

Research Terms of Reference

Residential Damage Analysis

UKR2212Ukraine

July 2022
Version 1.0

REACH Informing
more effective
humanitarian action

1. Executive Summary

Country of intervention	Ukraine			
Type of Emergency	<input type="checkbox"/> Natural disaster	<input checked="" type="checkbox"/> Conflict		
Type of Crisis	<input checked="" type="checkbox"/> Sudden onset	<input type="checkbox"/> Slow onset	<input checked="" type="checkbox"/> Protracted	
Mandating Body/ Agency	UHF, BHA			
Project Code	64AUR, 64AVR			
Overall Research Timeframe	06/07/2022 to 28/02/2023			
Research Timeframe	1. Start collect data: 06/07/2022		5. Preliminary presentation: N/A	
	2. Data collected: N/A		6. Outputs sent for validation: weekly for the map / biweekly for factsheet	
	3. Data analysed: N/A		7. Outputs published: weekly for the map / biweekly for factsheet	
	4. Data sent for validation: N/A		8. Final presentation: 28/02/2023	
Number of assessments	<input type="checkbox"/> Single assessment (one cycle) in multiple geographies: conflict-affected areas in North, East, and South of Ukraine <input checked="" type="checkbox"/> Multi assessment (more than one cycle)			
Humanitarian milestones	Milestone		Deadline	
	<input type="checkbox"/> Donor plan/strategy			
	<input type="checkbox"/> Inter-cluster plan/strategy			
	<input type="checkbox"/> Cluster plan/strategy			
	<input type="checkbox"/> NGO platform plan/strategy (3P Consortium)			
	<input checked="" type="checkbox"/> Other (Specify): High-level donor meetings		ongoing	
Audience Type & Dissemination	Audience type		Dissemination	
	<input checked="" type="checkbox"/> Strategic <input checked="" type="checkbox"/> Programmatic <input type="checkbox"/> Operational		<input type="checkbox"/> General Product Mailing (e.g., mail to NGO consortium; HCT participants; Donors) <input type="checkbox"/> Cluster Mailing (DRR working group) <input checked="" type="checkbox"/> Presentation of findings <input type="checkbox"/> Website Dissemination (Relief Web & REACH Resource Centre) <input checked="" type="checkbox"/> Bilateral dissemination to local authorities	
Detailed dissemination plan required	<input type="checkbox"/> Yes		<input checked="" type="checkbox"/> No	
General Objective	Inform humanitarian actors (specifically Shelter Cluster), area-based assessments, and local authorities in Ukraine by promoting a better understanding of conflict's impact on the residential buildings.			
Specific Objective(s)	1. Analyse damage to residential buildings in selected urban settlements within conflict-affected			

	areas. ¹ 2. Localize analysed data at a neighbourhood level with population estimates to provide better focus for response. 3. Connect assessment findings with local humanitarian needs and a capacity of humanitarian actors.																				
Research Questions	1. How have residential buildings in urban settlements under ongoing conflict been impacted? <ol style="list-style-type: none"> How many private houses are damaged? How many apartment buildings are damaged? What damage degree of impacted structures? 2. What are the local features of revealed damage at neighbourhood level? <ol style="list-style-type: none"> What population is likely to lose their shelters in impacted residential buildings? What neighbourhoods in specific settlement are impacted the most? 3. How to connect revealed findings with needs and humanitarian actors? <ol style="list-style-type: none"> What response can be carried out given the revealed damage estimates in specific settlement? 																				
Geographic Coverage	Conflict affected urban settlements in East, North and South of Ukraine.																				
Secondary data sources	Open Street Map, OCHA for neighbourhood boundaries, ESA Sentinel-1 and Sentinel-2 imagery, ESA WorldCover (2020), MAXAR (Geo-Eye, WorldView), Google Maps, UNOSAT (damage data), LUN																				
Population(s)	<table border="1"> <tr> <td><input type="checkbox"/></td><td>IDPs in camp</td> <td><input type="checkbox"/></td><td>IDPs in informal sites</td> </tr> <tr> <td><input checked="" type="checkbox"/></td><td>IDPs in host communities</td> <td><input type="checkbox"/></td><td>IDPs [Other, Specify]</td> </tr> <tr> <td><input type="checkbox"/></td><td>Refugees in camp</td> <td><input type="checkbox"/></td><td>Refugees in informal sites</td> </tr> <tr> <td><input type="checkbox"/></td><td>Refugees in host communities</td> <td><input type="checkbox"/></td><td>Refugees [Other, Specify]</td> </tr> <tr> <td><input checked="" type="checkbox"/></td><td>Host communities</td> <td><input checked="" type="checkbox"/></td><td>Returnees</td> </tr> </table>	<input type="checkbox"/>	IDPs in camp	<input type="checkbox"/>	IDPs in informal sites	<input checked="" type="checkbox"/>	IDPs in host communities	<input type="checkbox"/>	IDPs [Other, Specify]	<input type="checkbox"/>	Refugees in camp	<input type="checkbox"/>	Refugees in informal sites	<input type="checkbox"/>	Refugees in host communities	<input type="checkbox"/>	Refugees [Other, Specify]	<input checked="" type="checkbox"/>	Host communities	<input checked="" type="checkbox"/>	Returnees
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Visibility	IMPACT, ACTED, UNOSAT																				

¹ Single private homes and apartment buildings (both old and recently built).

² One factsheet on residential building damage for specific settlement (or city districts) per month.

2. Rationale

2.1. Background info

The escalation of hostilities in Ukraine, on 24 February 2022, has led to a rapid expansion of conflict-affected areas in the East, North and South of Ukraine. Multiple settlements, including large cities with dense built-up cover, were severely damaged between the end of February – April. Additional threats arise from natural disasters for ecosystems located in conflicted-affected areas with cascading negative effects on environment and human well-being.

Numerous incidents of building damage were [reported for both living houses and infrastructure](#) in impacted settlements. While in the first week since the beginning of escalation direct locations and type of damaged objects were transparently revealed, currently such reports in media are forbidden due to security reasons. That led to uncertainty in the understanding of the extent of damage to economics, transport, healthcare, and educational infrastructure in the areas of both ongoing and stopped hostilities.

Remote sensing data is an efficient and safe tool to estimate the occurrence and severity of damage to buildings infrastructure in affected settlements. While acquisition of 3D images by unmanned aerial vehicles (with possibility to visually examine all types of damage to buildings and structures) is rather impossible due to security concerns, high-resolution satellite imagery can be a relevant source of reliable data of conflict impact. Visual interpretation of conflict and post-conflict images in previously known locations of facilities, buildings and infrastructure can support a robust assessment of conflict impact on structures in affected urban areas.

Close cooperation with UNOSAT on the analysis of high-resolution optical satellite imagery is crucial to derive robust estimates of the damage of residential buildings. Those are a data source to calculate the population that lost their shelters. In larger urban settlements there could be a substantial variation of damage severity linked to local district (neighbourhood) features. Those are the average number of apartments in one building, dominance of private living houses or multi-floor buildings in the district, proximity to large infrastructural objects, road network connectivity. Detection of damage hotspots at neighbourhood level in larger urban settlements (i.e., cities with population > 200,000 citizens) with following affected population estimates might facilitate more convenient planning of shelter needs' assessments. This analysis of building footprints will result in a consistent flow of informative outputs for interested humanitarian actors and local authorities.

2.2. Intended impact

This assessment aims to report locations where damage to residential buildings should be the highest for humanitarian actors and local authorities. Although remote sensing satellite data cannot fully capture the damage caused by conflict hostilities, it illustrates general trends while field (ground or drone surveys) are restricted or impossible. Estimation of hotspots of damaged residential buildings at detailed (neighbourhood) level is primarily designed to inform Shelter Cluster and other interested humanitarian actors and local authorities in geospatially intuitive manner. Additionally, translations of project products to Ukrainian are intended to inform local policy makers and authorities for more robust planning and management in conflict-affected areas.

3. Methodology

3.1. Methodology overview

To estimate conflict impact on the residential buildings in urban settlements directly affected by ongoing hostilities, IMPACT will assess the visually detected damage using high-resolution optical satellite images in close cooperation with UNOSAT. UNOSAT initiative uses images provided by MAXAR company (World-View and Geo-Eye satellites with 50 cm spatial resolution) acquired during and after the conflict in several locations of Ukraine. Visual inspection of such scenes allows to detect most of the severe damage to buildings in urban settlements and is successfully applied for Rapid Damage Assessment (e.g., [Kharkiv](#); [Sumy](#); [Mariupol](#) maps) and Detailed Building Damage Assessment (e.g., [Irpin](#), [Bucha](#) map).

It is intended that all structures from data sets provided by UNOSAT will be visually inspected using high-resolution optical satellite imagery. These objects will be assigned to the one of four categories according to [UNOSAT methodology](#): 'possible

damage' (visible debris near building or indirect signs of damage on roofs or walls), 'moderate damage' (visible damage of walls and roofs), 'severe damage' (substantially damaged walls, destroyed roof), and 'destroyed' (only a few remnants of walls with no roof). Additionally, type of building (single-family home or apartment building, old or recently built), number of floors and entrances (for apartment buildings) will be assigned as necessary inputs to calculate number of apartments in specific building. This data will come from visual inspection from Google Maps, and data available for recently built houses on commercial website LUN.

To localize the damage to residential buildings in urban settlements at neighbourhood level, IMPACT will use UNOSAT damage data (for all structures). Building footprints will be a base data source to estimate the total number of populations who used to live in damaged or destroyed buildings. This population estimation will be based on the average number of people living in single apartments or private house specified for the given area of interest (average number of household members for oblast based on data from State Statistics Service). Hotspots of detected damage will be reported using GIS tools at neighbourhood level. *Neighbourhood will be defined as a specific block of built-up area with distinct features of residential buildings (small private houses sector; older multi-floor houses built up to 2000; newer multi-floor houses built in recent decades), and informal boundaries represented rather by wider streets.* Neighbourhood boundaries will be drawn with usage of official city plans rather than using historical urban zoning which precise boundaries are rather unavailable.

To connect revealed findings of damage with humanitarian needs and humanitarian actors' capacity, IMPACT will communicate with humanitarian actors and local authorities through cluster platforms, focusing on the Shelter Cluster. Settlement-level factsheets with neighbourhood-level maps will be shared publicly. Sharing of revealed damage data in geospatial (both SHP and KML extensions for users with different GIS capacity) and table formats by request will be essential part of efforts to incorporate research findings into humanitarian actors' workflow. Revealed findings are intended to be presented at humanitarian cluster meetings to better understand the gaps between the actual needs and response capacity.

3.2. Population of interest

The population of interest in this study includes host community members, IDPs and returnees in the urban settlements impacted by damage in response to the Russian invasion on February 24, 2022, in the East, North and South of Ukraine.

3.3. Secondary data review

UNOSAT damage data will be used as main data source of damaged structures (residential buildings) for density analysis of residential buildings at neighbourhood level. All objects in these data sets will be visually inspected using provided World-View and Geo-Eye images for specific conflict-affected areas.

Sentinel-1 and Sentinel-2 imagery are additional data sources to map land cover / land use and their changes. Locations of fire spots will be examined using FIRMS data of thermal anomalies. Data provided by OSM contributors and ESA WorldCover (2020) land cover / land use data set also will be used. These raster layers based on remote sensing data will be used to supplement the mapping and geospatial analysis if necessary.

Table 1. List of open data sources to be utilized

Data source	Short description	Area	Available data and comment
Sentinel-1	Remote sensing	Global	Radar imagery (10 m)
Sentinel-2	Remote sensing	Global	Multispectral imagery (10 m)
World-View and Geo-Eye	Remote sensing	Specific locations of interest	RGB-composites of visible bands (50 cm)
FIRMS	Remote sensing	Global	Thermal anomaly detection (500 m)
OCHA Settlement Boundaries	Administrative boundaries	Ukraine	Admin boundaries
OSM buildings network	Vector layer	Global	raw OSM
OSM road, electricity network	Vector layer	Global	raw OSM
Google Maps	Locations of facilities and structures	Global	Locations to impute into the main database
UNOSAT damage data	Vector layer	Ukraine	Locations of damaged structures

3.4. Primary Data Collection

No primary data collection will be conducted as part of this assessment.

3.5. Data Processing & Analysis

Building footprints with attributes (building height, type (residential / non-residential), etc.) will be used to map affected populations in need and exposed shelters. Density analysis will be conducted in GIS software to report the damage hotspots at district (neighbourhood) scale. Affected populations will be estimated using the average number of people living either in one apartment or private house specific for featured area of interest, i.e., average household size provided by State Statistics Service for specific oblast.

Table 2. Summary of data processing and analysis.

Section name	Process/analysis
Density of damage to residential buildings	Geospatial analysis of hotspots of damage to residential buildings at district (neighbourhood) level.
Estimation of populations impacted by conflict and who lost their shelters	Calculation of population based on the average number of people living in single apartments or private house being specific to a given area of interest.
Additional data for mapping	Using medium-resolution (Sentinel-1, 2) remote sensing data, global land cover raster products, OSM data to supplement geospatial analysis.

4. Roles and responsibilities

Table 3. Description of roles and responsibilities

Task Description	Responsible	Accountable	Consulted	Informed
Research Design	GIS Specialist	Country Coordinator	3P Consortium partners, GIS/Database Manager, IMPACT HQ Research Design & Data Unit (RDDU)	
Secondary Data Review	GIS Specialist, Climate & Resilience Unit Lead	Climate & Resilience Unit Lead	Country Coordinator, IMPACT HQ (RDDU) Research Design & Data Unit	
3 rd Party Data Requests	GIS Specialist	Climate & Resilience Unit Lead	Country Coordinator	
Data Processing (Checking, Cleaning)	GIS Specialist, GIS Officer	Climate & Resilience Unit Lead	IMPACT HQ (RDDU)	
Data Analysis	GIS Specialist, GIS Officer	Climate & Resilience Unit Lead	IMPACT HQ (RDDU)	
Map Production	GIS Specialist, GIS Officer	Climate & Resilience Unit Lead	IMPACT HQ Reporting Unit (GIS)	
Factsheet Writing	GIS Specialist	Climate & Resilience Unit Lead	IMPACT HQ Reporting Unit	
Factsheet Design	GIS Specialist	Climate & Resilience Unit Lead	Country Coordinator, IMPACT HQ Reporting Unit	
Dissemination	GIS Specialist	Country Coordinator	3P Consortium partners IMPACT HQ Research Department	
Monitoring & Evaluation	GIS Specialist	Country Coordinator	IMPACT HQ Research Department	IMPACT Head of Research
Lessons Learned	GIS Specialist	GIS Specialist	IMPACT HQ Research Department	IMPACT Head of Research

Responsible: the person(s) who executes the task

Accountable: the person who validates the completion of the task and is accountable for the final output or milestone

Consulted: the person(s) who must be consulted when the task is implemented

Informed: the person(s) who need to be informed when the task is completed

5. Data Management Plan

Data Management Plan is available upon request.

6. Monitoring & Evaluation Plan

IMPACT Objective	External M&E Indicator	Internal M&E Indicator	Focal point	Tool	Will indicator be tracked?
Humanitarian stakeholders are accessing IMPACT products	Number of humanitarian organizations accessing IMPACT services/products Number of individuals accessing IMPACT services/products	# of downloads of x product from Resource Centre	Country request to HQ	User_log	no
		# of downloads of x product from Relief Web	Country request to HQ		
		# of downloads of x product from Country level platforms	Country team		
		# of page clicks on x product from REACH global newsletter	Country request to HQ		
		# of page clicks on x product from country newsletter, sendingBlue, bit.ly	Country team		
		# of visits to x webmap/x dashboard	Country request to HQ		
IMPACT activities contribute to better program implementation and coordination of the humanitarian response	Number of humanitarian organizations utilizing IMPACT services/products	# references in HPC documents (HNO, SRP, Flash appeals, Cluster/sector strategies)	Country team	Reference_log	DRR Working Group publications
		# references in single agency documents			
Humanitarian stakeholders are using IMPACT products	Humanitarian actors use IMPACT evidence/products as a basis for decision making, aid planning and delivery Number of humanitarian documents (HNO, HRP, cluster/agency strategic plans, etc.) directly informed by IMPACT products	Perceived relevance of IMPACT country-programs	Country team	Usage_Feedback and Usage_Survey template	no
		Perceived usefulness and influence of IMPACT outputs			
		Recommendations to strengthen IMPACT programs			
		Perceived capacity of IMPACT staff			
		Perceived quality of outputs/programs			
		Recommendations to strengthen IMPACT programs			
Humanitarian stakeholders are engaged in IMPACT programs throughout the research cycle	Number and/or percentage of humanitarian organizations directly contributing to IMPACT programs (providing resources, participating to presentations, etc.)	# of organizations providing resources (i.e. Staff, vehicles, meeting space, budget, etc.) for activity implementation	Country team	Engagement_log	<input type="checkbox"/> Yes
		# of organizations /clusters inputting in research design and joint analysis			<input checked="" type="checkbox"/> Yes
		# of organizations /clusters attending briefings on findings;			<input checked="" type="checkbox"/> Yes