UKRAINE: Winterization 2022/2023: climatic conditions factsheet

July 2022

Situation overview

The escalation of hostilities in Ukraine on 24 February 2022 has led to a rapid expansion of conflict-affected areas and an increase in the number of conflict incidents in proximity to heating infrastructure. Conflict incidents in the vicinity of these sites and objects increase the risk of damage that may result in threats to human health and service functionality.

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. Ideally, winter preparations should begin in the late summer or early fall, giving ample time to identify and fix any potential problems or deficiencies.

Due to significant heating infrastructure **damage, preparations for the 2022/2023 winter season may be complicated in Ukraine**, especially in areas affected by hostilities or rocket attacks.

Winter climatic conditions

The climate in Ukraine is temperate continental, with cold winters and warm summers. Winter conditions could be characterized by number of days when the temperature drops below 0˚C at least for short time within a day (**frost days**) or when it persists below 0˚C across an entire day (**ice days**). During the last cold seasons (from September till May) in **2010-2020** the **number of frost days in Ukraine** on average was estimated to **105 days**. For Sumska, Luhanska and Ivano-Frankivska oblasts this number exceeded 115 days in average which can be explained by more harsh and continental climate conditions (Map 1) for two first, while the last one is partly situated in Carpathian Mountains. The same three oblasts experienced maximum number of frost days within the last 10-year period. Other regions with a **higher number of frost days**, both mean and maximum values, are **Kharkivska, Chernihivska, Zakarpatska, Chernivetska, Zhytomyrska and Donetska**.

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

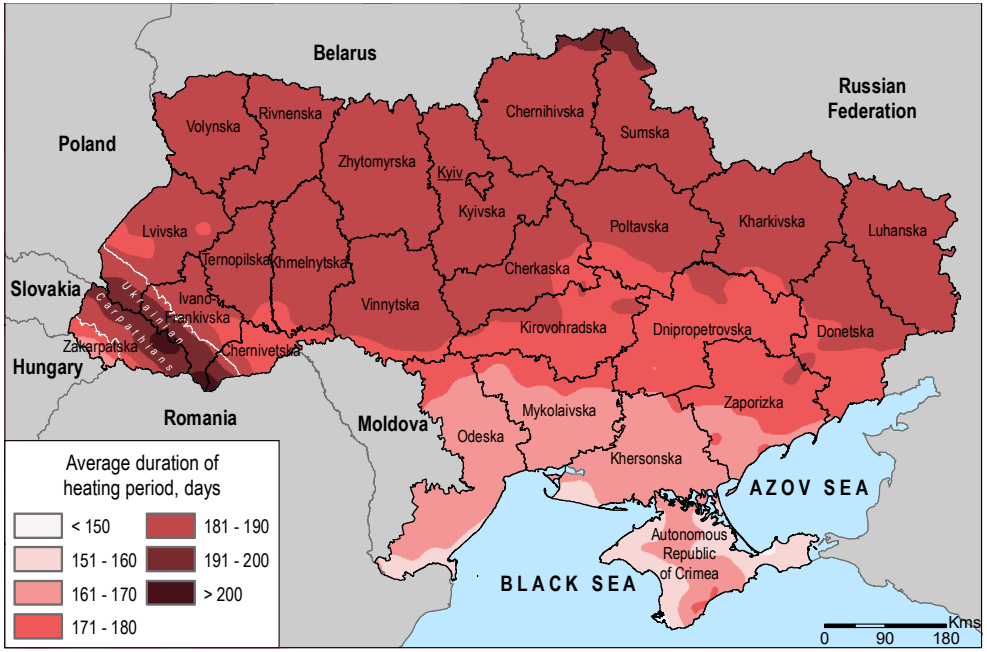
Data sources: Own calculation based on ERA5 Daily Aggregates (ECMWF / Copernicus Climate Change Service)
Coordinate System: UTM Zone 35N

Heating period in Ukraine

Official start of the heating period (time when a centralized heating system operation is required) in Ukraine is determined by the weather condition outside. When the **mean diurnal temperature of three consecutive days drops below 8˚ C** the local authorities may announce **the begging of the heating period** and run heating facilities. Analyzed climatic **data from 2010 to 2020 showed** that condition for **the start of the heating period** in average for Ukraine came **on the 14 of October** with substantial variation across the time and space (Graph 1). The north and west oblasts of Ukraine have an earlier start of the heating period than average and the difference with the southern part of the country might reach up to 20 days in average. In the northern oblasts including Kyiv the heating period under the current climate conditions might start as early as September 29.

The end of the heating period much depends on the warming in springtime which might lead to substantial variation in its length. After three consecutive days with diurnal mean temperature above 8˚ C supply of heat from centralized facilities can be stopped. As a rule, it happens sometime **in April.**

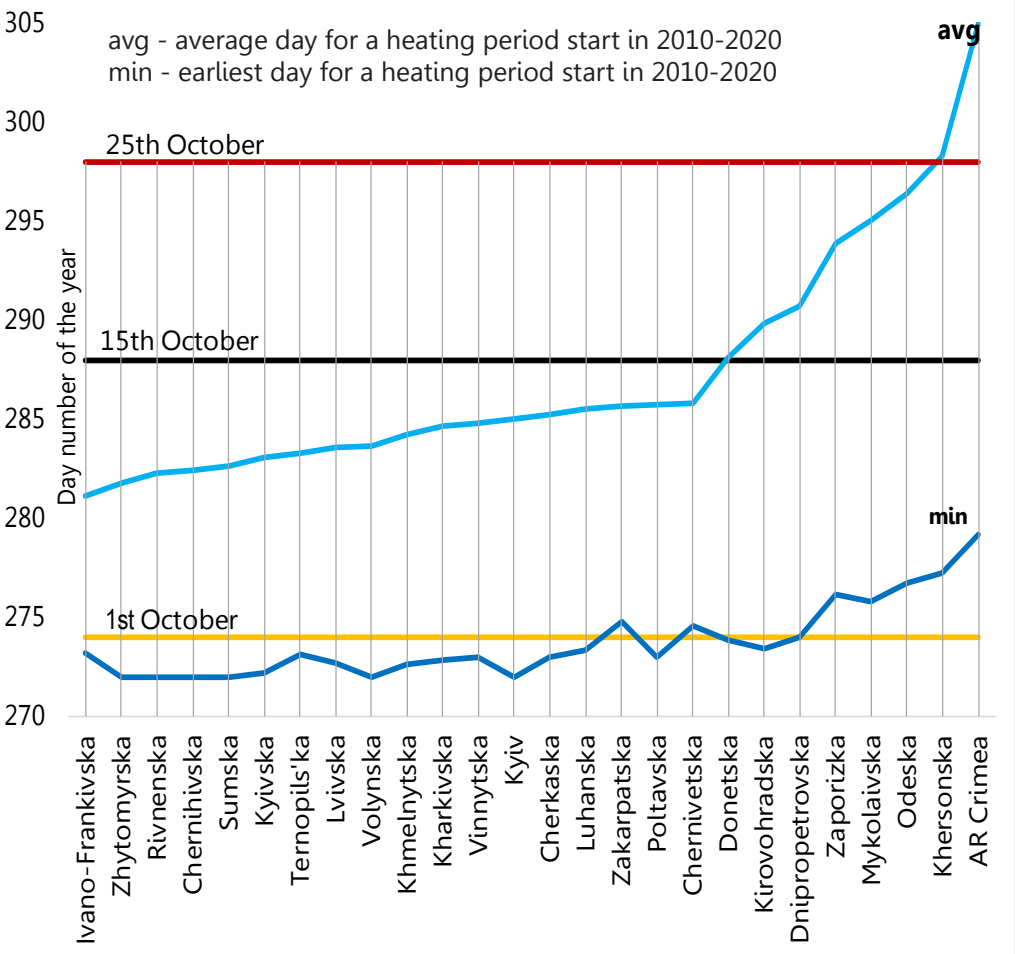
Map 2. The average duration of the heating period in days. Data source: (link).



Data sources: Own calculation based on ERA5 Daily Aggregates (ECMWF / Copernicus Climate Change Service)
Coordinate System: UTM Zone 35N

Heating period in Ukraine

Graph 1. Beginning of the heating period in oblasts. Data source: (link).



The average duration of heating period in Ukraine is estimated to **181 days** for the last 10-year period (Map 2). It lasts **the longest in Ivano-Frankivska, Chernihivska and Sumska oblasts** while **the shortest is in Crimea, Khersonska and Odeska oblasts** in the south. Moreover, oblasts in the west that have mountain areas, Crimea and stretched Odeska oblast feature the highest spatial variation in the length of the heating period for up to 40 days within one oblast. However, up in the mountains the settlement network becomes scarce, and people there usually heat their houses by themselves often relying on firewood.

Cold waves

According to a study of global climate-related mortality (2000 to 2019), published in the Lancet, extreme cold resulted in ~4.5 million annual deaths worldwide (link).

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 arrests (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). In addition, crops may be damaged, affecting food production and livelihoods (link).

Ukraine experienced **cold waves in 2006, 2012 and 2017**. Following the arrival of two Arctic cold fronts in 2006 (link), a record 884 people died as a result of the extremely low temperatures, whilst 2,045 children were evacuated from their homes and were moved to shelters due to lack of heating. Many people exposed to cold waves suffered health problems, as well as hot water and electrical system breakdowns, heating interruptions and carbon monoxide poisoning in attempts to heat shelters.

The satellite derived land surface temperature suggests that north-east oblasts, including **Sumska, Chernihivska, north of Kharkivska and Luhanska are the most exposed to cold waves** (Map 3). Damage to the Kremenchutska, Chernihivska, Okhtyrska, Luhanska, and Severodonetska thermal power plants endangers the start of the heating period in this oblast. 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.

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.

Suggested mitigation approaches

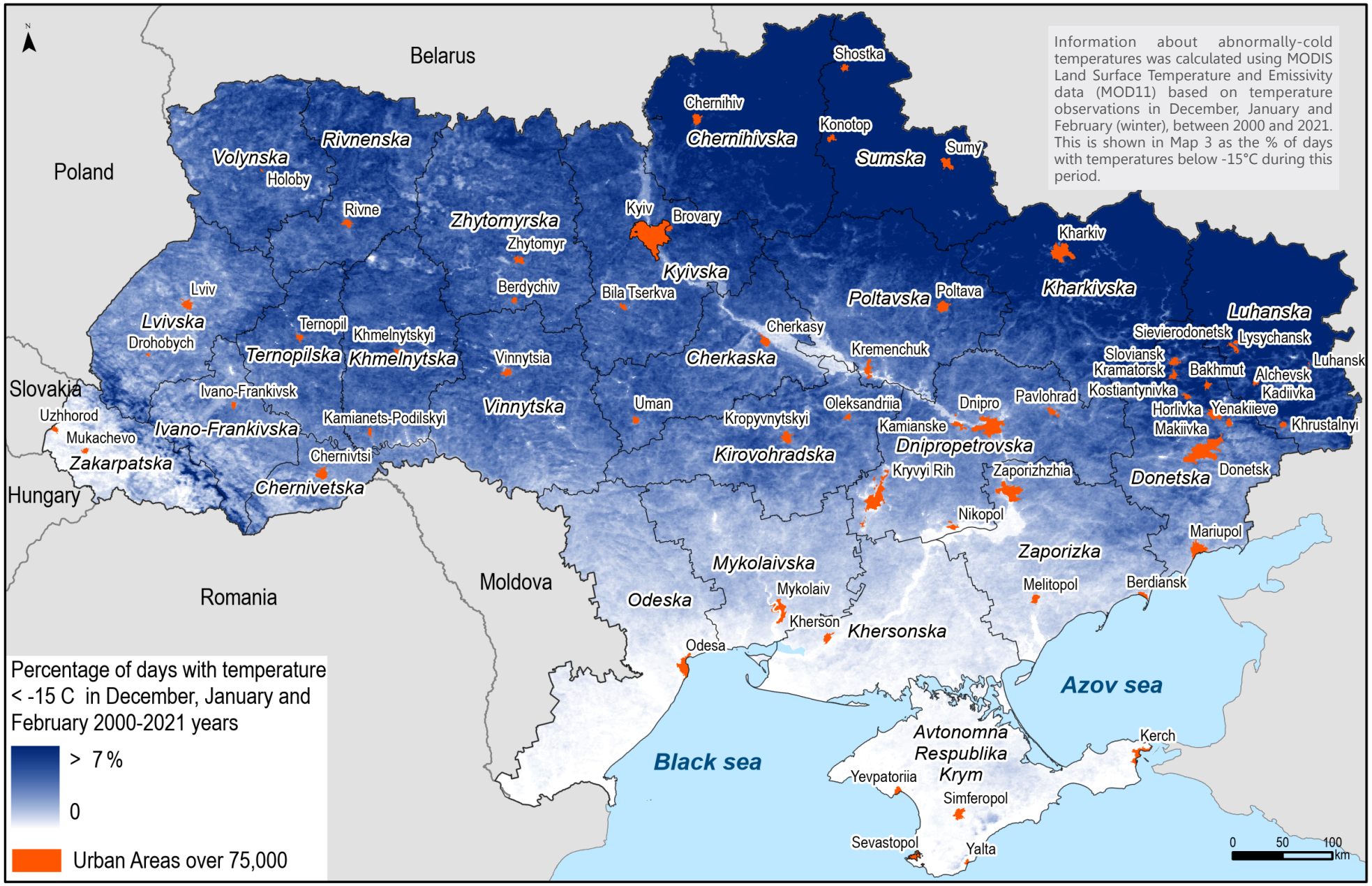
- Ensure vulnerable groups can access financial support for heating
- Provide shelters for the homeless and raise awareness of them
- Ensure warning system in place to warn residents of cold waves
- Increase awareness of home heating best practices, especially during failure of the mains supply

Key takeaways

- Sumska and Kharkivska oblasts are the most vulnerable to low winter temperature due to a combination of more severe climatic conditions and considerable damage to infrastructure and private houses caused by hostilities
- Many cities in Luganska and Donetska oblast as well some cities damaged by rocket attacks (Kremenchuk, Chernihiv, Okhtyrka) might face substantial challenges in preparation to the next heating period
- Also, winter conditions in the western mountain region might last longer than average in Ukraine because of harsher climatic conditions

Cold waves

Map 3. Percentage of days experiencing cold waves in Ukraine (2000-2021)



Damage to energy infrastructure

From February 24 to July 5, more than **15 heat supply network accidents** were recorded in Ukraine. Thirteen thermal power plants were affected by conflict. **The most significant damage** was recorded in **Donetska, Luhanska, Dnipropetrovska, Poltavska, Chernihivska and Kharkivska oblasts**.

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.

Electricity supply interruption has caused disruption to other dangerous facilities such as coal mines, water filtration systems, pump stations and sewage treatment plants. This increases the risk of pollutants and hazardous substances being released into the environment.

Myronivska TPP has been occupied, Slovyanska and Vuhlehirska TPPs ceased to operate due to shellings (Image 1). These energy facilities provided the energy for the largest industrial facilities and settlements in Donetska oblast.

Electricity production on other two big thermal power plants was also suspended in Central Ukraine. Problems on Zaporizka TPP in Energodar (Zaporizka oblast) were caused by the occupation and shortage of coal for further work (link). Moreover, citizens of Energodar, in meeting their needs in heat energy and warm water, rely on Zaporizka NPP, which has been occupied since the beginning of March. The Prydniprovska TPP in Zelenodilsk (Dnipropetrovska oblast) experienced several shellings being situated close to the frontline at the north of Khersonka oblast.

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. **Most of the centralized heating system is in Kharkivska oblast (72 %)** which was **heavily damaged** from the very beginning of the war (link).

It was reported by local authorities on the severe destruction of heat energy production plants in Okhtyrka (Sumska oblast) (link) and Chernihiv (Chernihivska oblast) (Image 2) (link) on March-April, also Kremenchuk (Poltavska oblast) (Image 3) on April-June (link). This creates **a substantial risk of lack of heating, especially in the next winter season**.

Image 2. Chernigivska TPP after damage on February-March 2022. Data source: (link).

Image 1. Burned areas (brown on image B) near Vuhlehirska TPP after damage (Sentinel 2a, band combination - B12–B8–B4)

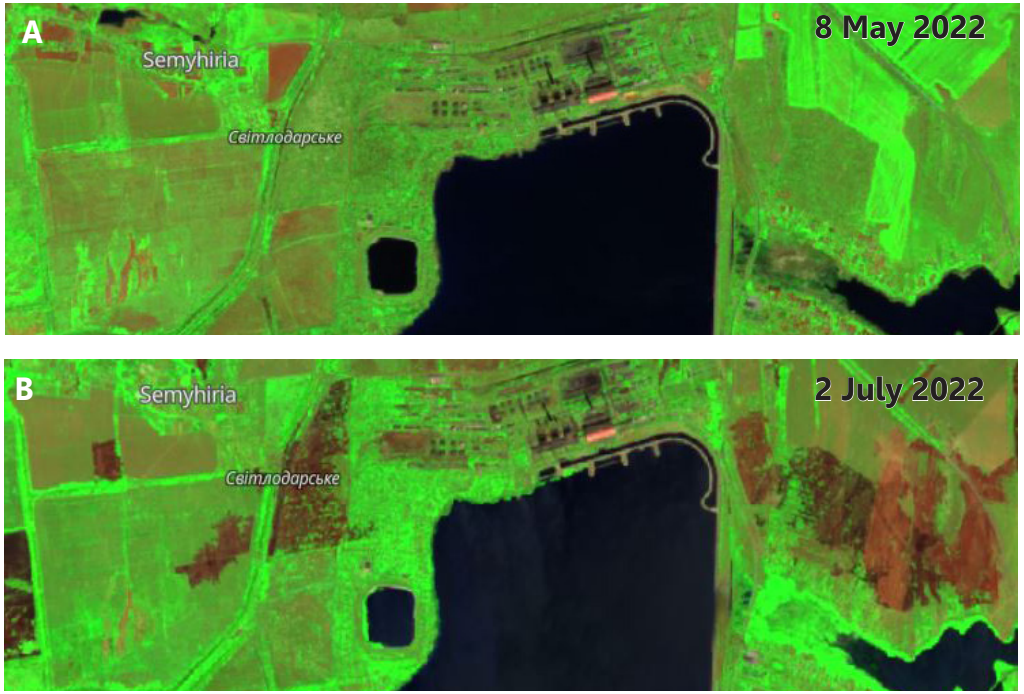


Image 3. Kremenchutska TPP after damage on April 2022. Data source: (link).