Climate Centre

Climate fact sheet | 2024

Ukraine

This climate fact sheet summarizes the available information on the climate of Ukraine and the impact of climate change on humanitarian activities in-country. Each fact sheet in the series was written using information from peer-reviewed academic papers, government publications, and other documentation from international non-governmental organizations.

1. Climate overview

Average temperature: Across most of the country, summer (May to August) annual mean temperatures range from 18–22°C, and winter (December to March) annual mean temperatures range from -4.8–2°C (World Bank Group, 2021).

Average precipitation: Precipitation distribution decreases moving north-west to south-east, with an annual mean of 1,200mm in the western mountains and 400–600mm across most of Ukraine (Yerofeyev & Hajda, 2020).

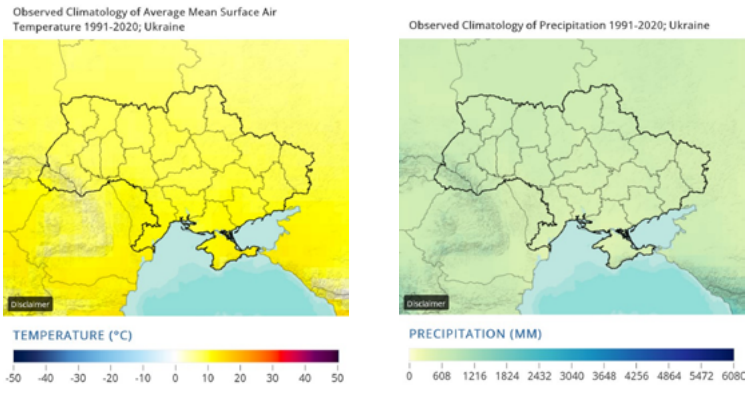

Figure 1: Observed climatology of (left to right) mean temperature and mean precipitation over 1991–2020 (from the World Bank Climate Change Knowledge Portal).

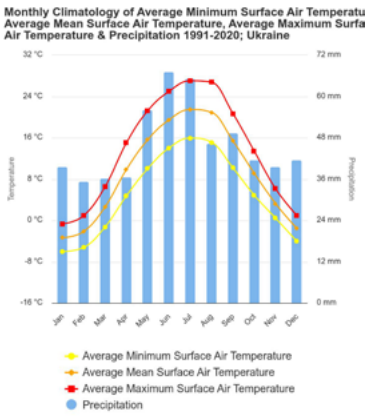

Figure 2: Observed average monthly climatology between 1991–2020 (from the World Bank Climate Change Knowledge Portal).

Short overview

Most of Ukraine is located in a temperate zone derived from the moderately warm and humid air from the Atlantic Ocean (Yerofeyev & Hajda, 2020). Plains and steppe cover 95 per cent of the country, and the remaining areas are covered by the Polissya mixed forest in the north, the Carpathian Mountains in the west, and the Crimean Mountains in the south (Ministry of Economic Development, Trade and Agriculture of Ukraine n.d.; USAID, 2016).

Ukraine experiences a summer and winter season where the west and north-west experience milder and more humid seasons, and the south and south-east experience less precipitation and greater temperature variability across seasons (Yerofeyev & Hajda, 2020).

Although not well documented, climatic annual variability in Ukraine is influenced by the El Niño–Southern Oscillation (ENSO), with El Niño (warmer and drier years) associated with droughts across the country (FAO & World Bank, 2019).

1.1 Climate change in Ukraine

Historical climate change	Projected climate change
Temperature	
▪ Annual mean temperature has increased by 0.8°C (compared to 1961–1990 averages), with the highest increase of 2°C in January (Shevchenko *et al.*, 2014). ▪ The onset of spring and autumn has changed; now occurring up to 6 days earlier compared to 1961–1990 (Shevchenko *et al.*, 2014).	▪ There is a projected increase in annual mean temperature of 4.7°C (RCP 8.5) and 2.5°C (RCP 4.5) by 2100 (World Bank, 2021), with highest rates of temperature increase expected in winter (USAID, 2016). ▪ Further changes in seasonal onset are projected, with shorter winters and earlier springs (Shevchenko *et al.*, 2014); it is also expected that spring and summer months will become warmer and the country's subtropical zone is likely to expand (World Bank, 2021).
Precipitation	
▪ Little variability in total annual precipitation, but significant change in the number of extreme precipitation events and their nature; heavy snowfall events have tripled in recent years (Shevchenko *et al.*, 2014).	▪ There is a projected increase of precipitation in northern and north-eastern regions, and 5–10 per cent rainfall reduction in southern and south-eastern regions by 2050 (World Bank, 2021). Significant precipitation variability is expected in eastern regions by 2100 (50 per cent decrease in summer and 60 per cent increase in autumn) (Gnatiuk *et al.*, 2013). Seasonally, rainfall is expected to increase in winter and spring, and decrease in summer (USAID, 2016).

2. Priorities of the Red Cross Red Crescent Movement under climate change

2.1 Scale up climate-smart disaster risk reduction (DRR), early action and preparedness

Existing hazard	Projected climate change
Floods	
River flood hazard is classified as high in most of the country (Think Hazard!, n.d.), meaning that there is the potential for damaging and life-threatening river floods – the country has numerous rivers (World Bank, 2021). In 2020, summer precipitation resulted in extreme weather phenomena causing flooding in Chernivtsi, Ivano-Frankivsk, Lviv, Ternopil and Zakarpattia regions with damages of 6.7 billion Ukrainian hryvnia (MENRU, 2022).	More frequent and intense precipitation days are expected in winter and summer with an increased number of extreme rainfall events such as floods (Think Hazard!, n.d.). Significant precipitation variability in eastern regions by 2100 is projected (50 per cent decrease in summer and 60 per cent increase in autumn) (Gnatiuk *et al.*, 2013). Climate change is also expected to exacerbate recurring floods (World Bank, 2021). Flash floods and landslides will be more likely due to extreme events, but reduced snow coverage will lower the frequency and intensity of early spring floods (USAID, 2016).
Wildfires and droughts	
An increase in forest fires has been observed in recent years; biodiversity loss contributes to conditions favourable to fire (World Bank, 2021). In 2020, damage caused by forest fires exceeded 26 billion Ukrainian hryvnia – with a total of 2,594 forest fires recorded by the State Forestry Agency (MENRU, 2022). The entire country has a high risk of wildfires (Think Hazard!, n.d.). The frequency of drought doubled during the period 1989–2010 and extended to new areas not affected historically (Nikolayeva *et al.*, 2012).	Projected changes are likely to increase wildfires as well as the presence of insects (World Bank, 2021). Climate change is also expected to exacerbate drought (*ibid*), with the southern and central oblasts expected to become drier, especially in the southern steppe (with the highest average daily maximum above 34°C) (*ibid*). Prolonged droughts are expected to worsen the potential for forest fires and shorten agricultural seasons (*ibid*). Annual severe droughts are projected to be 46 per cent more likely by 2100, compared to the period 1986–2005 (RCP 8.5) (*ibid*).

Existing hazard	Projected climate change
Heatwaves	
Frequency and duration of summer heat periods increased between 1991–2010 (Nikolayeva *et al.*, 2012).	By 2100, the number of very hot days per year (over 35°C) is projected to increase by 12 (under RCP 4.5) and 33 (under RCP 8.5) (World Bank, 2021).
Other hazards	
The frequency of extreme weather events increased by 1.5–2 times during the period of 1990–2010 (Nikolayeva *et al.*, 2012). The IFRC also supported operations relating to a measles outbreak (2019), cold waves (2012, 2019) and mudflow (2019) (IFRC, 2022).	

It is important to note that many of these hazards are interrelated and produce compound risks in the same areas and communities. In addition, risk must be understood as the interplay between hazard, exposure and vulnerability which makes certain individuals, communities and sectors more impacted by the hazards. All project design should take such compounding risks into account.

2.2 Reduce health impacts of climate change

Heatwaves and rising temperatures will increase heat-related illnesses, cardiovascular and respiratory diseases and expand the range of vector-borne diseases (USAID, 2016). In addition, the increasing flood risks are likely to increase the chance of injuries, death and damage to medical infrastructure (Snizhko *et al.*, 2021). On the one hand, increased air temperatures, highland heat effects and frequent heatwaves will increase the risk of heat-related stroke, heat fatigue and heat exhaustion (Shevchenko *et al.*, 2020; Shevchenko & Snizhko, 2015). As a result, the number of heat-related illnesses will continue increasing significantly due to climate change (Shevchenko *et al.*, 2020). Children, the elderly and those with underlying health conditions are more susceptible to these heat-related illnesses (UNICEF, 2021; Karamuska *et al.*, 2022). On the other hand, the number of cold and very cold days in winter is decreasing and the resulting temperature rise may favour the spread of vector-borne diseases such as mosquito-borne malaria and dengue fever, which are common in tropical climates (Karamushka *et al.*, 2022; Met Office, 2021).

Increased temperature and frequent heatwaves will also increase the risk of air pollution, which is already a significant health problem in Ukraine (UNICEF, 2021; Met Office, 2021). Rising temperatures and dry conditions will increase fine particles and pollutants in the air, thus increasing the risk of death due to air pollution (Met Office, 2021; Shevchenko & Snizhko, 2015). Furthermore, according to UNICEF (2021), heatwaves and other climate change-related disasters cause mental health problems such as anxiety, depression, aggression and substance abuse, especially in children and young adults. Also, increasing risks of floods will increase the risks of drowning, injuries and damage to infrastructure, including hospital access roads and health facilities (Shevchenko & Snizhko, 2015; Snizhko *et al.*, 2021). For example in 2020, flooding in eastern Ukraine affected 17 health facilities and jeopardized health services (IFRC, 2021). In addition, reducing water quality due to temperature increases and flooding may also increase the risk of waterborne diseases, such as diarrhoeal diseases (Climate Change Post, 2022; Shevchenko & Snizhko, 2015).

2.3 Ensure sustainable water supplies

Water, Sanitation and Hygiene (WASH)

Water stress, especially in the southern parts of the country, and reducing water quality are the two main climatic risks to the water and sanitation sector in Ukraine. Rising temperatures, precipitation decreases, and increased droughts will reduce river discharge and affect water availability in Ukraine (Didovets *et al.*, 2020; Ovcharuk *et al.*, 2020). Water availability will particularly reduce in the summer when there is increased consumption and high evaporation rates (Karamushka *et al.*, 2022).

Altered riverflow regimes and reduced water levels in lakes and rivers due to higher temperatures will likely reduce water quality; for example, through increased eutrophication (gradual increase in the concentration of phosphorus, nitrogen and other plant nutrients and minerals throughout the water body) in lakes and rivers (UNICEF, 2021). Similarly, temperature rises will increase the mineralization of the water sources in the country (Khilchevskyi *et al.*, 2020). According to the Met Office (2021), an increase in heavy precipitation also increases the risks of flooding which reduces overall water quality. Another threat to water supplies is saltwater intrusion due to sea-level rise in the coastal areas of Ukraine (UNICEF, 2021; World Bank, 2021). Saltwater contaminates freshwater aquifers that sustain municipal and agricultural water supplies. Furthermore, floods also cause damage to water supply infrastructure and pollute water wells (IFRC, 2021; Met Office, 2021).

Infrastructure and electricity

The ongoing conflict exacerbates climate-induced vulnerability to water shortages and floods as critical water infrastructure suffered heavy shelling, and damage continues to interrupt the water supply throughout the country (OCHA, 2017; REACH, 2022). The conflict between Russia and Ukraine started in 2014 when Russia annexed the region of Crimea, but took new dimensions in February 2022 with Russia's invasion of Ukraine, triggering internal and external displacement (IDMC, 2024).

Ukraine has the largest energy market in Europe due to high energy consumption (IEA, 2020). The projected impacts of climate change on Ukraine's energy sector include an increase in demand for air-conditioning to face warmer summer months, thus increasing pressure on old power units (of which 95 per cent have reached the end of their lifespan) (Climate Change Post, 2020).

The intensification of extreme cold and extreme heat events is increasing peak stress on power distribution systems, which rely heavily on non-renewable energy (Shevchenko *et al.*, 2014). Ukraine's ambition to address energy scarcity in remote rural areas and increase its share of sustainable hydropower production will be greatly affected by the climate-induced reduction of riverflows (Nikolayeva *et al.*, 2012). Exacerbating the increased pressure on energy infrastructure is the extensive damage sustained since the February 2022 escalation in hostilities. In October 2022 alone, damage to energy infrastructure was recorded in 19 out of 25 oblasts, as well as in Kyiv (REACH, 2022). Such damage has been observed to both power

generation plants and power distribution facilities. As a result, people are left even more vulnerable to extreme heat and extreme cold temperatures with decreased access to cooling and heating options.

2.4 Enable climate-resilient livelihoods and economic securityy

Ukraine's livelihood vulnerabilities to climate change are primarily derived from the potential for significant agricultural losses, production disruption, and declines in coastal environments suitable for tourism and fisheries (USAID, 2016).

Agriculture in Ukraine is a major food provider for local and international markets and accounted for 11 per cent of GDP, 20 per cent of employment and 40 per cent of the total exports before the Russia–Ukraine war (USAID, 2022). Warming temperatures and higher concentrations of atmospheric carbon dioxide may increase the yield of grain crops, especially in the north of the country (Tarariko *et al.*, 2017). The yield gains are partly because of the lengthened growing season as winters become warmer and favour the cultivation of crops such as winter wheat (World Bank, 2022). However, some studies indicate that yields of certain crops such as barley, maize, sorghum and wheat will be below normal and vary significantly, and, occasionally, there will be failed harvests as a result of climate change (Araujo-Enciso & Fellmann, 2020; World Bank, 2022). Climate-induced impacts on agriculture are projected to have severe impacts in eastern regions that are experiencing ongoing conflict and have high vulnerability to drought and precipitation decreases (Walz *et al.*, 2018; Gnatiuk *et al.*, 2013).

Warmer temperatures and drier conditions, especially in the southern region, will likely increase evaporation rates and irrigation water demands (Kovalenko *et al.*, 2019; Met Office, 2021; Skrypnyk *et al.*, 2021). In addition, dry and warmer periods as well as floods will increase the risks of erosion, with subsequent damage to soil quality and its attendant effects on agricultural production (Met Office, 2021). Other risks to agricultural production due to warmer temperatures include a sudden return of ground frost, pests and diseases (Tarariko *et al.*, 2017).

Climate-induced stressors on agricultural production pose a significant threat to local food security, with particular concerns about food availability in conflict zones where 1.2 million Ukrainians already face food insecurity (Thomson Reuters Foundation, 2017). Additionally, grain nutritional value is projected to decrease due to changes in meteorological conditions (Boychenko *et al.*, 2016).

In the fisheries subsector, higher temperatures will increase the number of pathogenic organisms affecting and often decreasing fish stock in natural water bodies and aquaculture (Levchenko & Danchuk, 2020). The Black Sea fisheries are an important source of employment, income and food for the coastal population (Gücü *et al.*, 2021). However, warming will also affect fisheries migration, overwintering and schooling behaviour, negatively impacting the sector (Hidalgo *et al.*, 2018). In addition, warmer conditions will cause non-native Indo-Pacific species to expand and survive in the Black Sea (topicalization) (Gücü *et al.*, 2021). Topicalization may alter the biodiversity of the Black Sea with consequences for the fisheries subsector. Furthermore, sea level rise could harm coastal ecosystems and damage port infrastructures, affecting fisheries and other livelihood sources (UNICEF, 2021).

2.5 Address climate displacement and protection

Current and future displacement challenges

Ukraine currently has the world's largest internal displacement crisis. In 2022, 16.9 million migrations were triggered by conflict, and 5.9 million people were left in internal displacement at the end of the year (IDMC, 2023). The number of internally displaced persons (IDPs) at the end of 2023 decreased to 3.7 million (IDMC, 2024). Additionally, there are 6.5 million refugees globally, out of which around 6 million are in Europe (UNHCR, 2024). Prior to the invasion of Ukraine by Russia, there had been ongoing armed conflict triggered by Russia's annexation of Crimea and the Donetsk and Luhansk regions' proclamation of independence. This triggered an internal displacement crisis of over 2 million IDPs, from which only 800,000 are located in the government-controlled territory (Cazabat & Tucci, 2019), which has compromised people's ability to adapt to climate change impacts and caused significant disruption to the accessibility of essential services (Cazabat & Tucci, 2019; OSCE, 2017). Ukraine has also experienced climate disasters such as the record-breaking rains in 2021 in the regions of Odesa and Zaporizhzhia, which led to flooding and the displacement of 2,000 people (IDMC, 2022).

Active conflict may prevent evacuation and lead to immobility during extreme weather events, further endangering lives. Currently the war in Ukraine shows no sign of stopping, increasing the likelihood that people will become caught in or between extreme weather events such as flooding or wildfires and active conflict. This situation is already common for those living around the line of contact (LoC) in Donetsk and Luhansk, with one study finding that extreme cold increased protection risks due to people needing to fetch firewood in areas with land mines and decreased the ability to travel long distances as roads became impassable due to poor weather conditions (REACH, 2018).

Populations in the eastern regions of Ukraine are particularly vulnerable to climate-induced drought and disruption of precipitation patterns in addition to exposure to the armed conflict and lack of access to governmental services and aid (Gnatiuk *et al.*, 2013; Waltz *et al.*, 2018). Alongside environmental stressors, farmers in conflict zones face increased income insecurity having lost access to their traditional markets along the LoC in non-government-controlled areas (Rozwadowski *et al.*, 2018). As many fields cannot currently be cultivated due to the placement of mines around the LoC, economic security is further threatened.

Extreme temperatures and increases in the number of both extremely hot and cold days pose a particular threat for displaced people, particularly those in transit or living in housing affected by the conflict. There is a risk that many IDPs will be unable to adequately stay cool or warm in their homes due to damage from the conflict, and a risk that people displaced by conflict and in transit become caught in a heat- or cold-wave, as occurred in March 2022 for thousands of Ukrainian refugees on the move (Lada, 2022).

Potential needs of migrants and displaced people

A significant number of people requiring humanitarian assistance in eastern Ukraine are over 60 years old and pensioners (Bacchi, 2017), reducing their mobility and increasing their risk of heat-related illnesses and vulnerability to extreme weather events such as flooding (BMJ, 2019). Furthermore, many are required to cross the LoC to withdraw pensions and seek assistance, waiting in a queue at checkpoints exposed to seasonal environmental conditions, including extreme heat or cold (Bacchi, 2017).

Migration law and policies

- EU Temporary Protection Directive, 2022. This EU policy allows all Ukrainian refugees to receive temporary protection in the EU, including the right to stay and work.
- Strategy of State Migration Policy Until 2025, 2017. This policy by the Government of Ukraine centres around migration goals such as increasing the freedom of movement for Ukrainians and reducing the negative effects of emigration from Ukraine.

Weapons contamination

Even prior to the February 2022 escalation, Ukraine was ranked as being one of the most weapons contaminated countries in the world (OCHA 2019). Weapons contamination in Ukraine includes explosive remnants of war (ERW) and the remains of military tanks and equipment (DRC, 2022). As climate change adds pressure to agricultural yields, so too does weapons contamination, creating compound risks. The remains of military tanks and equipment leach toxic substances into the soil affecting soil quality and potentially decreasing agricultural yields. ERW prevent agricultural workers from accessing their fields, limiting their ability to plant and harvest crops, negatively affecting livelihoods (*ibid*). At the same time, international research warns of the potential displacement of mines during severe flooding, moving them to other areas. Light anti-personnel mines can sometimes float and travel long distances in flood waters (Hagen & Teufert, 2009). Furthermore, as heat becomes more extreme in the summer months, this may trigger spontaneous explosions of ERW (Schwartzstein, 2019).

2.6 Policy

Relevant information from the Nationally Determined Contribution (NDC) (2021)

Emission target: Commits to a 65 per cent reduction below 1990 levels by 2030. It focuses on energy. This is a significant increase of ambitions; however, this goal is still not compatible with the 1.5°C global target (Climate Analytics, 2021).

Area of focus on adaptation: None. 'By 2030 Ukraine plans to create a baseline for adaptation to climate change in order to increase resilience and reduce vulnerability to climate change, as foreseen in Article 7 of the Paris Agreement'.

Inclusion of DRR: No.

National designated entity: Ministry of Ecology and Natural Resources of Ukraine, Climate Change and Ozone Layer Protection Department.

Stakeholders: Sweden, European Union, European Bank, Low Carbon Ukraine, Berlin Economics, UNDP (MENRU, 2021).

Other national policies on climate

- Climate Analytics highlights that 'once peace is restored, in addition to very large reconstruction and humanitarian needs, Ukraine will need international support to build a climate-resilient society and economy in line with the Paris Agreement' (Climate Analytics, 2021). The impacts of the conflict in crisis will affect the achievement of climate objectives nationally and worldwide, although the possible impacts are not yet defined (Avis, 2022).
- Ukraine officially supported the European Green Deal, aiming for a climate-neutral continent by 2050. This commitment was integrated in 2021 into the National Economic Strategy with a flexible timeline of 2060 to implement this objective (MENRU, 2021).
- Local action at the city level has been widely adopted with 257 signatories of the Covenant of Mayors in Ukraine, including set greenhouse gas emissions reduction targets through the Sustainable Energy and Climate Action Plan (SECAP) in 184 communities (MENRU, 2021).

Climate finance

National Societies cannot apply directly for climate finance from the GCF, but they can be an implementing partner for an accredited entity, engaging in the early stage of the project development. National Societies can explore options for accessing climate funds through smaller funds, such as the GEF's Small Grants Programme or the FFEM's Small Scale Initiatives Program, or National Climate Funds. These funds are not accessible in every country. Other funding from bilateral donors or multilateral climate funds like Adaptation Fund, CREWS, or GCCA+ could be explored (Climate Centre, 2022a).

Engaging in national climate adaptation planning is vital for accessing climate finance.

Additional resources

Climate Centre. (2022a). *Fact sheet on climate cinance.* Red Cross Red Crescent Climate Centre. https://www.climatecentre.org/wp-content/uploads/Fact-Sheet-on-Climate-Finance.pdf

Climate Centre. (2022b). *Entry points for National Societies on climate finance partnerships.* Red Cross Red Crescent Climate Centre. https://www.climatecentre.org/wp-content/uploads/Entry-Points-for-Climate-Finance-Partnerships.pdf

References

Araujo-Enciso, S.R., & Fellmann, T. (2020). 'Yield variability and harvest failures in Russia, Ukraine and Kazakhstan and their possible impact on food security in the Middle East and North Africa', *Journal of Agricultural Economics*, 71(2), 493–516. https://doi.org/10.1111/1477-9552.12367

Avis, W. (2022). *Ukraine crisis and climate and environment commitments.* Institute of Development Studies. https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/17419

Bacchi, U. (2017). *Cold, hungry and lost: Ukrainian pensioners face fourth winter on the frontline – Ukraine.* Thomson Reuters Foundation. https://reliefweb.int/report/ukraine/cold-hungry-and-lost-ukrainian-pensioners-face-fourth-winter-frontline

BBC. (2022). *How many Ukrainian refugees are there and where have they gone?* https://www.bbc.co.uk/news/world-60555472

BMJ Opinion. (2019). 'Conflict in eastern Ukraine is a reminder that older people are especially vulnerable in emergencies', *British Medical Journal,* Opinion. https://blogs.bmj.com/bmj/2019/06/04/conflict-in-eastern-ukraine-is-a-reminder-that-older-people-are-especially-vulnerable-in-emergencies/

Boychenko, S., Voloshchuk, V., Movchan, L. & Serdjuchenko, N. (2016). 'Features of climate change on Ukraine: Scenarios, consequences for nature and agroecosystems'. *Proceedings of National Aviation University*, 69(4). https://www.researchgate.net/publication/311851156_FEATURES_OF_CLIMATE_CHANGE_ON_UKRAINE_SCENARIOS_CONSEQUENCES_FOR_NATURE_AND_AGROECOSYSTEMS

Cazabat, C., & Tucci, M. (2019). *The ripple effect: Economic impacts of internal displacement.* Internal Displacement Monitoring Centre. https://www.internal-displacement.org/sites/default/files/publications/documents/201902-economic-impact-cost-estimates.pdf

Climate Analytics. (2021). *What is Ukraine's pathway to limit global warming to 1.5°C?* http://1p5ndc-pathways.climateanalytics.org/countries/ukraine/

Climate Change Post. (2022). *Health Ukraine: Vulnerabilities.* https://www.climatechangepost.com/ukraine/health/#:~:text=The%20adverse%20human%20health%20consequences,is%20rarely%20appreciated%20(4).

Climate Change Post. (2020). *Fresh water resources Ukraine*. https://www.climatechangepost.com/ukraine/fresh-water-resources/

Didovets, I., Krysanova, V., Hattermann, F.F., del Rocío Rivas López, M., Snizhko, S., & Müller Schmied, H. (2020). 'Climate change impact on water availability of main river basins in Ukraine', *Journal of Hydrology: Regional Studies*, 32, 100761. https://doi.org/10.1016/j.ejrh.2020.100761

DRC. (2022). *Removing explosive remnants of war in Ukraine.* Danish Refugee Council. https://pro.drc.ngo/resources/news/removing-explosive-remnants-of-war-in-ukraine/European Commission. (2022). *Country profile: Ukraine.* https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk/Country-Risk-Profile

DRMKC (2022): Thow, A., Poljansek, K., Nika, A., Galimberti, L., Marzi, S. & Dalla Valle, D., *INFORM REPORT (2022) Shared evidence for managing crises and disasters*, Disaster Risk Management Knowledge Centre. https://publications.jrc.ec.europa.eu/repository/handle/JRC129343

FAO & World Bank. (2019). *Understanding the drought impact of El Niño/La Niña in the grain production areas in Eastern Europe and Central Asia (ECA): Russia, Ukraine, and Kazakhstan (RUK)*. Food and Agricultural Organization & World Bank. https://reliefweb.int/report/ukraine/understanding-drought-impact-el-ni-ola-ni-grain-production-areas-eastern-europe-and

Gnatiuk, N., Krakovska, S., Palamarchuk, L., & Bilozerova, A. (2013). 'Climate change projections for Ukraine in the 21st century based on the best RCM ensembles [Abstract]', *Geophysical Research Abstracts*, 15. https://www.researchgate.net/publication/258771304_Climate_change_projections_for_Ukraine_in_the_21st_century_based_on_the_best_RCM_ensembles

Government of Ukraine. (2021). *Updated Nationally Determined Contribution of Ukraine to the Paris Agreement.* United Nations Framework Convention on Climate Change. https://unfccc.int/sites/default/files/NDC/2022-06/Ukraine%20NDC_July%2031.pdf

Gücü, A.C., Ünal, V., Ulman, A., Morello, E.B., & Bernal, M. (2021). 'Management responses to non-indigenous species in the Mediterranean and the Black Sea in the face of climate change', in *Adaptive management of fisheries in response to climate change (Technical Paper 667, p. 161*). T. Bahri, M. Vasconcellos, D. Welch, J. Johnson, I. Perry, X. Ma, & R. Sharma (eds), Food and Agricultural Organization. https://doi.org/10.4060/cb3095en

Hagen, E., Teufert, J.F. (2009). Flooding in Afghanistan: A Crisis. In: Jones, J.A.A., Vardanian, T.G., Hakopian, C. *Threats to Global Water Security. NATO Science for Peace and Security Series C: Environmental Security.* Springer, Dordrecht. https://doi.org/10.1007/978-90-481-2344-5_19

Hidalgo M., Mihneva V., Vasconcellos M. & Bernal M. (2018). Chapter 7: Climate change impacts, vulnerabilities and adaptations: Mediterranean Sea and the Black Sea marine fisheries, in: *Impacts of climate change on fisheries and aquaculture: Synthesis of current knowledge, adaptation and mitigation options.* Food and Agriculture Organization of the United Nations. https://www.fao.org/inland-fisheries/topics/detail/en/c/1147089/

IDMC. (2022). *Country profile: Ukraine.* Internal Displacement Monitoring Centre. https://www.internal-displacement.org/countries/ukraine

IDMC. (2024). *Country profile: Ukraine.* Internal Displacement Monitoring Centre. https://www.internal-displacement.org/countries/ukraine/

IDMC. (2023). *GRID Report 2023.* https://api.internal-displacement.org/sites/default/files/publications/documents/IDMC_GRID_2023_Global_Report_on_Internal_Displacement_LR.pdf

IEA. (2020). *Ukraine energy profile.* International Energy Agency. https://www.iea.org/reports/ukraine-energy-profile

IFRC, GO. (2022). *All Ukraine emergencies.* International Federation of Red Cross and Red Crescent National Societies. https://go.ifrc.org/emergencies/all?country=1

IFRC. (2021). *Ukraine floods: Final report - DREF operation n° MDRUA010*. International Federation of Red Cross and Red Crescent National Societies. https://reliefweb.int/report/ukraine/ukraine-floods-final-report-dref-operation-n-mdrua010

Karamushka, V., Boychenko, S., Kuchma, T., & Zabarna, O. (2022). 'Trends in the environmental conditions, climate change and human health in the southern region of Ukraine', *Sustainability*, 14(9), 5664. https://doi.org/10.3390/su14095664

Khilchevskyi, V.K., Kurylo, S.M., & Zabokrytska, M.R. (2020). 'Long-term fluctuations in the chemical composition of surface waters and climate change', *XIV International Scientific Conference "Monitoring of Geological Processes and Ecological Condition of the Environment"* 1–5. https://doi.org/10.3997/2214-4609.202056003

Kovalenko, P., Rokochinskiy, A., Jeznach, J., Koptyuk, R., Volk, P., Prykhodko, N., & Tykhenko, R. (2019). 'Evaluation of climate change in Ukrainian part of Polissia region and ways of adaptation to it', *Journal of Water and Land Development*, 41(1), 77–82. https://doi.org/10.2478/jwld-2019-0030

Lada, B. (2022). *Extreme cold snap to add hardships for Ukraine refugees.* Accuweather. https://www.accuweather.com/en/winter-weather/extreme-cold-snap-to-add-hardships-for-ukraine-refugees/1152922

Levchenko, A., & Danchuk, O. (2020). *Assessment of the occurrence of microorganisms and other fish parasites in the freshwater aquaculture of Ukraine in relation to the ambient temperature.* Odessa State Agrarian University. http://lib.osau.edu.ua/jspui/handle/123456789/2677

Met Office. (2021). *Climate change impacts for Ukraine*. https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/services/government/met-office_climate-change-impacts-for-ukraine_report_08dec2021_english.pdf

MENRU. (2021). *Analytical review of the updated Nationally Determined Contribution of Ukraine to the Paris Agreement.* Ministry of Ecology and Natural Resources of Ukraine, Climate Change and Ozone Layer Protection Department. https://mepr.gov.ua/files/images/2021/29042021/Analytical%20Report_%20Project_EN.PDF

Ministry of Economic Development, Trade and Agriculture of Ukraine. (n.d.). *Geographical location of Ukraine*. http://www.ukrexport.gov.ua/eng/about_ukraine/geo/?country=ukr

Nikolayeva, L., Denisov, N. & Novikov, V. (2012). *Climate change in Eastern Europe – Belarus, Moldova, Ukraine*. http://archive.zoinet.org/web/sites/default/files/publications/CCEE-English-web.pdf

OCHA. (2019). *Eastern Ukraine one of the areas most contaminated by landmines in the world.* Office for the Coordination of Humanitarian Affairs. https://www.unocha.org/story/eastern-ukraine-one-areas-most-contaminated-landmines-world

OCHA. (2017). 'Conflict cuts water supply for thousands in eastern Ukraine'. *News and updates.* Office for the Coordination of Humanitarian Affairs. https://www.unocha.org/fr/story/conflict-cuts-water-supply-thousands-eastern-ukraine

OSCE. (2017). *Environmental assessment and recovery priorities for eastern Ukraine.* Organization for Security and Co-operation in Europe. https://www.osce.org/files/f/documents/4/3/362566_0.pdf

Ovcharuk, V., Gopchenko, E., Kichuk, N., Shakirzanova, Z., Kushchenko, L., & Myroschnichenko, M. (2020). 'Extreme hydrological phenomena in the forest steppe and steppe zones of Ukraine under the climate change', *Proceedings of the International Association of Hydrological Sciences*, 383, 229–235. https://doi.org/10.5194/piahs-383-229-2020

REACH. (2022). *Ukraine: Energy infrastructure damage situation overview for 10-24th October 2022*. https://reliefweb.int/report/ukraine/ukraine-energy-infrastructure-damage-situation-overview-10-24th-october-2022

REACH. (2018). *Ukraine: Extreme cold means extreme conditions for those living on the line of contact*. https://www.reach-initiative.org/what-we-do/news/ukraine-extreme-cold-means-extreme-conditions-for-those-living-on-the-line-of-contact/

Rozwadowski, R., O'Connell, J., Toirov, F., & Voitovska, Y. (2018). *The agriculture sector in eastern Ukraine: Analysis and recommendations*. Food and Agriculture Organization. http://www.fao.org/3/i8862en/I8862EN.pdf

Schwartzstein, P. (2019). 'Climate change may be blowing up arms depots: More intense heat waves can destabilize the components of munitions, particularly where explosives are not properly stored', *Scientific American.* https://www.scientificamerican.com/article/climate-change-may-be-blowing-up-arms-depots/

Shevchenko, O., Oliinyk, R., Snizhko, S., Svintsitska, H., & Kostyrko, I. (2020). 'Indexing of heatwaves in Ukraine', *Water*, 12(4), 962. https://doi.org/10.3390/w12040962

Shevchenko, O., & Snizhko, S. (2015). 'Vulnerability and adaptation in the Ukrainian cities under climate change', Conference: *9th International Conference on Urban Climate*. http://www.meteo.fr/icuc9/LongAbstracts/poster_3-14-7831638_a.pdf

Shevchenko, O., Vlasyuk, O., Stavchuk, I., Vakolyuk, M., Il`iash, O. & Rozhkova. (2014). *National climate vulnerability assessment: Ukraine.* Climate Forum East. https://climateforumeast.org/uploads/other/0/708.pdf

Skrypnyk, A., Zhemoyda, O., Klymenko, N., Galaieva, L., & Koval, T. (2021). 'Econometric analysis of the impact of climate change on the sustainability of agricultural production in Ukraine', *Journal of Ecological Engineering,* 22(3), 275–288. https://doi.org/10.12911/22998993/132945

Snizhko, S., Trypolska, G., Shevchenko, O., Obodovskyi, O., Didovets, I., & Kostyrko, I. (2021). 'Structure design of the flood hazard assessment and mapping technology for adaptation of Ukrainian water sector to climate change', *Geoinformatics*, 2021(1), 1–6. https://www.earthdoc.org/docserver/fulltext/2214-4609/2021/gis2021/Structure_design_of_the_flood_hazard_assessment_and_mapping_technology_for.pdf?expires=1655926408&id=id&accname=guest&checksum=1DC20C54A6CE1B7E73ACAAD76E94D49E

Tarariko, O., Ilienko, T., Kuchma, T., & Velychko, V. (2017). 'Long-term prediction of climate change impact on the productivity of grain crops in Ukraine using satellite data', *Agricultural Science and Practice*, 4(2), 3–13. https://doi.org/10.15407/agrisp4.02.003

Think Hazard!. (n.d.). *Ukraine.* Global Facility for Disaster Reduction and Recovery. https://thinkhazard.org/en/report/254-ukraine

Thomson Reuters Foundation. (2017). *UN's World Food Programme says to stop food aid to eastern Ukraine.* https://reliefweb.int/report/ukraine/uns-world-food-programme-says-stop-food-aid-eastern-ukraine

UNICEF. (2021). *Potential climate and environment impacts on children in Ukraine* (Brief). https://www.unicef.org/ukraine/media/15736/file/Brief.%20Climate%20and%20environment%20for%20children.pdf

USAID. (2022). *Agriculture fact sheet [EN/UK].* United States Agency for International Development. https://reliefweb.int/report/ukraine/agriculture-fact-sheet-enuk

USAID. (2016). *Climate risk profile: Ukraine.* United States Agency for International Development. https://www.climatelinks.org/sites/default/files/asset/document/2016_USAID_Climate%20Change%20Risk%20Profile_Ukraine.pdf

Waltz, Y., Dall, K., Graw, V., Carlos, J., De Leon, V., Kussul, N., & Jordaan, A. (2018). *Understanding and reducing agricultural drought risk: Examples from South Africa and Ukraine.* United Nations University, Institute for Environment & Human Security. https://www.preventionweb.net/files/62611_policyreport181213en.pdf

World Bank. (2022). *Ukraine: Building climate resilience in agriculture and forestry.* https://documents.worldbank.org/en/publication/documents-reports/documentdetail/893671643276478711/ukraine-building-climate-resilience-in-agriculture-and-forestry

World Bank. (2021). *Ukraine: Country summary.* Climate Change Knowledge Portal. https://climateknowledgeportal.worldbank.org/country/ukraine

Yerofeyev, I. & Hajda, L. (2020). *Soils of Ukraine.* Britannica. https://www.britannica.com/place/Ukraine/Soils