), the estimated volume of CDW generated per square metre (m^2) is equal to 0.73 m^3/m^2. This was based on several case studies highlighted in the study. For example, while a residential building of four floors and two basements generated an estimated volume of 0.6 m^3/m^2, a one-floor villa produced an estimated volume of 1.3 m^3/m^2. The average of the case studies was adopted to be 0.73 m^3/m^2.

[4] This density takes into consideration the CDW produced from the main building structure only (concrete, masonry, steel and tiling), which comprises the majority of CDW. No additional allowance is made for doors, kitchen and toilet fixtures, and electromechanical items, as these had been removed when the quantification process was carried out for the purposes of the Tamraz, Srour and Chehab study.

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