UKRAINE

Cold Spot Risk Assessment

Winterization 2022/23

Factsheet - November 2022

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Introduction

In their flash update from 17th October 2022, the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) highlighted the ongoing winterization efforts to help at least **2.4 million Ukrainians prepare for the upcoming cold conditions.** Overall capacity to cope with cold temperatures is being further impaired by **ongoing destruction and failure of infrastructures** (e.g., electricity, water, heating) (UNOCHA 2022). The combination of more severe climatic conditions and considerable damage to infrastructure and private houses caused by hostilities can potentially further aggravate vulnerabilities of the affected population exposed to low winter temperatures.

Conflict escalation and ongoing hostilities has caused **significant damage to public utilities, gas and energy infrastructure in most oblasts** putting the population at risk of losing access to heating due to potential war-related damage to centralized heating systems or energy infrastructure. In addition, hostilities lead to the inability to repair damage, thus further impacting functionality of these systems (REACH 2022a). Those impacts have been putting a growing number of **people at risk of having insufficient heating or insulation to cope with cold temperatures.** The approaching winter conditions are particularly concerning for IDPs living in collective centers and people living in damaged homes or homes needing renovation, especially in rural areas (ACAPS 2022). Winterization needs therefore include but are not limited to repairing damaged buildings (e.g., broken windows) and bomb shelters, restoring infrastructures, providing cash assistance and supporting preparations for an influx of new IDPs. 6.2 million Ukrainian are already internally displaced and some oblasts expect that many more could arrive before winter. This **expected wave of displacement before the start of the winter** could increase the impacts of winter-related hazards on vulnerable people and amplify the severity of humanitarian needs (UNOCHA 2022).

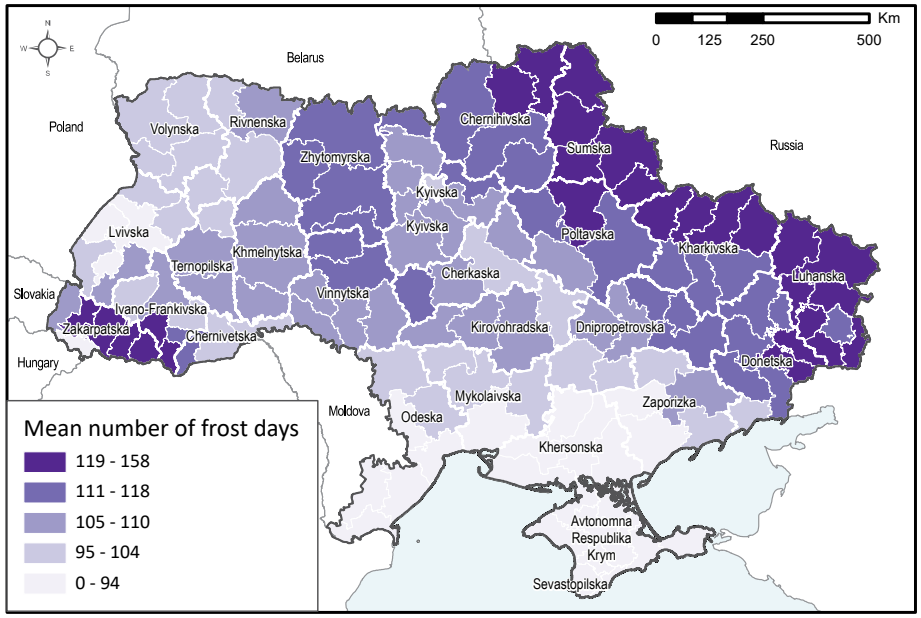
Winter conditions

The climate in Ukraine is temperate continental, with cold winters and warm summers. Winter conditions can be characterized by the **number of days when the temperature drops below 0˚C** for at least a short time within a day (**frost days**) (**Map 1**) or when it persists below 0˚C across an entire day (ice days). During the past cold seasons (from September until May) in 2010-2020 the number of frost days in Ukraine on average was estimated to 105 days per season (REACH 2022b).

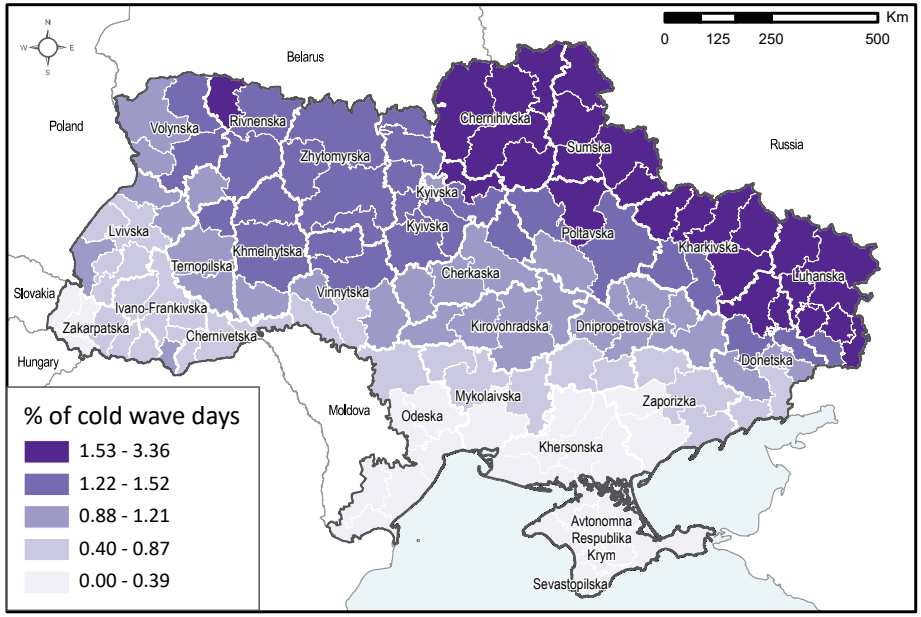
Cold waves are defined by either a rapid drop in air temperature or a sustained period of excessive cold (link). Severe cold is a **threat to human health** as prolonged exposure can lead to conditions such as hypothermia, frostbite and cardiac arrest (link). Icy and snowy conditions can also lead to deterioration in transport conditions, increasing risks of road accidents (link), whilst utility networks such as water, heating and electricity may be disrupted (link). While a range of infrastructure can be affected, the most exposed to low temperatures are water and heating infrastructure. Freezing of water pipes, damage to power lines and failure of heating systems can cause lasting damage to water, power, and heating supplies, putting populations at further risk (REACH 2022b).

Satellite derived land surface temperature suggests that north-east oblasts are the most exposed to cold waves (**Map 2**). Damage to the Kremenchutska, Chernihivska, Okhtyrska, Luhanska, and Severodonetska thermal power plants endangers the start of the heating period in these oblasts. Coastal areas experience the least days with extremely low temperatures, with warm air masses from the Azov and Black seas having a moderating effect on temperatures in the winter season (REACH 2022b).

Map 1. Mean number of days when daily minimum temperature < 0°C per raion. Data source: (link).



Map 2. Mean percentage of days experiencing cold waves (days with temperatures below -15°C) per raion (Dec-Feb: 2000-2021). Data source: (link).



Winterization

Winterization is a term used to describe the process that a plant, refinery, or other facility undergoes to prepare for cold weather (link). Depending on the type of facility and the anticipated temperature drops, winterization may include a number of plans, processes, and procedures (REACH 2022b).

In Ukraine, the **repair of structural damages** (Image 1), such as broken windows or damaged pipelines, is an important activity for winterization preparation. A Humanitarian Situation Monitoring (HSM) assessment from August 2022 revealed that the scale of reported damage to private housing was particularly high in Irpin (Kyivska oblast), Druzhba (Kharkivska), Hlyboke (Odeska), and Dniprove (Dnipropetrovska), where Key Informants (KIs) reported that **"more than half" of houses had been damaged since the start of the war**. Those structural damages increase the impacts of winter hazards and reduce the capacity of residents to cope with cold conditions. KIs further reported that **high prices** (reported by KIs in 91%, n=278 of assessed settlements) **and lack of money** (reported by KIs in 69%, n=211 of assessed settlements) were the **main barriers** that most people would face in **accessing heating during winter** in their settlement (REACH 2022c).

Winterization approaches and strategies regarding winter 2022/23 in Ukraine consider climate conditions, vulnerable groups, and infrastructure capacities as well as conflict-caused damages. For example, UNOCHA's winterization plan states to '**prioritize IDPs and people living in sub-standard housing with critical interventions that can ensure warm, safe and dignified living conditions**'.

The aim of the present **Cold Spot Risk Assessment** is to support the winterization process of the humanitarian response by improving the understanding of winter-related hazards, exposure, and vulnerabilities and compounding impacts on conflict-affected people in winter 2022/23 in Ukraine.

Image 1. Damaged residential building. Data source: (ACTED 2022).

Cold Spot Risk Assessment

This **Cold Spot Risk Assessment** aims to identify geographic locations of 'Cold Spots', meaning geographic areas where **winter-related hazards** (e.g., cold waves) compound with **susceptibilities** (eg., internal displacement; older persons; etc.) and **Lack of Coping Capacity (LOCC)** (e.g., infrastructure damages (Image 2)), **impacting vulnerable people** most severely.

The concept of the analysis is derived from the **disaster risk model** by the United Nations Office for Disaster Risk Reduction (UNDRR) which defines **risk as combination of hazard, exposure, and vulnerability (consisting of susceptibility and LOCC)**.

Key Definitions (Source: UNDRR 2017)

Risk
Risk is defined as the consequence of the interaction between hazards and the characteristics of exposure and vulnerabilities. Within this study, following risk formula is used:

Risk =
Hazard x Exposure x Vulnerability (Susceptibility + Lack of Coping Capacity)

Hazard
'A hazard is a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. Hazards may be natural, anthropogenic or socionatural in origin'. **This study focuses on winter-related hydrometeorological hazards, including cold waves and cold temperatures.**

Exposure
'The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas'. **This study focuses on people exposed to winter-related hazards.**

Vulnerability
'The characteristics determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.' **In this study vulnerability is defined as combination of susceptibility and Lack of Coping Capacity (LOCC):**

- **Susceptibility**: People's susceptibility to the impacts of hazards, which can be enhanced due to certain conditions (e.g., internal displacement, age, economic instability).
- **Lack of Coping Capacity:** Conditions which reduce people's capacity to cope with impacts of hazards (e.g., damages to heating infrastructures, structural damages to buildings like broken windows or pipes).

Image 2. Damaged road infrastructure. Data source: (ACTED 2022).

Methodology

A **geospatial analysis** was carried out in order to identify 'Cold Spots' with the highest compounding impacts of winter-related hazards and vulnerabilities on exposed people. The geographic scope of the analysis included **all of Ukraine's raions (administrative boundary level 2).** In a first step, data sets of **indicators** for the groups **hazards** (e.g., cold days, cold waves), **exposure** (population density), **susceptibilities** (e.g., number of IDPs per raion; percentage of elderly population), and **LOCC** (e.g., infrastructure damages; central heating outputs) were identified. The **selecting criteria for data sets** included their **quality** (considering completeness, actuality, reliability of source, consistency, accuracy) and **suitability** (relevance as indicator in one of the four groups, type of data, coverage, sensitivity of information (can the data be analysed & shared considering 'Do No Harm Principles'). In the decision process for including or excluding indicators, information from reviewed documents on winterization (e.g., groups particularly vulnerable to winter-related hazards like IDPs (link)) as well as opinions of experts with knowledge and experience of country- and situation-context in Ukraine were consulted.

In a next step, suitable data sets of selected indicators were **aggregated to raion (admin 2) level**. The indicators' values were then assigned into **5 classes ('Very Low'** to **'Very High')** using 'Quantiles' or 'Manual breaks', depending on the type of data and value distribution. Within each of the groups hazard, susceptibility, and LOCC the indicator layers were then **overlaid** to identify those raions where all indicators overlay with the same or higher class value. Across the three groups the **'Cold Spot Index (CSI)'** was then calculated, using following formula:

CSI =

Hazard Class * 0.35 + Exposure Class * 0.25 + Vulnerability ((Susceptibilities Class + LOCC Class) / 2) * 0.4

This formula defines Cold Spot risk as combination of **hazard** (weighted **35%**), **exposure** (weighted **25%**), and **vulnerability** (weighted **40%** and understood as a combination of susceptibility and LOCC). Exposure was assigned the lowest weight due to the strong limitations of data actuality and accuracy of currently available population statistics.

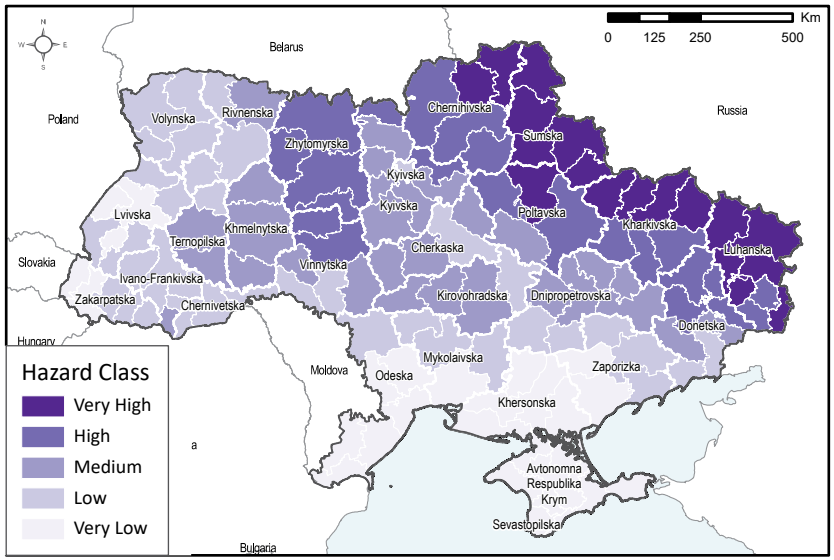
For example: The raion 'Iziumskyi' was assigned a Hazard Class of '4 (High)', Exposure Class of '4 (High)', Susceptibility Class of '4 (High)', and LOCC Class of '5 (Very High)', resulting in a 'Cold Spot Index' value of '4,2'. (CSI = 4 * 0.35 + 4 * 0.25 + ((4 + 5) / 2) * 0.4 -> CSI = 4,2)

The **CSI result values** were classified in **5 classes ('Very Low'** to **'Very High')** using 'Natural Breaks' as the classification method in order to **identify those raions with similar situations** in terms of winter-related impacts across Ukraine. In a final step the **three raions with highest CSI** value (**Bohodukhivskyi** (CSI = 4.8), **Kharkivskyi** (CSI = 4.8), **Chuhuivskyi** (CSI = 4.8)) were identified and highlighted.

The software used in this analysis were ArcGIS Pro (version 3.0.2.) & QGIS (version 3.26.2).

HAZARD

Map 3. Assigned winter-related hazard class per raion. Data source: (see below).



Hazard Indicators

The hazard component in the analysis assesses exposure to winter-related hazards across Ukraine (**Map 3**). The two indicators included are:

Cold Waves

Cold waves have been selected as indicator due to the strong impact of extreme cold temperature on lives and livelihoods.

Unit: Mean Percentage of days experiencing cold waves (days with temperatures below -15°C) in Ukraine (Dec-Feb: 2000-2021).
Source: MODIS Land Surface Temperature and Emissivity Data (MOD11).

Limitations: Historic data analysis provides insight into past trends, however it does not provide an outlook into cold wave conditions in winter 2022/23. Further, the data was aggregated to raion level, therefore reducing the geographic accuracy.

Frost Days

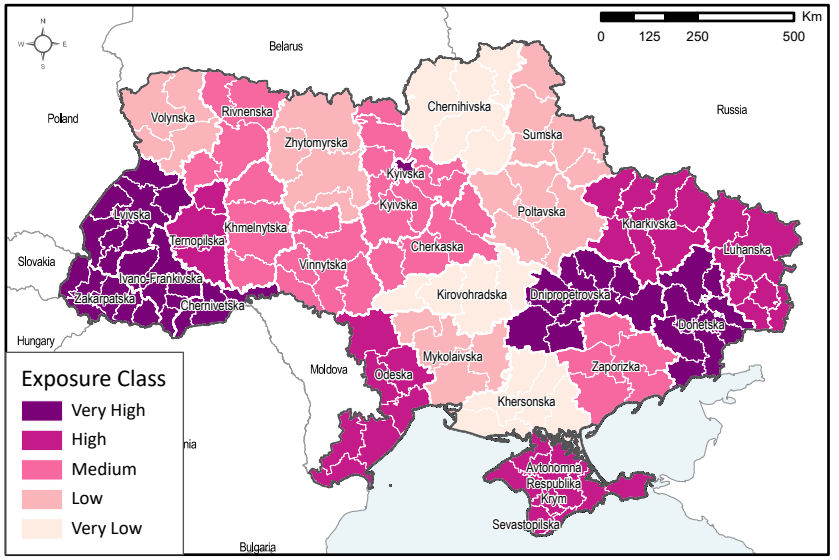
The mean number of frost days was included as indicator to assess areas with long durations of cold temperatures.

Unit: Mean number of frost days (daily minimum temperature < 0°C) during the cold season (Sep-May) in Ukraine (2010-2020).
Source: Own calculation (REACH 2022) based on ERA5 Daily Aggregates (ECMWF / Copernicus Climate Change Service).

Limitations: Historic data analysis provides insight into past trends, however it does not provide an outlook into cold wave conditions in winter 2022/23. Further, the data was aggregated to raion level, therefore reducing the geographic accuracy.

EXPOSURE

Map 4. Assigned exposure class per raion. Data source: (See below).



Exposure Indicators

The exposure component focuses to identify areas where most people are potentially exposed to winter-related hazards (**Map 4**).

Population Density

Population density has been included as indicator in order to consider people's presence and therefore exposure per area (e.g., If an area has extreme cold temperatures but is uninhabited, no people are exposed to the hazard and therefore there is no disaster risk in the area).

Unit: Number of people present per km^2 based on population statistics per oblast (2020).
Source: Common Operational Dataset on Population Statistics (COD-PS) (UNFPA 2020).

Limitations: Firstly, population data is per oblast and therefore very general. Secondly, the statistics do not differentiate between population numbers in urban vs rural area. Therefore, population density is overrepresented in rural and underrepresented in urban areas. Thirdly, the data is based on 2001 population census data and projected forward to account for population change due to natural increase (reference year: 2020). Therefore, population statistics are estimates and not fully accurate in terms of current population distribution across Ukraine. This inaccuracy is enhanced by the massive movements of population between oblasts, raions as well as people leaving Ukraine throughout the past months. Therefore, population densities calculated based on this source are likely not fully accurate but overrepresenting population in non-government controlled areas and conflict-affected zones. Due to these strong limitations, it was decided to assign the least weight to the exposure group in the CSI formula.

VULNERABILITY

Map 5. Assigned susceptibility class to winter conditions. Data source: (see right).

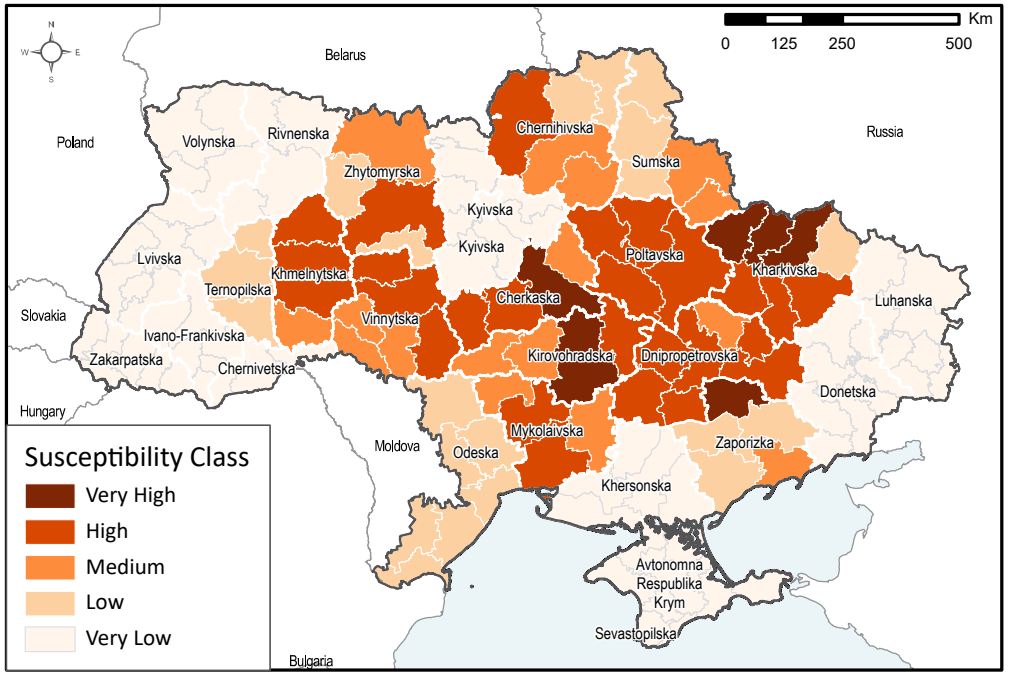


Image 3. Damaged building in rural area. Data source: (ACTED 2022).

Susceptibility Indicators

The Susceptibility component assesses susceptibilities to winter conditions across Ukraine (**Map 5**). The three indicators included are:

Internal Displacement

Internally displaced people have been identified as a group particularly vulnerable to winter-related hazards like extreme cold.

Unit: Number of IDPs per raion as of 03 October 2022.
Source: The International Organization for Migration (IOM) 2022.

Limitations: Number of IDPs include all types of IDPs, no further differentiation of living conditions (e.g., number of IDPs in collective sites) can be derived.

Older Persons

Older persons (>65 years) have been identified as a group particularly vulnerable to winter-related hazards like extreme cold.

Unit: Percentage of older persons (>65 years) population per oblast.
Source: Common Operational Dataset on Population Statistics (COD-PS) (UNFPA 2020).

Limitations: Firstly, population data is per oblast and therefore very general. Secondly, the statistics do not differentiate between population numbers in urban vs rural area. Therefore, percentage of elderly is likely overrepresented in rural and underrepresented in urban areas. Thirdly, the data is based on 2001 population census data and projected forward to account for population change due to natural increase (reference year: 2020). Therefore, population statistics are estimates and may not be accurate in terms of current population distribution across Ukraine. This inaccuracy is enhanced by the massive movements of population between oblasts, raions as well as people leaving Ukraine throughout the past months. Therefore, population numbers calculated based on this source are estimations and may overrepresent population in non-government controlled areas and conflict-affected zones.

Household Income

Average monthly income has been included as a vulnerability indicator to winter-related hazards since the capacity to purchase e.g., heating fuels or pay for infrastructure repairs can have a strong impact on the vulnerability to cold conditions.

Unit: Average monthly income per household per oblast in 2020 divided by actual subsistence level (MEB: UAH 4334 (Aug 2021)).
Source: Income: State Statistics Service of Ukraine 2020; MEB: Ukraine Cash Working group 2022.

Limitations: The average monthly income per household data is from 2020, therefore not representing actual income values as of today. However, it provides an indication of areas with historic trends of higher or lower income which impacts long-term vulnerabilities.

VULNERABILITY

Map 6. Assigned Lack of Coping Capacity class to winter conditions. Data source: (see right).

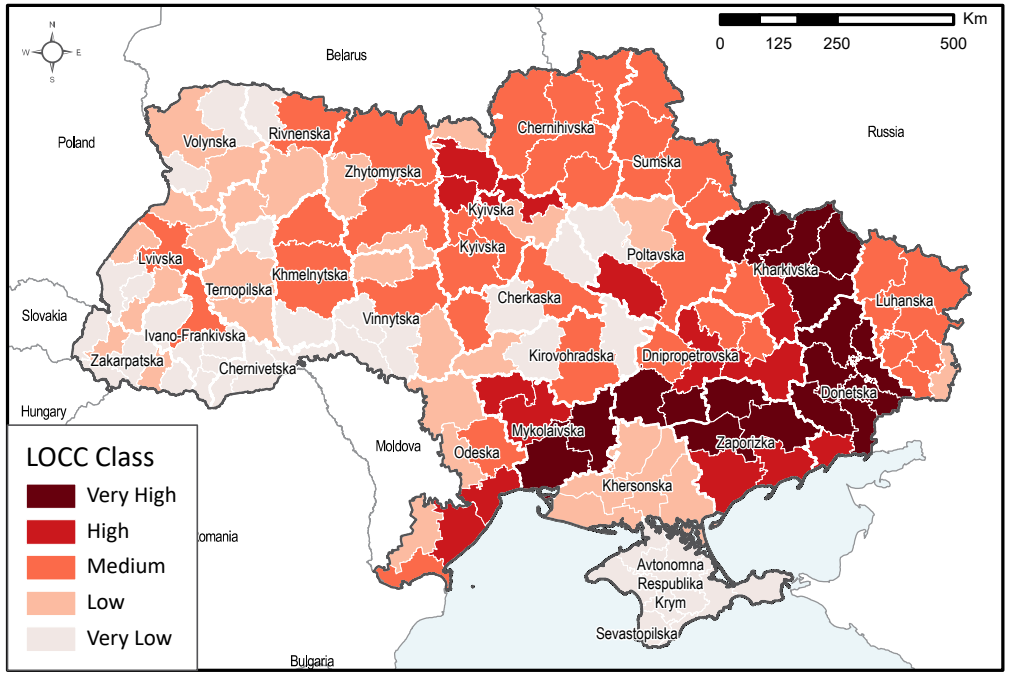


Image 4. Destroyed bridge and structural damages. Data source: (ACTED 2022).

Lack Of Coping Capacity (LOCC) Indicators

The LOCC component assesses infrastructure damages and capacities relevant for coping with cold conditions across Ukraine (**Map 6**). The three indicators included are:

Conflict Incidences

Conflict incidences were included as indicator to assess potential structural damages (e.g.,broken windows, damaged pipelines (Image 4)) per raion which reduce capacities to cope with cold-conditions. Most recent incidences are weighted more than incidences from earlier this year to consider potential repairs over time.

Unit: Number of conflict incidences (type: 'battles' or 'explosions/remote violence') per raion (February - October 2022) weighted by time period.
Source: The Armed Conflict Location & Event Data Project 2022.

Limitations: There is no information available on the current status of damaged structures or infrastructures. Therefore, infrastructure that had been damaged in an earlier time period might have been repaired in the meantime.

Damages to Heating Infrastructure

Heating infrastructure damages were included as indicator to assess potential structural damages to heating infrastructure (e.g., NPP, CHP, TTP, gas pipelines, etc.) per raion. Heat pipeline networks, particularly above ground, are exposed to damage from artillery shelling and air strikes. Electricity is critical for both domestic and industrial activities. Because of the linkages between electricity, heating and water supply systems, electricity shortages can have cascading negative consequences for households, inhibiting their ability to heat their homes and access water.

Unit: Number of heating infrastructure damages (e.g., NPP, CHP, TTP, gas pipelines, etc.) per raion (February - October 2022) weighted by time period (Most recent incidences are weighted more to consider potential repairs over time).
Source: REACH 2022 – infrastructure damages database (data on request).

Limitations: Firstly, there is no information available on the current status of damaged infrastructures. Therefore, infrastructure that had been damaged in an earlier time period might have been repaired in the meantime. Secondly, REACH infrastructure damage database collects information from public sources on reported damages. Therefore, the database is limited in its completeness and not representing every occurred incidence but biased towards publicly reported incidences.

Heat Output

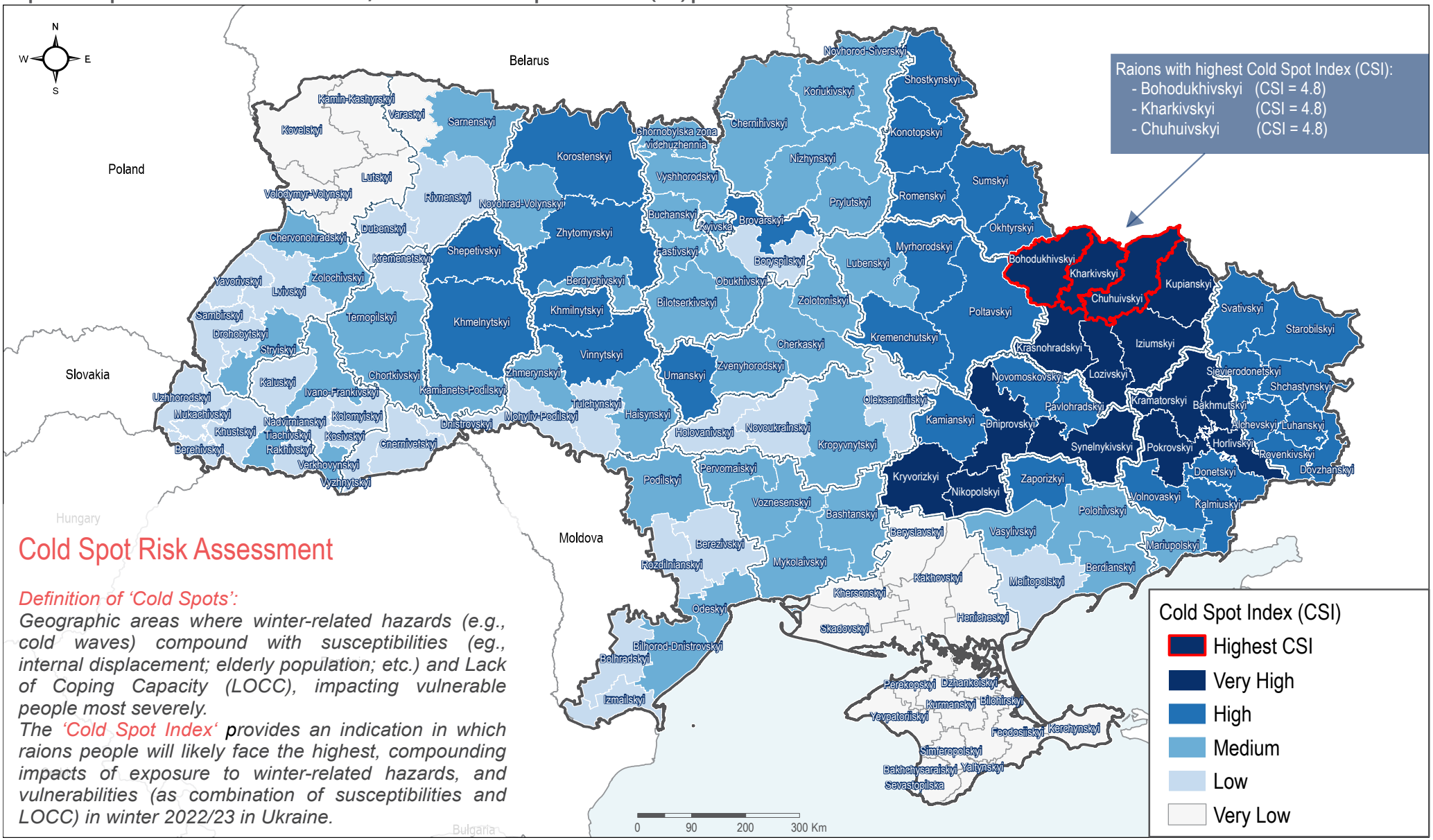
High heat outputs indicate high needs for heating as well as reliance on central heating. Citizens of eastern and central Ukraine as well as the capital city of Kyiv are dependent on heat energy supplied from centralized facilities usually managed by public utility companies. The highest share of residential buildings which are equipped with central heating facilities are in Zaporizka, Donetska, Dnipropetrovska and Kharkivska oblasts and Kyiv city ranging from 55,8 % to 98,7 % (link).

Unit: Heat output per oblast, indicating the amount of heat energy generated and supplied to consumers by centralized heat generating facilities.
Source: State Statistics Service of Ukraine 2020.

Limitations: Firstly, heat output data is per oblast and therefore very general. Secondly, the data is from 2020, therefore not representing actual heat outputs as of today. However, it provides indication of areas which are highly relying on centralized heating and therefore structural damages to heating reduce people's capacity to cope with cold conditions.

Cold Spot Risk Assessment

Map 7. Cold Spot Risk Assessment Winter 2022/23 Ukraine as Cold Spot Risk Index (CSI) per raion. Data Source: Own calculation based on indicators listed in this factsheet.

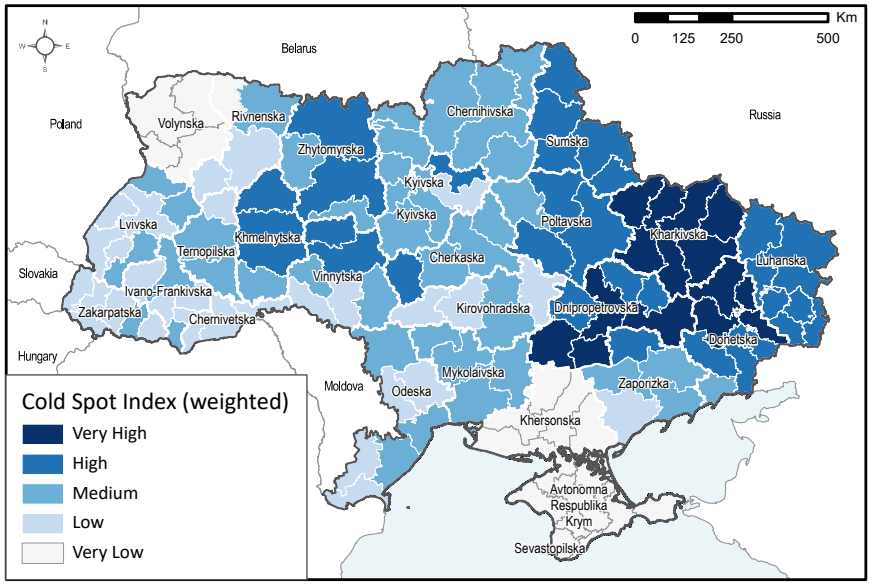


Coordinate System:WGS 1984 Web Mercator Auxiliary Sphere
Projection: Mercator Auxiliary Sphere

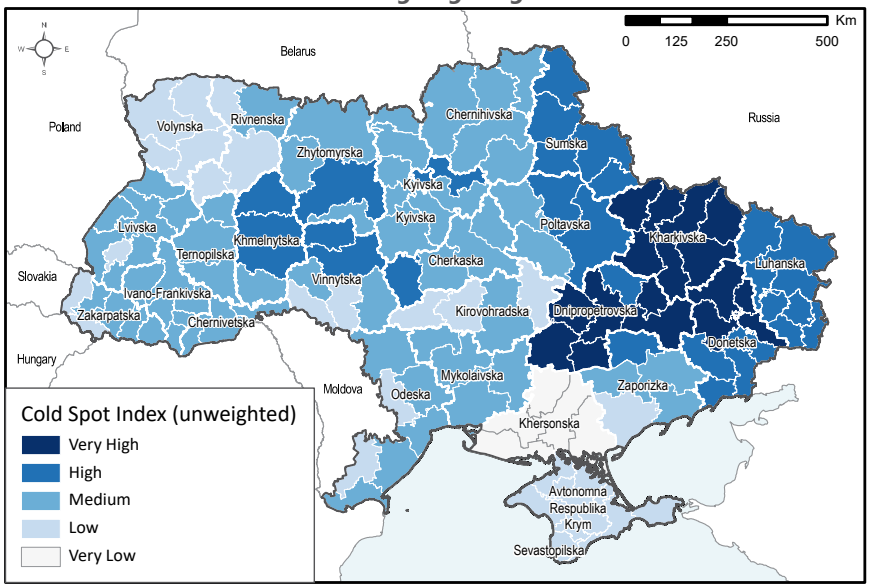
Data Sources:
Administrative Boundaries: OCHA 2022

Note: Data, designations and boundaries contained on this map are not warranted to be error-free and do not imply acceptance by REACH partners, associates or donors mentioned on this map.

Map 8. Cold Spot Risk Assessment Winter 2022/23 Ukraine as Cold Spot Risk Index (CSI) per raion. CSI was calculated with weights (35% Hazard, 25% Exposure, 40% Vulnerability). Data Source: Own Calculation.



Map 9. Cold Spot Risk Assessment Winter 2022/23 Ukraine as Cold Spot Risk Index (CSI) per raion. CSI was calculated without assigning weights. Data Source: Own Calculation.



Limitations

It is essential to mention that this 'Cold Spot Risk Assessment' is highlighting areas with likely most severe impacts on people, based on the analysed indicators. Areas which are classified as 'Very Low' have a very low CSI based on those specific indicators. However, this does not mean that those areas have overall no vulnerability or needs. It is likely that vulnerabilities are present which were not captured with the analysed indicators. For example, using number of IDPs per raion as indicator draws the focus to raions with high numbers of IDPs, meanwhile conflict-affected population which did not leave might face severe impacts by winter conditions as well. It is therefore essential to capture data on those currently 'invisible' groups.

The strongest technical limitations in this assessment are the availability and quality of data sets. The most accurate data is on climate conditions and hazards. However, it is historic data and therefore provides insights into historic trends but does not provide an outlook to winter conditions in 2022/23. The least accurate and most outdated data is on population statistics, income, and capacities of central heating systems. Data is available per oblast, which is very general and dated back to 2020. Especially for analysis of population exposure to hazards it is essential to have accurate and up-to date population statistics. Therefore, population statistics are estimates and not fully accurate in terms of current population distribution across Ukraine. Inaccuracies in population statistics are enhanced by the massive movements of population between oblasts, raions as well as people leaving Ukraine throughout the past months. Therefore, population numbers and densities calculated based on currently available sources are estimates and likely overrepresent population in non-government controlled areas and conflict-affected zones. Due to these strong limitations it was decided to assign exposure the least weight in the CSI formula. Map 8 on the left shows a CSI output map with weights assigned (35% Hazard; 25% Exposure; 40% Vulnerability). Map 9 shows a CSI output map with equal weights assigned to the three groups. Though the maps look similiar on first sight, the comparison shows that with weights assigned raions in the west (e.g., within Zakarpatska oblast) fall within a lower CSI category while e.g., Kremenchutskyi raion in the south-west of Poltavska oblast falls into a higher CSI category than with no weights assigned. This example highlights the importance and impact population data can have within this analyses and stresses the need for accurate and up-to-date data.

A further limitation of the assessment is the classification of analysed data and the final CSI values. It was decided to use quantiles as method in setting group classes of indicators in order to provide insight on the most impacted areas relative within Ukraine. However, it needs to be noted that using quantiles can group quite differing values into one class. For the final CSI map, natural breaks were used as method to group raions with similar situations in terms of winter-related impacts. There is no standardized classification or fixed thresholds for this type of analysis which is why it was aimed to find the best balance between providing detailed information while keeping clarity in the results.

Lastly, this assessment highlights areas of likely most severe impacts on people in winter 2022/23, ultimately putting a spotlight on those raions. It will be essential to ensure coordination of humanitarian assistance to avoid an over-representation of actors and humanitarian assistance in 'spotlight area', leaving out other areas which might face relatively less but still severe impacts.

Key findings

- The analysis of indicators per group showed that winter-hazards are most severe in the north-eastern regions. Considering vulnerability, susceptibilities to winter conditions are most severe in the central and eastern regions and LOCC in the eastern and southern regions, following the areas along the present or historic line of conflict.
- Overall, the assessment showed that cold spot impacts will likely be most severe (CSI = Very High) in the eastern areas of the country, including raions in the oblasts **Kharkivska**, **Donetska**, and **Dnipropetrovska**. In the western area, raions within the oblasts Vinnytska, Khmelnytska, and Zhytomyrska fall into the CSI category 'High'.
- The Cold Spot Risk Assessment showed that the raions **Bohodukhivskyi** (CSI = 4.8), **Kharkivskyi** (CSI = 4.8), **Chuhuivskyi** (CSI = 4.8) have the highest CSI values. Those raions are also newly liberated areas (Map 10), likely facing severe impacts and needing specific winterization assisstance.

Map 10. Cold Spot Risk Assessment Winter 2022/23 Ukraine & Areas of Control. Data source: (link).

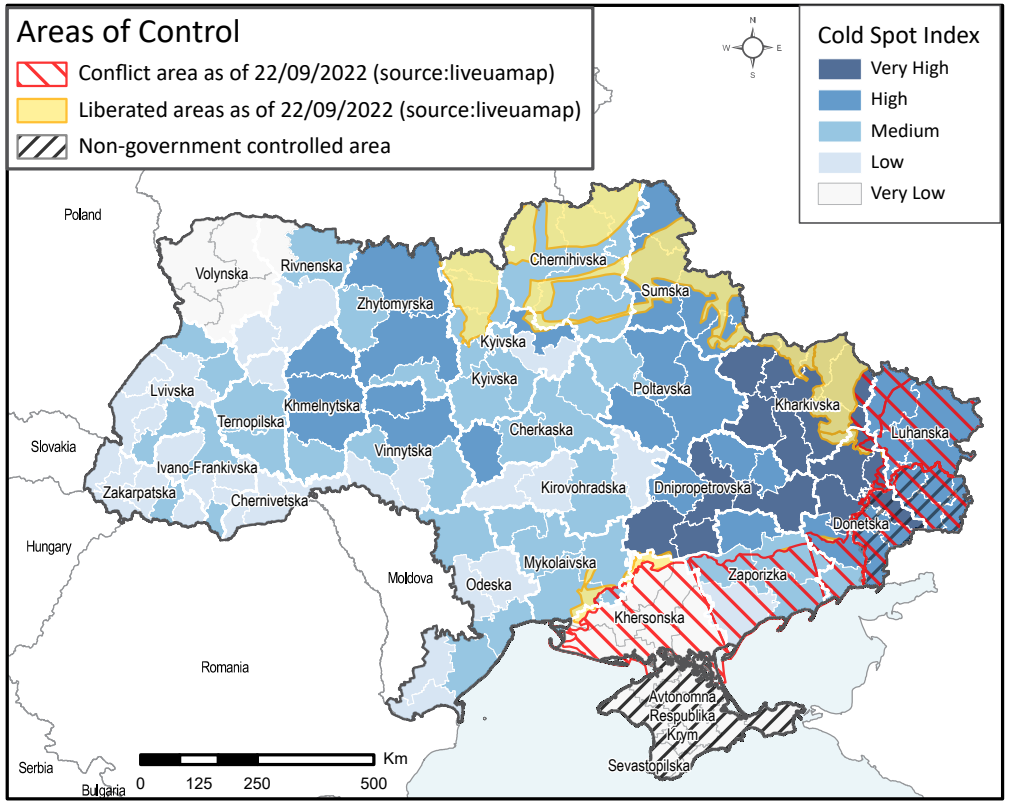


Image 5. Damaged residential building. Data source: (ACTED 2022).

Moving forward

In the upcoming winter months it will be essential to improve data availability and data quality and specifically collect information on groups vulnerable to winter conditions which are under- or not represented in currently available data sets. This includes but is not limited to:

- Information on **IDPs:** hosting/shelter typology & IDP demographic groups (babies, young children, and older persons are most susceptible to hypothermia).
- **People who have not moved** and are particularly vulnerable to cold conditions (e.g. older persons in rural areas or residents of damaged buildings).
- Accurate and up-to-date **population statistics** on raion level.
- **Socio-economic data** on raion level: market analysis on price/access to fuel, electricity, fire wood/pellets access/affordability of heating sources.
- Data on **residential shelter damages** by raion.
- Frequency & duration of **blackouts** per region (a blackout for more then 72 hours will result in risk of hypothermia even for those indoors if without heating).
- Status of **damaged energy or heating infrastructure** (newly damaged / still damaged / repaired).
- Information on needs specifically to winterization in **newly liberated areas** (**Map 10**).

Further Resources

- Winterization 2022/23: climatic conditions
- Winterization 2022/23: damage to energy infrastructure
- Energy infrastructure damage: Situation overview for 10-24th October 2022
- Humanitarian Situation Monitoring August 2022

All images were provided by ACTED Communications Unit.