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IKI INTERNATIONAL CLIMATE INITIATIVE

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MINISTRY OF ECONOMY
AND ENVIRONMENT OF UKRAINE

Climate Resilience of the Odesa Region

risks • vulnerability • adaptation



Climate Resilience of the Odesa Region

risks · vulnerability · adaptation

Based on the results of a gender-responsive assessment of climate risks and vulnerability in the Odesa Region

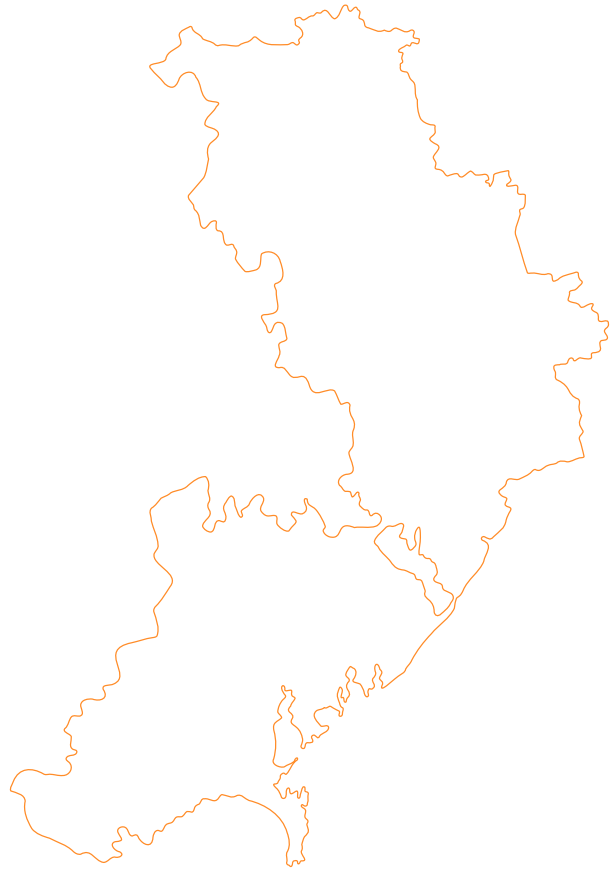
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01

About the Study

The Odesa Region has a unique geographic and natural-climatic setting, combining steppe areas, a seacoast, and the Black Sea. At the same time, it is one of the most water-scarce regions of Ukraine, where limited water resources coincide with a large share of agricultural land use and a high concentration of population and infrastructure in coastal and urban areas. Climate change amplifies existing challenges related to water scarcity, droughts, and extreme heat, creating additional threats to agriculture, coastal areas, and critical infrastructure. The resilience of port, energy, transport, and municipal infrastructure is particularly important, as is communities' capacity to adapt to these interconnected risks. At the same time, the impact of climate risks is not the same for different population groups: it depends on living conditions, employment, access to resources and services, and on social and gender factors.

The full-scale war has added new challenges: damage to critical facilities, prolonged power and water outages, changes to transport routes, internal displacement, and increased pressure on health and social services.

The study aims to comprehensively assess climate risks and vulnerability in the Odesa Region and provide a practical basis for regional and local adaptation policy. The assessment is gender-responsive and considers the region's demographic and spatial characteristics, projected changes in key climate indicators, housing, material, and social vulnerability factors, gender differences, community institutional response mechanisms, and the vulnerability of key sectors to climate hazards.

The assessment results outline key guideposts for the region's recovery and adaptation.

Rebuilding the Odesa Region must be climate-resilient, territorially differentiated, and gender-responsive.

> The greatest risk arises where heat, droughts, and flooding are compounded by worn-out infrastructure, low household incomes, and limited capacity of local authorities

Management decisions must ensure the protection of critical services and equal access for women and men — including internally displaced persons (IDPs), veterans, and people with limited mobility — to safe housing, water, energy supply, and health care.

The assessment should serve as the basis for the next step: developing a Climate Change Adaptation Strategy for the Odesa Region and an action plan for its implementation. Next, the analytical conclusions must be turned into specific projects for individual territories, with designated implementers, funding sources, timelines, and an annual monitoring system.

02

Key Assessment Results

The assessment shows how climate change interacts with the Odesa Region's natural, territorial, social, and institutional conditions. Below are selected key results that together form an overall picture of the region's climate risks and vulnerability.

Heat is intensifying

+4 °C

Rising temperature is the most consistent and systemic trend of climate change in the Odesa Region. By the end of the century, under the RCP 8.5 scenario, the mean annual temperature could rise **by more than 4 °C**, the number of hot days could increase by 20–30 per year, and tropical nights by 30–50

Precipitation patterns are changing

In the warm season, reduced precipitation, combined with rising temperatures and evaporation, **will intensify moisture shortages**. At the same time, intense short-duration rainfall may increase the risk of localized flooding, erosion, and overloading of drainage systems

Water resources and ecosystems are among the most vulnerable

Changes in the water regime affect the rivers, estuaries, wetlands, and other natural systems of the region. Water resources are among the region's **most critical vulnerabilities**

Fire danger is increasing

+20 days

By the end of the century, under the RCP 8.5 scenario, the number of days with high fire danger is projected to **increase by more than 20 days annually** across the entire region

Climate scenarios. The study uses two scenarios of future greenhouse gas emissions: RCP 4.5 — a scenario in which emissions stabilise, and RCP 8.5 — a high-emissions scenario. They represent different possible pathways of future climate change rather than precise predictions of the future.

Summer heat has a greater impact on households

17 %
29.8 %

Compared with **17.0% in winter**, the share of households unable to maintain a comfortable indoor temperature rises to **29.8% in summer**. Summer overheating is becoming an important issue for housing, energy, and social policy

Combined risk factors sharply increase vulnerability

73.3 %

73.3% of households exposed to three or more risk factors are unable to maintain a comfortable indoor temperature in summer. The accumulation of housing, financial, and social constraints reduces their capacity to cope with extreme heat

Vulnerability varies by territory

Urban, rural, and semi-urban communities depend differently on infrastructure, water resources, agricultural production, and their own financial and human capacity. As a result, the **same climate hazards** can have **different consequences** for different territories

Women and men have different resources and capacities for adaptation

Gender differences in income, employment, access to resources, care responsibilities, and participation in decision-making can affect **vulnerability** to climate hazards and the **capacity to adapt**

Communities lack systematic adaptation

84.7 %

In **84.7%** of territorial communities, no local climate adaptation program exists. At the same time, adaptation must be integrated into regional recovery and account for the diverse needs of territories and sectors

03

How the Climate of the Odesa Region Is Changing

Climate change in the Odesa Region is evident in the growing frequency, duration, and intensity of extreme weather events, as well as systemic changes in temperature and water regimes. The most consistent and pronounced trend are rising air temperature and an increasing number of extremely hot days. At the same time, precipitation patterns are changing, water scarcity is intensifying, and fire danger is rising. These changes are already reshaping natural ecosystems, territories, and various sectors of the Odesa Region.

Heat and heatwaves

Temperatures are rising — and extreme heat is becoming more frequent and longer-lasting

What is happening?

Rising temperatures are one of the most consistent climate signals for the Odesa Region. Under both scenarios, temperatures are projected to rise throughout the century, but the scale of change will depend largely on the future emissions trajectory. The largest differences between the scenarios are projected to become pronounced by the end of the century.

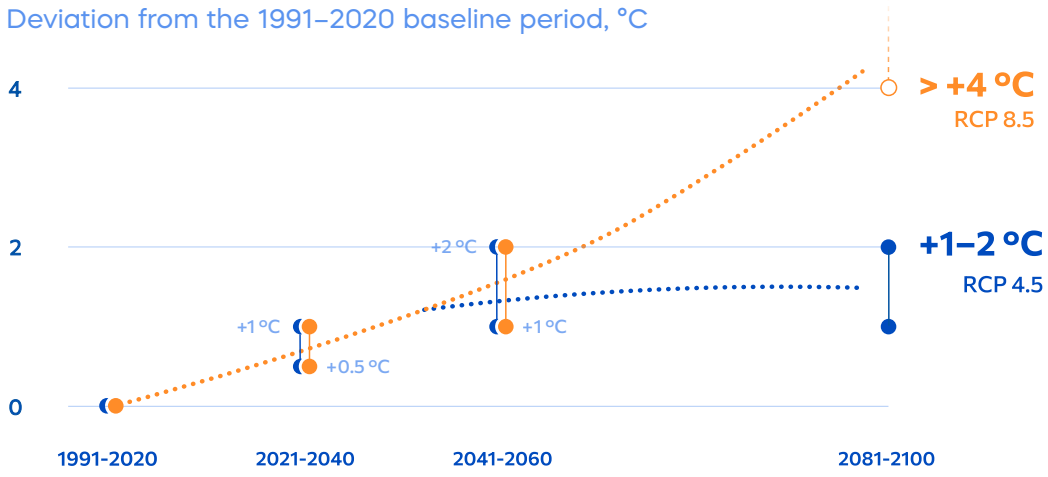
Under the RCP 4.5 scenario, the mean annual air temperature may rise by 1–2 °C by the end of the century compared with the 1991–2020 baseline period. Under the RCP 8.5 scenario, the change at the end of the century exceeds 4 °C. In the coming decades, the differences between scenarios are much smaller, but they grow over time.

Warming is not limited to a rise in mean temperature. The nature of the heat itself is also changing: the number of days above +35 °C and tropical nights, when temperatures do not fall below +20 °C, is increasing. It is the duration of heat stress — not only individual temperature peaks — that matters for the region's natural and socio-economic systems.

Under the RCP 8.5 scenario, by the end of the century the number of hot days may increase by 20–30 days per year, and the number of tropical nights by 30–50 nights per year. Under the RCP 4.5 scenario, these increases remain substantially more moderate.

How the mean annual temperature will change

Deviation from the 1991–2020 baseline period, °C



+20–30 days

with temperatures **above +35 °C**

+30–50 days

with temperatures **not below +20 °C**

tropical nights

Why does it matter?

Rising temperature will have a systemic impact on the region's natural and socio-economic systems. In particular, agroclimatic zones will shift, which will require a review of agricultural specialization, crop structure, and the timing of fieldwork.

Changes in the temperature regime will also affect the territory's water balance. At higher temperatures, moisture losses through evaporation will escalate, reducing the effective replenishment of water resources even without a significant decline in precipitation.

For natural ecosystems, rising temperature will translate into a gradual transformation of species composition and reduced resilience of certain ecosystem types. For settlements and infrastructure, the thermal load on buildings and utility networks will increase.

Heat's impact on public health poses a distinct challenge. Prolonged heatwaves and tropical nights increase thermal stress on the body, raise the risk of dehydration and heatstroke, and can exacerbate cardiovascular diseases.

More in the full report: Changes in temperature, the number of hot days, tropical nights, and frost days for the RCP 4.5 and RCP 8.5 scenarios. The full report is available at the link on p. 2.

Precipitation patterns: between downpours and drought

Precipitation patterns will change: heavy rainfall will intensify, and dry spells will become more prolonged

What is happening?

Annual precipitation in the Odesa Region will not decrease significantly. Both climate scenarios project a slight increase, mostly up to 5%, and under RCP 4.5, 5–10% by the end of the century. However, changes in annual precipitation totals do not fully reflect future changes in the water regime. The seasonal distribution of precipitation, its intensity, and the duration of dry spells are no less important.

Annual precipitation is expected to increase mainly in the cold season. From November to April, precipitation may increase by 5–10% in most projected periods. In the warm season—from May to October—changes will mostly remain insignificant, with a slight downward trend.

At the same time, precipitation patterns will change. Maximum one-day and five-day precipitation is projected to increase, along with a gradual increase in the number of days with heavy downpours. By the end of the century, an additional 1–3 such days per year are projected.

At the same time, the maximum duration of consecutive dry days will grow. Under the RCP 4.5 scenario, the increase will remain within 3 days per year. Under RCP 8.5, at the end of the century, it may be 3–7 days.

It is not so much the amount of precipitation that is changing, but its pattern

↑ **annual precipitation**
slight increase

↑ **intense precipitation**
increase in maximum 1-day and 5-day precipitation

↑ **cold season**
+5–10% precipitation

↓ **warm season**
minor changes with a downward trend

More in the full report: Changes in annual and seasonal precipitation, intense precipitation, and the duration of dry spells for the RCP 4.5 and RCP 8.5 scenarios. The full report is available at the link on p. 2.

Why does it matter?

For the Odesa Region, even an increase in annual precipitation will not necessarily translate into an improved water balance. If the additional precipitation falls mainly in the cold season or occurs as short-duration, intense rainfall, much of the water will become surface runoff rather than replenishing water resources. At the same time, rising temperatures will increase evaporation, and reduced warm-season precipitation will aggravate the shortage of available moisture.

For small rivers and reservoirs, these changes will produce a combination of multi-directional processes. During intense rainfall, water levels can rise sharply in the short term, while during prolonged dry periods runoff will decline and the risk of periodic drying-up will grow. For water supply systems, this will exacerbate the seasonal imbalance between water demand and natural replenishment.

In agriculture, reduced moisture availability during warm seasons will increase the risk of soil drought and unstable water supply for crops. At the same time, heavy downpours can intensify surface runoff, erosion, and the loss of the fertile soil layer.

For built-up areas, intensified precipitation will place additional load on storm-water sewage and drainage systems and increase the risk of localized flooding. Therefore, when assessing future changes in the water regime, it is critical to consider not only total annual precipitation, but also its seasonal distribution, intensity, and the duration of dry spells.

Increased precipitation does not necessarily result in greater water availability



Fire danger

The number of days with high fire danger will increase — the largest changes are expected in the second half of the century

What is happening?

Fire danger depends on several weather factors. To assess it, the study used the Fire Weather Index (FWI), which accounts for air temperature, relative humidity, wind speed, and precipitation. High index values indicate weather conditions favourable for fire ignition and spread.

Under current climate conditions, the Odesa Region experiences between 40 and 100 days per year with an elevated level of fire danger. Their number increases from north to south across the region.

In the near term — 2021–2040 — no significant changes are projected: under both scenarios, the number of such days will vary within 5 days per year relative to the baseline period.

By mid-century, the trend becomes more pronounced. Under the RCP 4.5 scenario, an increase of 5–10 days per year in the number of days with high fire danger is projected across the whole region. Under RCP 8.5, a similar increase is expected in the northern part of the region, while the southern part is projected to see an increase of 10–15 days.

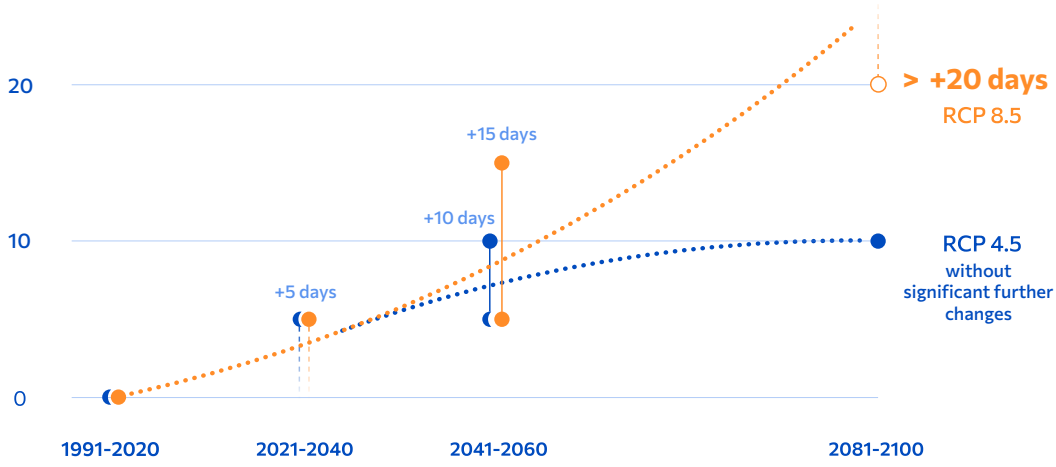
Under the RCP 8.5 scenario, the largest changes are projected for the end of the century:

> the number of days with an elevated level of fire danger may increase by more than **20 days** per year across the entire territory of the Odesa Region



Increase in the number of days with a high level of fire danger

Deviation from the 1991–2020 baseline period



Why does it matter?

An increase in days with high fire danger leads to more frequent and intense fire-prone situations. The most sensitive areas are those with grassy vegetation, including steppe gullies, shelterbelts, and peri-urban green zones.

For natural ecosystems and forestry, this translates into an escalating risk of landscape fires, habitat degradation, and loss of ecosystem services. In the long term, artificial forest plantations in the steppe zone, which form the basis of the Odesa Region's Forest fund, are especially vulnerable.

In agriculture, the risk of crop loss due to the ignition of stubble, dry vegetation, and pastures will increase, and as well as the need for additional fire-prevention measures. For energy and transport infrastructure, the likelihood of fire damage will also increase.

Public health will also face consequences: smoke and deteriorating air quality exacerbate the risk of respiratory diseases.

> Fire danger poses not only a direct ignition threat but also cumulative environmental, infrastructure, economic, and social risks

More in the full report: Projected change in the number of days with an elevated level of fire danger for the RCP 4.5 and RCP 8.5 scenarios. The full report is available at the link on p. 2.

Changing seasonality

Winters will become warmer and less snowy, and familiar seasonal cycles will gradually shift

What is happening?

Climate change in the Odesa Region will affect not only summer heat or precipitation patterns but also the course of the seasons. One of the most noticeable effects will be milder winters: minimum temperatures will rise, there will be fewer frost days, and snow cover will last for shorter period.

Minimum daily winter temperatures are projected to rise under both climate scenarios. In the coming decades, the increase will mostly be 0.5–1 °C and will accelerate over time. By the end of the century, under the RCP 8.5 scenario, the minimum winter temperature may rise by more than 4 °C relative to the baseline period.

At the same time, the number of frost days will decline significantly. As early as 2021–2040, both scenarios project a decrease of about 10–20 days per year. By mid-century and the end of the century, the reduction will intensify and, over much of the region, may exceed 20 days per year.

Warmer winters will also affect snow cover. The full report links rising winter temperatures to shorter snow cover duration and less stable snow accumulation. As a result, winter water accumulation will change too: even an increase in cold-season precipitation will not always result in a corresponding replenishment of water resources.

Changing seasonality will also affect other processes. An earlier growing season start may increase plants' sensitivity to late spring frosts.

WINTER TEMPERATURE

> 4°C ↑

increase in daily minimum by the end of the century · RCP 8.5.

FROST DAYS

> 20 days / year ↓

by the end of the century under both scenarios

More in the full report: Projected change in winter air temperature, the number of frost days, and the duration of the cold period for the RCP 4.5 and RCP 8.5 scenarios. The full report is available at the link on p. 2.

Why does it matter?

Milder winters will have mixed consequences. On the one hand, a shorter cold season will reduce strain from prolonged frosts and gradually decrease the heating energy demand. On the other hand, changes in winter conditions will pose challenges for natural and economic systems adapted to the usual seasonal cycle.

For agriculture, a shorter frost period may prolong the growing season. At the same time, an early start of vegetation increases plants' sensitivity to late spring frosts. Changes in temperature and snow regimes will also affect soil processes and crop overwintering conditions.

For natural ecosystems, warming will lead to shifts in phenological rhythms—the periods of animal winter dormancy and hibernation, as well as plant dormancy and regrowth. Such changes may affect local ecosystem stability and create more favourable conditions for warm-adapted species.

Aquatic systems will also be affected. Shorter periods of stable snow cover will change winter water accumulation patterns, and a less stable ice regime will alter the conditions in small watercourses and reservoirs.

> A warmer winter implies not only fewer frost days but also changes in the seasonal rhythms to which agriculture and the region's aquatic and natural systems are adapted

SHIFT IN SEASONAL RHYTHMS

earlier vegetation and changes in natural cycles

SNOW COVER

shorter and less stable

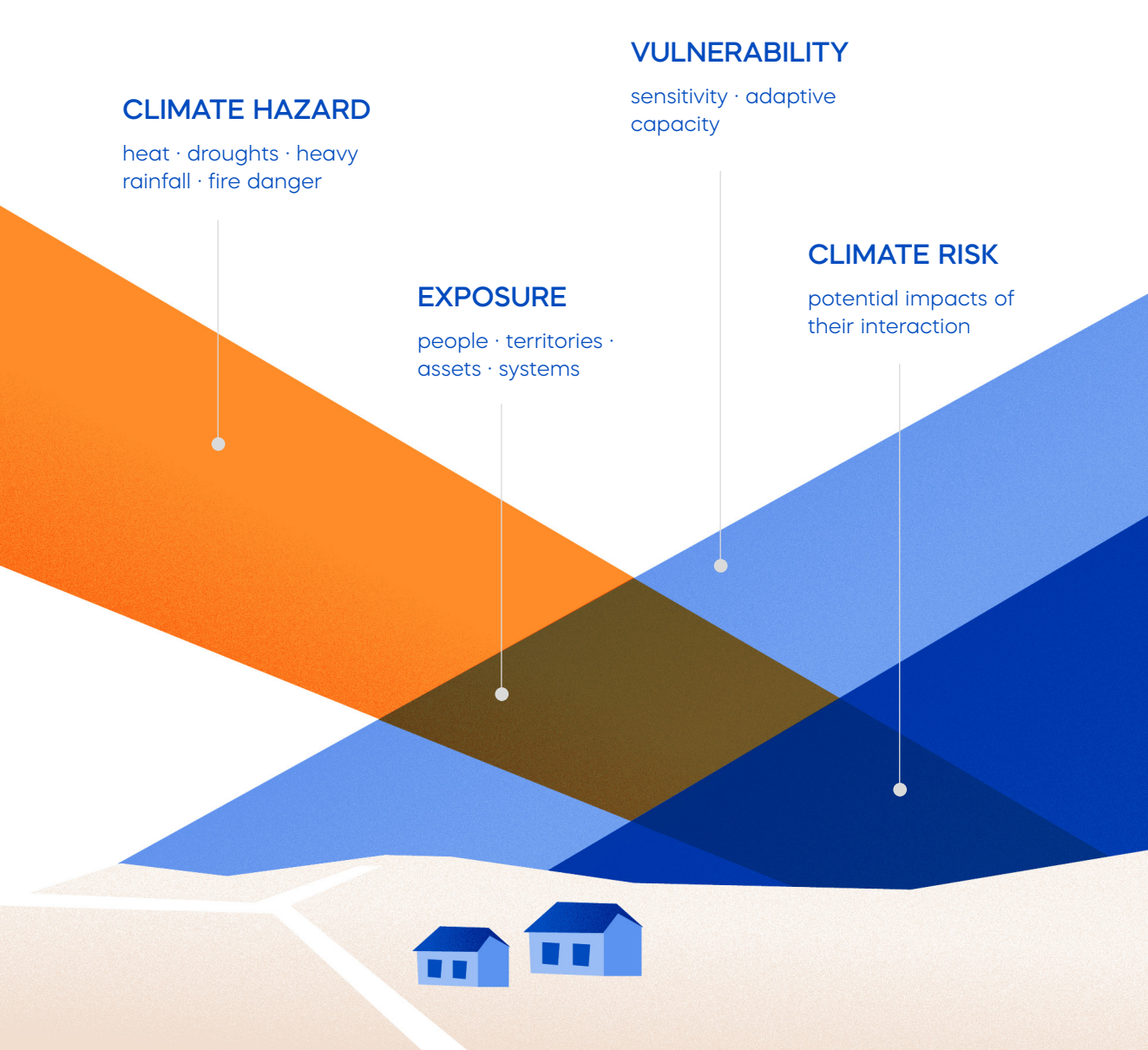


04

From Climate Change to Risks

Climate change creates new threats and amplifies existing ones. However, its consequences across different territories, natural systems, sectors, and population groups will be uneven.

The scale of these consequences depends not only on the climate hazard itself, but also on who or what is exposed to it, how sensitive they are, and their adaptive capacity.



05

Vulnerability of the Odesa Region to Climate Change

Climate risk is not merely a meteorological phenomenon. It is most pronounced where the physical impacts of climate change compound with social vulnerability, infrastructure deficits, and insufficient institutional capacity among local authorities.

The mere presence of a climate hazard does not determine the scale of its consequences

Heat, drought, or heavy rainfall of the same intensity can affect individual territories, people, and systems differently. What matters is who or what is exposed to the hazard, how sensitive they are to its impact, and what their adaptative capacity is.

Vulnerability is shaped by the combination of sensitivity and adaptive capacity. Sensitivity shows how strongly a person, object, or system may respond to a climate hazard. Adaptive capacity, by contrast, describes the ability to adjust to new conditions, reduce potential losses, or cope with consequences. Therefore, high sensitivity increases vulnerability, while high adaptive capacity can mitigate it.

At the community level, vulnerability is not determined by a single factor alone. Territorial and infrastructure conditions, households' economic capacity and housing quality, the population's social and gender characteristics, and local institutions' ability to plan adaptation and respond to climate challenges shape community vulnerability. That is why the same climate hazard can have quite different consequences even between neighbouring communities.

At the same time, climate change affects the systems and sectors on which the region's everyday life depends: water resources and natural ecosystems, energy and transport, agriculture and forestry, and public health. Their vulnerability is likewise determined by a combination of sensitivity to specific climate hazards and the ability to adapt to them.

The vulnerability of the Odesa Region is examined at two levels: through the conditions that determine the vulnerability of the population and communities, and through the vulnerability of the region's key sectors. Together, these levels reflect both differences between territories and population groups and the sensitivity of the systems on which the region's life depends.

Vulnerability of the population and communities

The same climate hazard can have different consequences across different communities and population groups. Vulnerability depends not only on the nature and intensity of the climate impact but also on the conditions in which people live, the state of infrastructure, available resources, and the community's capacity to prepare for and respond to these hazards.

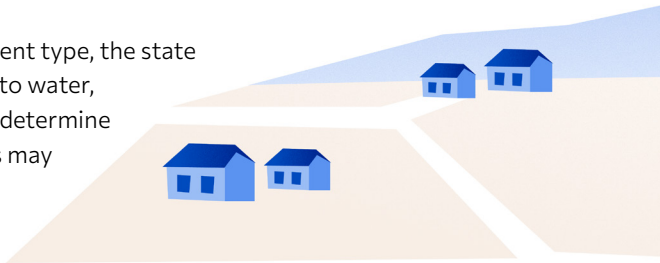
For the Odesa Region, several factors are of particular significance. Climate risks increase where adverse natural phenomena are superimposed on worn-out infrastructure, financial and housing constraints of households, the social vulnerability of the population, and insufficient adaptive capacity of communities.

The vulnerability of the population and communities is shaped along four interrelated dimensions: territorial, household, social-gender, and institutional. They cover different conditions that give rise to vulnerability—from the characteristics of a specific territory and the resources of an individual household to social characteristics of the population and the capacity of local self-government to respond to climate hazards.

01 TERRITORIAL FACTOR

Where and under what conditions do people live?

Geographic location, settlement type, the state of infrastructure, and access to water, transport, and basic services determine how strongly climate hazards may affect a particular area.



02 HOUSEHOLD FACTOR

What resources and conditions does a household have?

Income, housing conditions, spending on basic needs, debt burden, and the ability to provide heating or cooling affect a household's capacity to withstand and adapt to climate shocks.



03 SOCIAL AND GENDER FACTOR

Why climate hazards affect people differently?

Age, health, mobility, income, working conditions, access to support, and caregiving responsibilities can increase the vulnerability of individuals and population groups.



04 INSTITUTIONAL FACTOR

How are communities ready to respond?

The availability of adaptation plans, resources and specialists, early warning systems, civil protection mechanisms, and support for vulnerable groups determines a community's capacity to reduce the potential impacts of climate hazards.



The four factors do not operate in isolation. Vulnerability increases when several adverse conditions compound: for example, when a climate impact hits a territory with worn-out infrastructure, households have limited financial resources, and the community itself has insufficient capacity to prepare and respond.

> **Vulnerability is determined not only by individual factors but also by their potential accumulation and mutual reinforcement. Similar climate hazards can have different consequences depending on the socio-economic conditions of people and communities**

Territorial factor

Where and under what conditions do people live?

Community resilience depends on their geographic location, type of settlement, and infrastructure condition. Therefore, the same climate events can create different problems depending on where they occur.

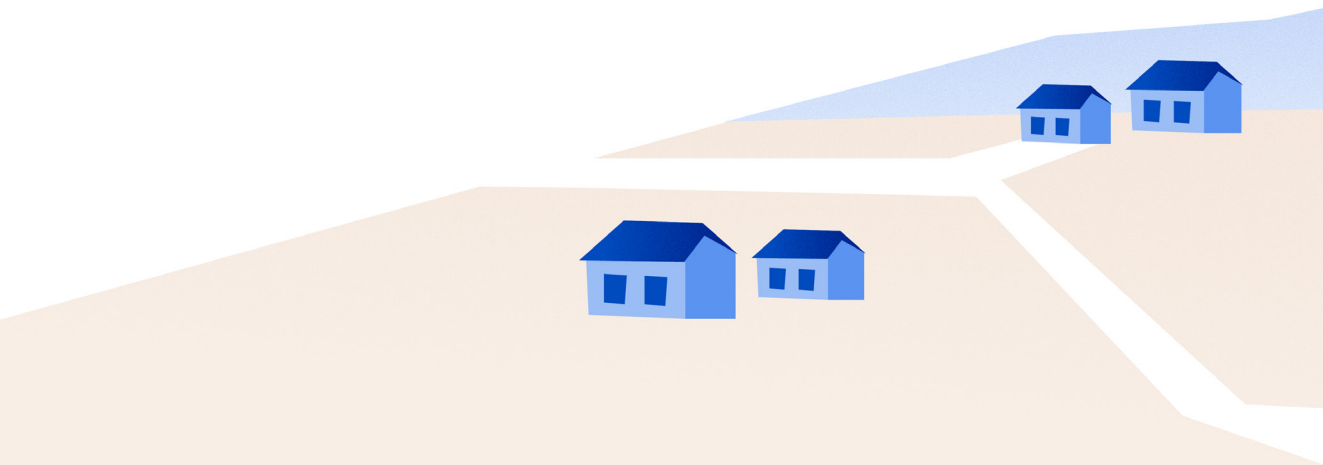
In urban areas and agglomerations, dense development and a large share of artificial surfaces intensify the “urban heat island” effect. During intense precipitation, the state of drainage systems becomes an additional issue: deteriorated stormwater infrastructure increases the risk of sudden localized flooding. Dependence on centralized water and energy supply networks can also amplify the consequences of extreme weather events.

Rural and urban-type communities face different constraints. They depend more heavily on the agricultural sector and water availability, and droughts and water shortages can be intensified by worn-out or absent centralized water supply. Spatial isolation becomes an additional factor — greater distances and more difficult access to transport, health, social, and other basic services.

Thus, the territorial factor shows, above all, the conditions in which a climate hazard unfolds: patterns of development and settlement, infrastructure conditions, and access to water and services. These can amplify or mitigate the consequences of the climate hazard for the population.

SAME HAZARD — DIFFERENT IMPACTS

depending on local conditions and access to infrastructure and services



Household factor

What resources and conditions does a household have?

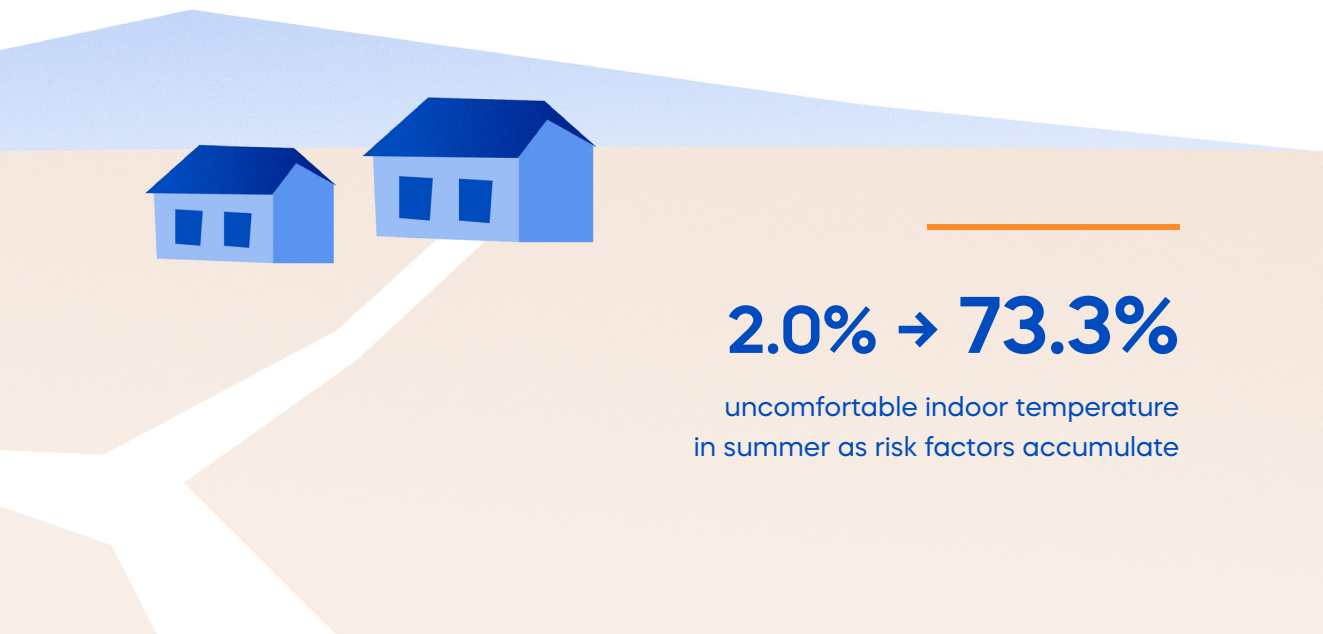
A household's capacity to withstand climate impacts depends largely on its financial resources and housing conditions. Low incomes, debt, the need for home repairs, excessive costs of basic needs, and a lack of cooling equipment or independent energy supply can significantly limit adaptation options.

One indicator of this vulnerability is the capacity to maintain a comfortable indoor temperature. In summer, 29.8% of households in the region cannot ensure an adequate temperature, while in winter, 17.0% report the same difficulties. In rural areas, both indicators are higher: 33.9% in summer and 22.1% in winter, compared with 28.0% and 14.8% in urban ones.

However, settlement type alone does not fully explain vulnerability. The accumulation of social, financial, and housing constraints matters far more. Debt, the need for major home repairs, difficult life circumstances, the presence of older adults, and the lack of cooling equipment occur simultaneously, compounding the impacts of thermal stress.

Among households with no identified risk factors, only 2.0% report uncomfortable indoor temperatures in summer. With three or more factors, this figure rises to 73.3%.

Thus, a household's vulnerability is not determined by a single characteristic. What matters most is the accumulation of constraints, leaving a family with diminishing resources to prepare, adapt, and recover.



2.0% → 73.3%

uncomfortable indoor temperature
in summer as risk factors accumulate

Social-gender factor

Why climate hazards affect people differently?

Climate hazards do not affect everyone equally. Age, health status, income level and stability, working conditions, mobility, and caregiving responsibilities can shape both people's sensitivity to climate impacts and their capacity to prepare, respond, and recover.

One of the factors is inequality in access to financial resources. In 25 of the 33 communities that provided comparable income data, women's reported income was lower. The typical gap was 16.2% in urban communities, 12.7% in semi-urban, and 15.2% in rural communities. These figures do not indicate different pay for the same work, but may reflect differences in employment structure, working hours, professional positions, and access to more stable jobs. Fewer financial resources, in turn, translate into reduced ability to invest in adaptation independently or to recover quickly after an emergency.

The distribution of caregiving responsibilities is also important. The need to care for children, older adults, or family members with disabilities can reduce mobility during evacuation or other emergencies.

Age, health status, and life circumstances may also increase vulnerability. Older adults, people living alone, individuals with chronic illnesses, internally displaced persons, and veterans may be especially sensitive to the physiological effects of heat or to disruptions in health and social services.

At the same time, socio-gender vulnerability does not imply that one population group is always more vulnerable than another. The mechanisms of impact may differ themselves. For example, work in agriculture, construction, transport, and municipal and emergency services — sectors with a high share of male employment — is more often associated with being outdoors, physical exertion, and exposure to elevated temperatures.

Thus, social-gender vulnerability is determined not by belonging to one universal "vulnerable group," but by specific circumstances that give different people various levels of sensitivity to climate hazards and different opportunities for adaptation.

DIFFERENT CIRCUMSTANCES — DIFFERENT VULNERABILITY

age, health, income, working conditions, mobility, and caregiving responsibilities



Institutional factor

How are communities ready to respond?

Vulnerability depends not only on capacity of individuals and households. Local self-government capacity to prepare for climate hazards, organize a response, and support the population is also critical.

Communities already use some response mechanisms. 87.9% of communities reported that they fully or partially integrate heat and other climate risks into the educational process. Evacuation plans are fully or partially in place in 59.3% of communities, while early warning systems for floods and rising water levels are implemented in 56.6%.

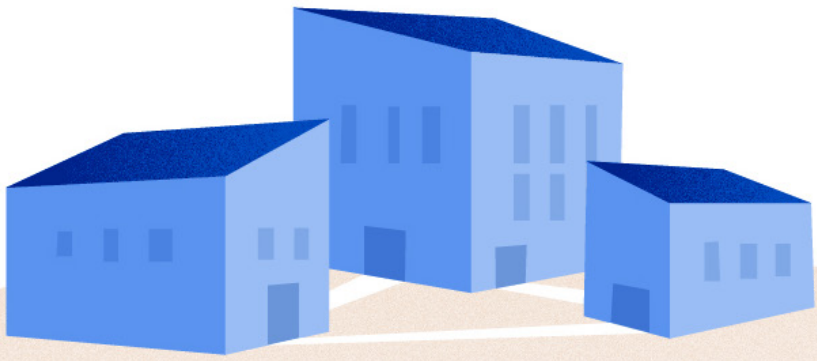
At the same time, the biggest gaps remain in strategic planning and targeted support for vulnerable groups. 84.7% of communities have no local climate change adaptation program. Other barriers include a shortage of ecology and civil protection specialists, limited local budgets, and insufficient coordination between services.

Special support mechanisms for specific population groups are also underdeveloped. 89.7% of communities have no special programs to support people aged 60+ during heat, floods, and frosts, and 78.3% have no special programs to support IDP women.

Thus, communities already have certain response instruments in place; however, they do not always form a comprehensive adaptation system. The gap between operational measures and the long-term capacity to plan, coordinate action, and support vulnerable groups remains substantial.

84.7%

of communities do not have a local climate adaptation programme



Four factors — one system of vulnerability

Territorial conditions, household resources, social characteristics of the population, and local self-government capacity are deeply interconnected. Together, they can exacerbate consequences of climate hazards, while simultaneously shaping different adaptation capacity for communities.

Territorial profiling

Different conditions — different adaptation needs

Territorial profiling summarizes assessment results for different territory types. Unlike the territorial factor, which characterizes the spatial and infrastructure conditions that give rise to vulnerability, it accounts for a broader combination of risks, vulnerability factors, and adaptive capacities.

Three characteristic profiles have been identified for the Odesa Region:

01 RURAL AREAS

Vulnerability is driven by heavy dependence on the agricultural sector, depletion of surface and groundwater sources, and chronic droughts.

Key adaptation focus: Introduce water-saving technologies in agriculture (no-till, drip irrigation), conserve soil moisture, clear and protect small rivers, create and restore shelterbelts, and diversify rural livelihoods.



02 SMALL COMMUNITIES WITH LIMITED CAPACITY

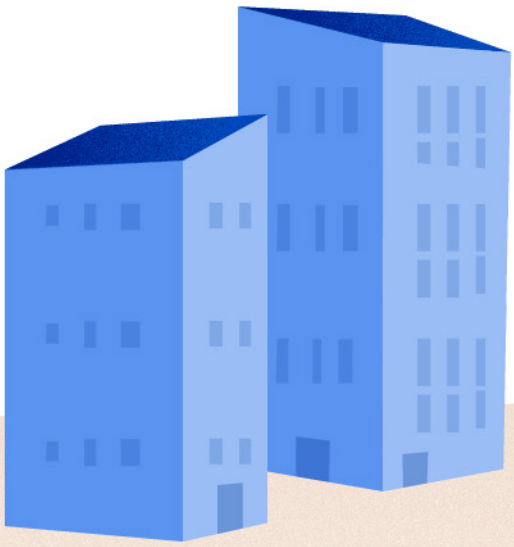
Vulnerability is determined less by geography than by resource shortages: the absence of their own adaptation programs and a lack of budget funds, staff, and expertise.

Key adaptation focus: Enhance civil protection and early warning systems, develop basic adaptation plans, launch inter-community cooperation to provide shared services, and attract external grant and state funding.

03 URBAN AREAS

They are characterized by high population density and building density. The heat problem is amplified by the urban heat island effect, and heavy dependence on centralized networks creates risks of cascading failures (water and power outages during heat).

Key adaptation focus: Develop green and blue infrastructure (parks and cooling zones, shading), implement building thermal retrofits, protect critical infrastructure, and introduce operational heatwave response plans.



Accessibility of adaptation

Different barriers for diverse types of communities

Territorial profiles outline characteristic combinations of climate risks, vulnerability factors, and adaptation needs. A distinct issue is how accessible the adaptation measures themselves are to the population.

Similar programs and financial conditions can lead to different results in urban, semi-urban, and rural communities. These differences relate to household income and housing conditions, transport accessibility, access to health, education, and social services, and the availability of local adaptation programs.

These differences are summarized in a matrix that, separately for urban, semi-urban, and rural communities, matches the assessment results with the main barriers and appropriate ways to respond.

URBAN COMMUNITY

Debt, housing conditions, renting, and co-payment requirements may limit access to existing programs

Challenge: Income gap — 16.2%. High share of women among IDPs with critical financial need. Special support programs for IDP women exist in 6.7% of communities.

Response: Lower or zero co-payment for low-income households; payment for works without prior financing; checking IDP coverage; cooling centres and backup power for social facilities.

SEMI-URBAN COMMUNITY

Financial constraints + **limited accessibility of transport, health care, education, and social services**

Challenge: Women's employment is not lower, but their income is on average 12.7% lower. The share of communities with an adaptation program is the highest among the three types — 33.3%.

Response: Combining adaptation measures with the continuity of basic services; taking into account income, household composition, and transport accessibility.

RURAL COMMUNITY

Households largely bear the financial burden of heating, water, transport, repairs, and backup energy supply

Challenge: Income gap — 15.2%. 9.1% of communities have a local adaptation program. Housing and financial constraints tend to accumulate more often.

Response: A higher share of grant funding; direct provision of fuel and basic equipment; mobile services; autonomous water and energy supply; accessible transport.

What do climate risks mean for the population

The impact of climate change goes far beyond temperature indicators, as it directly deteriorates people's quality of life, health, and financial resilience. The assessment shows resource shortages in some households and uneven readiness among local self-government bodies for climate hazards.

The real state of vulnerability of the population of the Odesa Region is characterized by three key facts:

29.8% of households in the region are unable to maintain a comfortable indoor temperature in their homes in summer

In winter, 17.0% of households report this issue, suggesting that summer heat stress has become a more critical challenge than winter cold.

In rural settlements, both indicators are higher: 33.9% of households cannot maintain a comfortable indoor temperature in summer and 22.1% in winter, whereas in cities the figures are 28.0% and 14.8%, respectively.

73.3% of households with three or more risk factors suffer from summer heat

Among households with no identified risk factors, only 2.0% report uncomfortable summer temperatures. With three or more factors, this figure rises to 73.3%. In winter, the corresponding difference is 2.8% versus 55.0%.

Risk accumulation also has a territorial dimension: about half of rural households have two or more factors, compared with roughly a third of urban ones. This means that the greatest vulnerability is driven not by any single factor, but by a combination of factors.

84.7% of communities in the region have no local climate adaptation program

Community readiness for climate hazards remains uneven. Some response mechanisms already exist: 59.3% of communities reported having evacuation mechanisms and 56.6% early warning systems. At the same time, the vast majority of communities lack local climate adaptation program.

Special support mechanisms for specific population groups are even less common: 89.7% of communities have no special program to support people aged 60 and older during climate extremes, and 78.3% have no program to support IDP women. This highlights a gap between individual operational response mechanisms and comprehensive long-term adaptation planning.

Most Vulnerable Sectors of the Odesa Region

Climate change poses threats to the Odesa Region's natural resources, infrastructure, economy, and public health. The most vulnerable sectors include water resources and natural ecosystems, energy and transport, agriculture, and forestry, as well as public health.

Depending on the available data, vulnerability was assessed either by combining sensitivity and adaptive capacity or across different climate scenarios and projection periods.

The consequences for each sector depend not only on climate hazards but also on existing problems—the condition of natural areas and infrastructure, the availability of water, land-use patterns, and the adaptive capacity of various systems.

The assessments below show each sector's potential vulnerability to climate change, assuming current characteristics persist. The results allow for a comparison for vulnerability and the identification of adaptation priorities, but they do not project the sectors' exact future conditions or expected economic losses.

Natural ecosystems

For the biodiversity and natural ecosystems of the Odesa Region, the key climate hazards include warming, extreme heat, reduced cold, droughts, and fire danger.

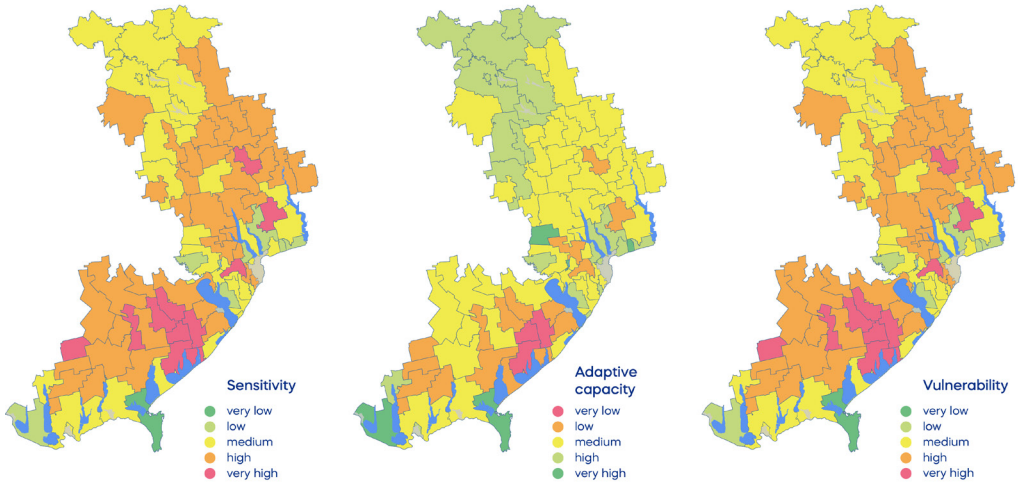
Gradual warming shifts natural cycles and the thermal limits of species' survival, contributing to changes in their ranges and in the species composition of steppe, forest, and coastal-aquatic ecosystems. At the same time, the risk of spreading heat-tolerant, invasive species and pests is growing. Combined with moisture deficit, thermal stress can reduce the productivity and recovery capacity of natural habitats, while weakening their ecosystem functions.

The region's biodiversity hotspots include not only the nature reserve fund areas and the Emerald Network, but also natural and semi-natural landscapes: steppe ravines, forests, and shelterbelts, shrublands, wetlands, rivers, ponds, reservoirs, and lakes. Natural steppe, coastal, wetland, and floodplain ecosystems surrounded by arable land, built-up areas, or other modified landscapes are especially sensitive to climate change.

The considerable extent of modified lands surrounding natural areas increases their fragmentation and deprives them of natural buffers. Under conditions of warming, extreme heat, and reduced precipitation, this limits opportunities for species migration, natural recovery, and the preservation of the local water balance.

Biodiversity vulnerability

How territorial sensitivity and adaptive capacity interact



Sensitivity indicator: share (%) of anthropogenically transformed land around key natural and wetland areas within a 500 m buffer zone.

Adaptive capacity indicator: share (%) of natural and semi-natural areas within the community.

The adaptive capacity of ecosystems, by contrast, increases where more natural and semi-natural areas are preserved. They support ecological connectivity, create microclimatic refugia, help maintain the local water balance, provide space for species migration and natural regeneration of vegetation, and mitigate the impact of extreme heat and drought.

Most communities in the Odesa Region are characterized by high or very high sensitivity of natural ecosystems to climate hazards. A relatively higher adaptive capacity characterizes northern communities, where a larger share of forest cover is preserved, as well as certain coastal communities with extensive areas of wetlands and estuaries.

As a result, the vulnerability of biodiversity and natural ecosystems in the Odesa Region is assessed as predominantly medium and high. Low and very low vulnerability levels were recorded in fewer than ten communities across the region

More in the full report: Assessment of the vulnerability of natural ecosystems to climate change and recommended adaptation measures. The full report is available at the link on p. 2.

Water resources

For the water resources of the Odesa Region, the main climate hazards include intensifying moisture deficit, rising evaporation, and more frequent extreme droughts. Small and medium watercourses in the region are especially sensitive to these changes; a significant share of them originates in arears characterized by heavily ploughed land, sparse natural vegetation, and increased aridity.

The sensitivity of water resources was assessed using several interrelated indicators. Extensive ploughing reduces the landscape's natural capacity to retain water, increases surface runoff and erosion, and deteriorates conditions for the replenishment of soil and groundwater. On ploughed slopes, these processes become even more pronounced: during intense rainfall, water flows faster over the surface, causing soil washout, the siltation of riverbeds and water bodies, and loss of catchment moisture.

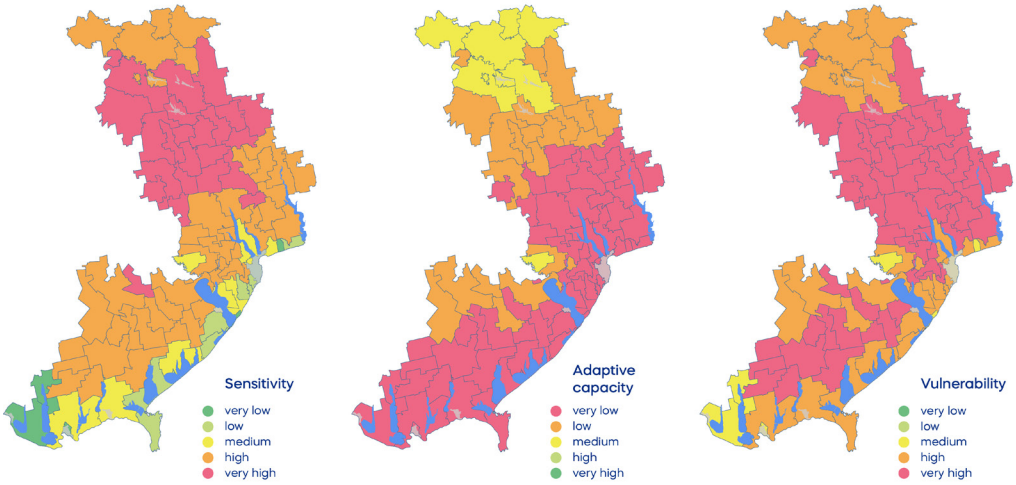
Rising evaporation places further strain on water resources. Even with relatively minor changes in precipitation, greater moisture losses through evaporation can negatively affect the water balance by reducing the amount of water left to form runoff, infiltration, and replenishment of water resources.

The capacity of water systems to adapt to these changes depends on other characteristics of the territory, including the preservation of natural vegetation, forests, and wetlands, as well as the conditions for retaining water, its infiltration, and runoff formation. Natural and semi-natural areas slow down surface runoff, promoting moisture retention, bank stabilization, and erosion reduction.

For the assessment, these indicators were combined into two composite indices — sensitivity and adaptive capacity (see the map). Their combination forms the overall water resource vulnerability indicator, which is shown on the map. Thus, the map reflects not a single factor but the combined outcome of an assessment of both natural and anthropogenic conditions that can amplify or mitigate the impact of climate hazards.

Water resources vulnerability

How the sensitivity and adaptive capacity of water resources interact



According to the assessment results, almost all of the Odesa Region exhibits a very low adaptive capacity for water resources in terms of the share of natural areas. Relatively better conditions in terms of runoff and infiltration are preserved in the north of the region, while the central and southern parts exhibit low and very low adaptive capacity.

As a result, water resource vulnerability across the entire region is classified as high or very high. It reaches its highest level in the central and south-western areas of the region. The main factors behind this vulnerability are the high degree of land ploughing, particularly on slopes, low forest cover, and the low natural landscape capacity to retain water.

In the absence of adequate adaptation measures, the consequences may include progressive shallowing and drying up of small rivers, deterioration of drinking and irrigation water quality, lower groundwater levels, and a critical shortage of water resources for the needs of the population and agriculture

More in the full report: Assessment of the vulnerability of water resources to climate change and recommended adaptation measures. The full report is available at the link on p. 2.

Energy

Climate change will differently affect the two main components of the energy sector: electricity supply and heat supply. For the electric power system, the main challenge will be growing summer demand, while heat supply systems will need to adjust to a shorter heating season and reduced demand for thermal energy.

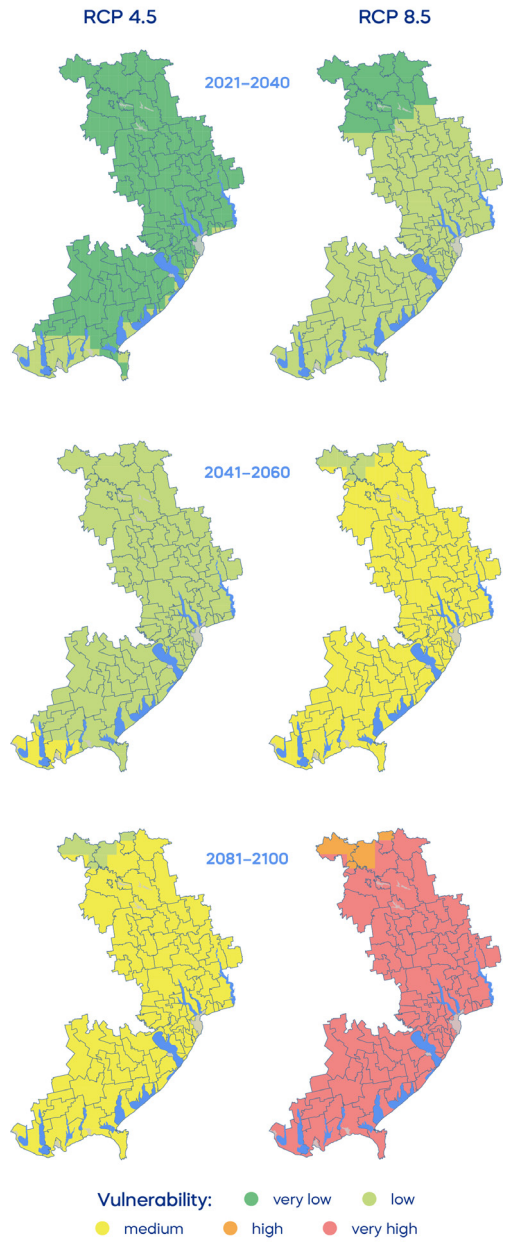
Electricity supply

For power generation and supply systems, the most key factors are growing demand for cooling, maximum summer temperatures, and an increase in the number of tropical nights.

During prolonged heat, widespread use of air conditioning increases electricity consumption and places peak loads on the system. Elevated temperatures also reduce power generation and transmission efficiency, lower grid capacity, and raise the risk of equipment failure and outages. The increased number of tropical nights extends the period of thermal stress and limits the opportunities for lower energy consumption and night-time equipment cooling.

Under both scenarios, the vulnerability of power supply systems is projected to remain mostly negligible to low during 2021–2040 but is expected to rise to low and medium levels across the entire region by 2041–2060.

The greatest differences between the scenarios become apparent by the end of the century. In 2081–2100 under RCP 4.5, vulnerability remains predominantly low across most of the territory but rises to medium to high in coastal and southern communities. Under RCP 8.5, it becomes very high across the entire territory of the Odesa Region.



Heat supply

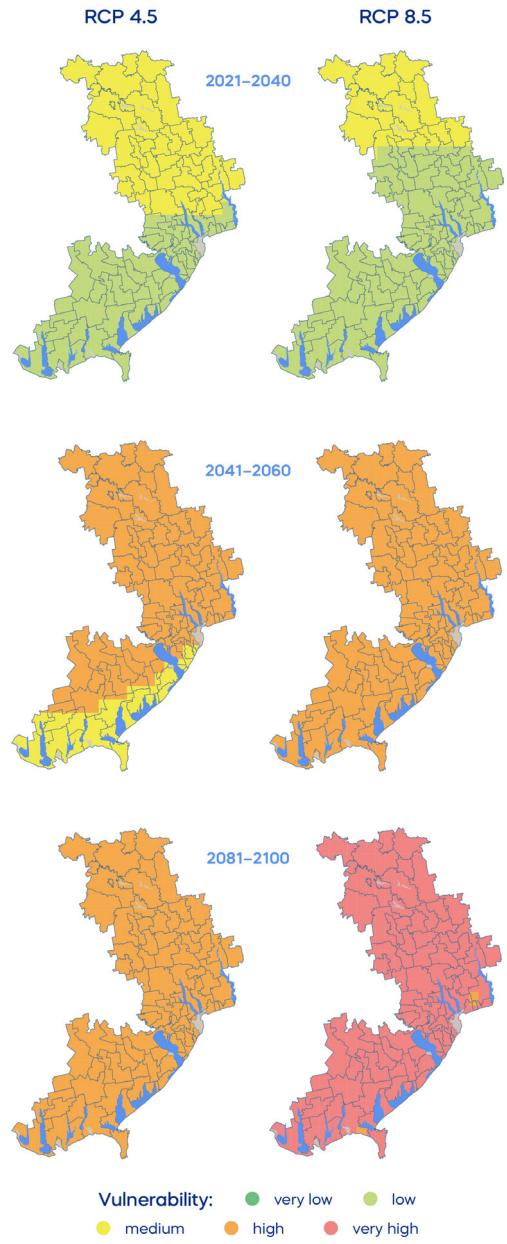
For heat supply systems, the key climate factors are reduced heating demand, the overall rise in mean annual temperature, and an increase in the number of tropical nights.

In the coming decades, warming will also bring positive effects: reduced demand for thermal energy and fuel costs during the heating season. Therefore, in 2021–2040 the vulnerability of heat supply systems under both scenarios remains mostly negligible or low.

In the longer term, however, a shorter heating season will introduce a different type of challenge. Centralized systems designed for a much colder climate and a longer heating period will operate at an ever-lower load. This may reduce their technical and economic efficiency and will require a gradual reconfiguration of heating infrastructure.

In 2041–2060, the vulnerability of heat supply systems rises to a mostly elevated level. By the end of the century, it is projected to reach high and very high levels under RCP 4.5 and under RCP 8.5, respectively.

Shifts in thermal patterns will also gradually transform building requirements: alongside reduced demand for winter heating, maintaining a comfortable microclimate in summer will become more important. Heat supply adaptation will require more flexible systems, retrofitted buildings, and modernized infrastructure, as well as adjustments to a much shorter heating season.



Transport

The vulnerability of the transport sector was assessed separately for public transport and roads. For both components, rising temperatures and intense precipitation are important climate hazards, but the nature of their impact differs.

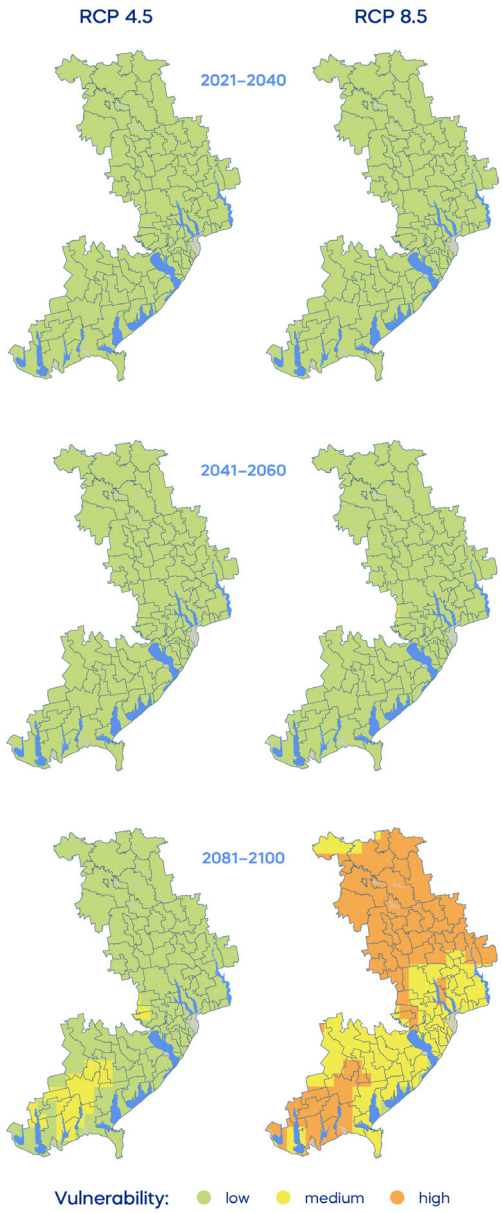
Public transport

For public transport, the most key factors include an increase in the number of hot days, heavy downpours, and rising maximum summer temperatures.

Prolonged heat reduces passenger comfort and safety, creates additional heat stress for staff, and affects the operation of vehicles. Extremely hot temperatures also accelerate the wear and tear of rolling stock and associated infrastructure.

Heavy downpours pose a different type of threat, as they can flood streets and transport hubs, disrupt the regularity and continuity of service, and damage vehicles and infrastructure.

According to the assessment results, for most time periods and under both scenarios, the vulnerability of public transport remains mostly negligible and very low. A marked increase is expected by the end of the century under the RCP 8.5 scenario: during 2081–2100, vulnerability is projected to rise to medium and high levels across practically the entire region.



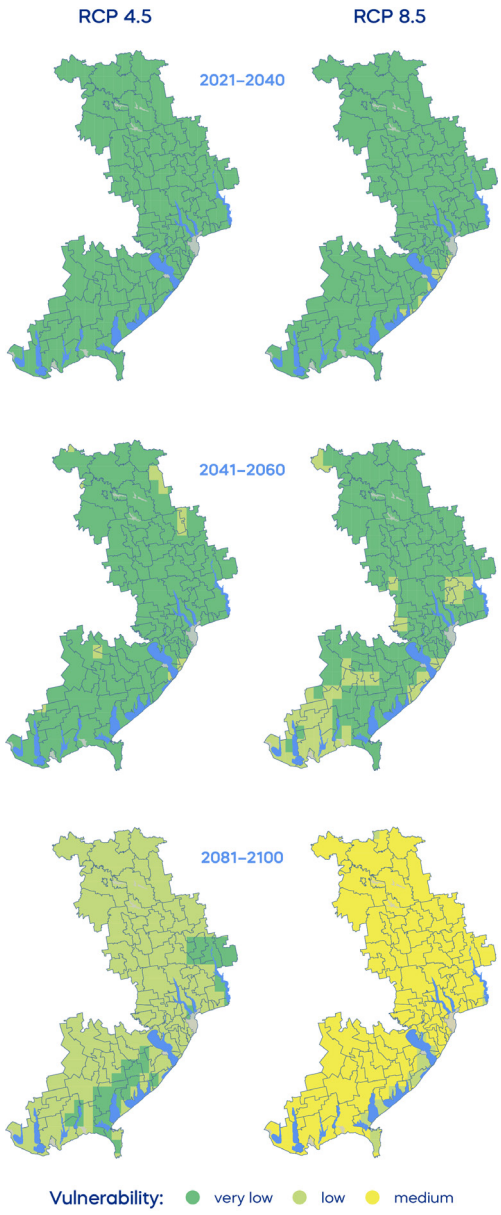
Roads

For roads, the main climate hazards are prolonged and intense precipitation, as well as an increase in the number of hot days.

Prolonged precipitation can cause road flooding, washout and destruction of the road surface, and intensified erosion. On slopes, this raises the risk of rockfalls and landslides along highways. Intense short-duration rainfall also increases the likelihood of local damage and emergencies.

Prolonged summer heat directly affects road pavement materials: it contributes to the deformation of asphalt-concrete surfaces and rutting, shortens their service life, and can heightens the risk of road traffic accidents.

Despite these hazards, the calculated vulnerability of roads remains mostly negligible and low for most of the projected period. It reaches a medium level only by the end of the century, in 2081–2100 under the RCP 8.5 scenario.



Agriculture

Agriculture in the Odesa Region is highly dependent on the temperature regime and water supply. At the same time, the nature of climate risks differs for the sector's two main subsectors — crop production and livestock farming — so their vulnerability was assessed separately.

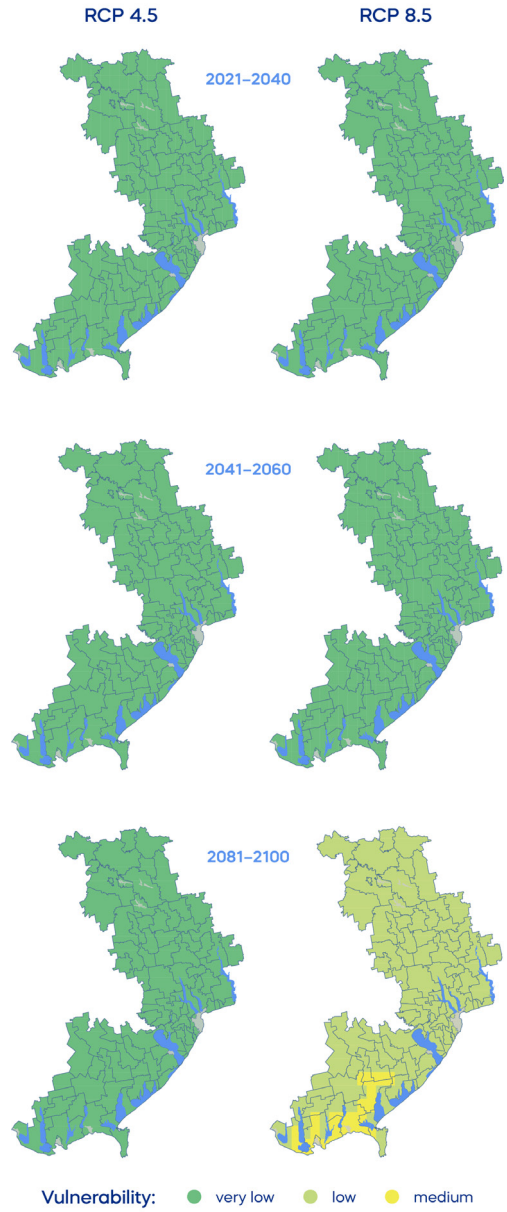
Crop production

For crop production, the key climate hazards are prolonged dry spells, changes in precipitation during the warm season, and an increase in the number of hot days.

For the steppe landscapes of the Odesa Region, the main limiting factor is moisture deficit. The duration of the dry spell directly affects the risk of crop loss, while warm-season precipitation affects crop water supply during critical crop growth stages and throughout the entire growing season. The increased number of hot days further intensifies crop heat and water stress.

Despite the high dependence of crop production on climate conditions in the Odesa Region, its vulnerability assessed based on the selected indicators remains relatively low for virtually all assessed periods and scenarios. This is explained by the fact that the projected changes in warm-season precipitation, the duration of dry spells, and the number of hot days relative to the 1991–2020 baseline period are mostly moderate in the climate models used.

This result does not imply that crop production is immune to climate risks. The high dependence of yields on water supply, soil degradation, and the existing moisture deficit can have substantial consequences even with relatively minor changes in climate indicators. Prolonged dry periods and heat can intensify moisture deficit, crop thermal and water stress, soil degradation, and the risk of crop loss.



Livestock farming

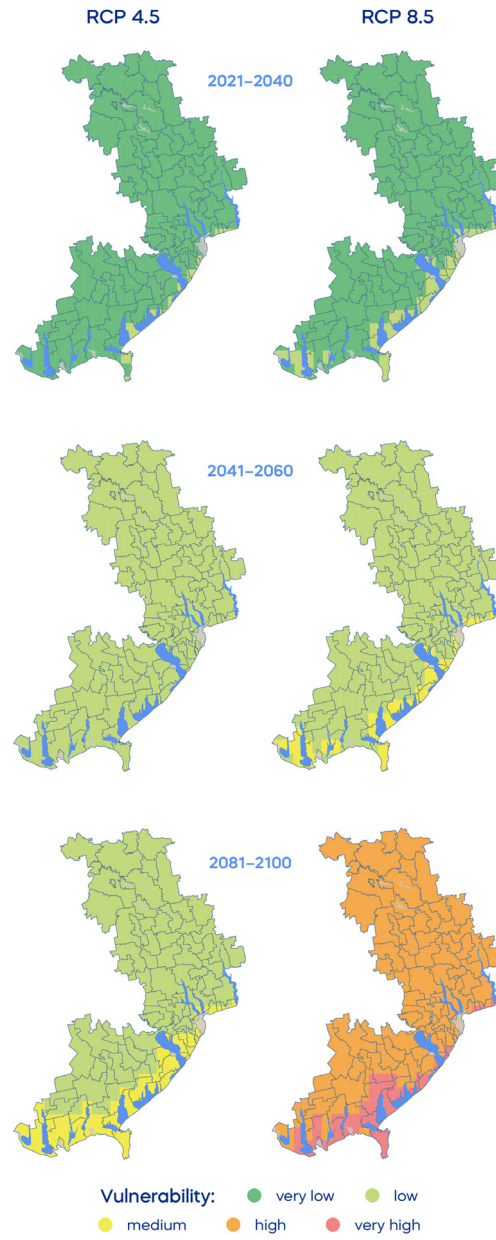
For livestock farming, the main climate hazards are rising maximum summer temperatures, an increase in the number of tropical nights, as well as prolonged droughts.

High summer temperatures are the main cause of heat stress in livestock, especially when animals are kept outdoors or in facilities without microclimate control. Tropical nights place an additional strain, since the lack of nighttime cooling prevents animals from recovering from daytime heat, thereby reducing productivity, and increasing the risk of mortality. Prolonged droughts further affect the sector by diminishing feed base and water supplies.

Under the RCP 4.5 scenario throughout the 21st century, and under RCP 8.5 until mid-century, the vulnerability of livestock farming remains mostly negligible and low. For these time horizons, the projected changes in maximum summer temperature, the number of tropical nights, and the duration of dry spells do not yet present high climate hazard intensity.

The situation changes dramatically by the end of the century under the RCP 8.5 scenario. During 2081–2100, livestock vulnerability rises to high and very high levels, driven by a significant intensification of summer heat and a sharp increase in the number of tropical nights.

Under such conditions, the climate pressure may exceed the adaptive potential of traditional livestock housing systems. Possible consequences include critical heat stress, reduced productivity, increased mortality, water supply deficit, quality feed shortages, as well as higher costs of maintaining proper housing conditions.



Important: the assessment results characterize the intensity of projected changes in selected climate hazards and are not a direct estimate of future economic losses in agriculture. Therefore, a low assessed level of vulnerability, especially for crop production, does not imply the sector is immune to risks.

More in the full report: Assessment of the vulnerability of agriculture to climate change and recommended adaptation measures. The full report is available at the link on p. 2.

Forestry

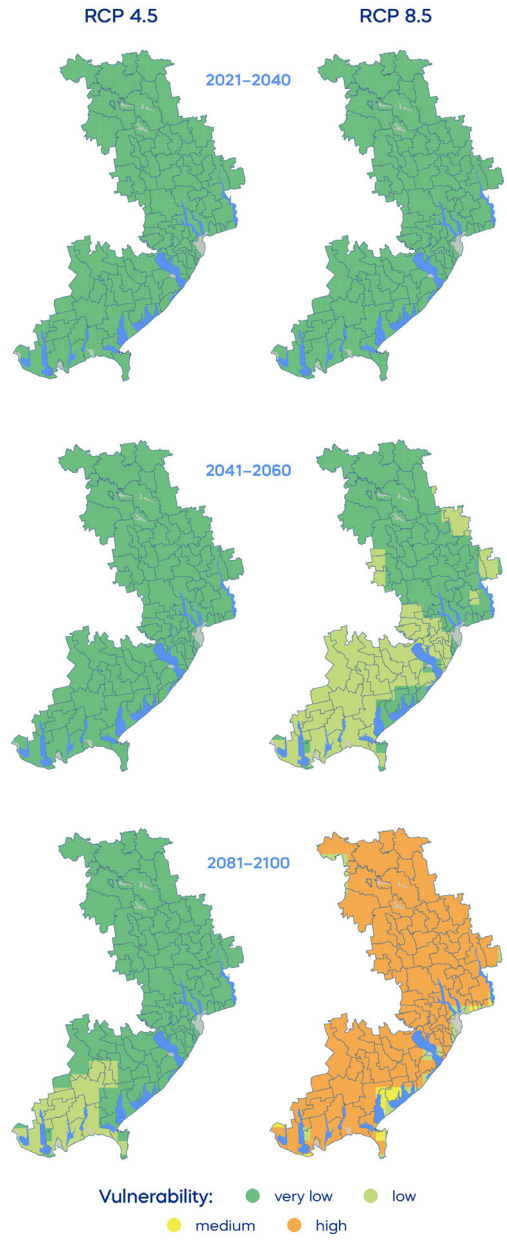
For forests and forest plantations in the Odesa Region, the main climate hazard is the escalating wildfire risk linked to high summer temperatures and droughts. Forestry vulnerability was assessed based on the number of high fire danger days, the duration of dry spells, and the number of hot days.

Wildfire danger is driven by the combined influence of temperature, humidity, wind, and prior drying of vegetation. Prolonged periods without precipitation promote dry biomass buildup and soil drying, while more frequent hot days further increases the risk of ignition and rapid spread of fires.

Until the mid-21st century, forestry vulnerability in the Odesa Region is projected to be mostly negligible and low under both scenarios. A similar outlook persists through the end of the century under RCP 4.5, as projected shifts in wildfire danger, the duration of dry periods, and the number of hot days will remain relatively minor.

Significant changes are expected in 2081–2100 under the RCP 8.5 scenario, when vulnerability is projected to rise to medium and high levels. The main reason is a significant increase in the number of high fire danger days, accompanied by growth in the duration of dry spells and the number of hot days.

The compound effect of these factors creates conditions highly conductive to ignition and rapid forest fire spread. This risk is especially relevant for the steppe zone's artificial forest plantations, which make up majority of forests in the Odesa Region.



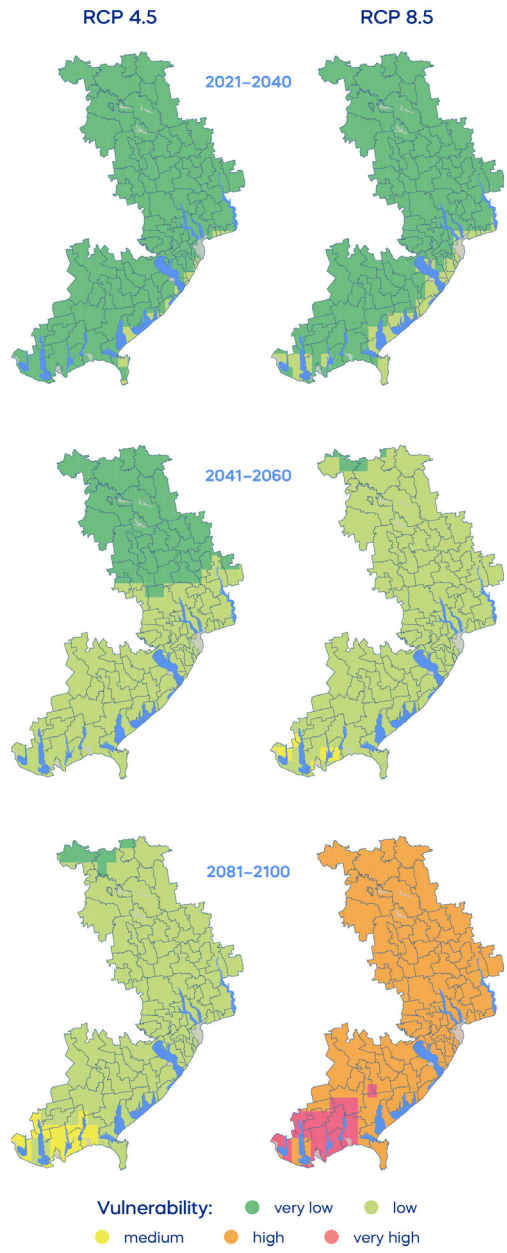
More in the full report: Assessment of the vulnerability of forestry to climate change and recommended adaptation measures. The full report is available at the link on p. 2.

Public health

For public health in the Odesa Region, the most significant climate hazards are heat and prolonged periods of hot temperatures. Their impact was assessed using indicators such as the number of tropical nights, hot days, and the maximum summer temperatures - metrics linked to heat stress, morbidity, mortality, and healthcare system strain.

Tropical nights, defined as nights when the minimum air temperature exceeds 20 °C, are of particular importance. The lack of nighttime cooling prevents the body from recovering after daytime overheating, raises risks for the cardiovascular system, and is especially dangerous for older adults and other vulnerable groups. In cities, this impact is further intensified by the urban heat island effect.

An increase in the number of hot days with a maximum temperature above 35 °C heightens the frequency of heat stress, heatstroke, and dehydration, while exacerbating chronic diseases and intensifying medical facility strain. Particular risks arise for people who work outdoors. Peak summer temperatures reflect the intensity of the most extreme heatwaves and indicate the risk of exceeding the physiological adaptation thresholds of certain population groups.



Important: the assessment results characterize the intensity of projected changes in selected climate hazards, not directly the expected scale of consequences for public health. Therefore, low vulnerability values for some scenarios and time periods do not imply an absence of risks: even a relatively minor rise in temperature metrics can have profound social and medical consequences, especially in large cities.

More in the full report: Assessment of the vulnerability of public health to climate change and recommended adaptation measures. The full report is available at the link on p. 2.

Under the RCP 4.5 scenario, public health vulnerability is projected to gradually increase from a negligible to a low level throughout the century. This shift is driven by increases in tropical nights and hot days, while maximum summer temperatures remain relatively moderate within the applied assessment system.

Under the RCP 8.5 scenario, a much faster growth is expected. By the end of the century, vulnerability is projected to reach high and very high levels, driven by the increasing duration and intensity of heatwaves, a sharp rise in tropical nights, and the extreme summer temperature peaks.

Older adults, children, and individuals with chronic illnesses are the groups most vulnerable to heat stress. Possible consequences include intensified heat stress, heatstroke, and dehydration, exacerbation of cardiovascular, and respiratory diseases, increased mortality, and mounting strain on healthcare and social protection systems. In large cities, these consequences may be further amplified by high population density, the urban heat island effect, and uneven access to cooling.

Most vulnerable to heat exposure:

OLDER ADULTS

CHILDREN

PEOPLE WITH CHRONIC ILLNESSES

Heat exposure:

heat stress | dehydration | exacerbation of diseases | increased strain on healthcare facilities

Key Risks and Priority Responses

The vulnerability assessment shows different combinations of climate hazards and their consequences for natural systems, infrastructure, the economy, and public health. For the different sectors, it is possible to identify the key risks and the corresponding adaptation measures.

The matrix below summarizes the main results of the sectoral assessment in the format **"sector — key risk — priority response"**. It does not cover all possible climate impacts and measures considered in the full report, but it synthesizes the most essential linkages crucial for determining further adaptation pathways.

01

NATURAL ECOSYSTEMS

drought **fires** **degradation**

Restoration of wetlands, rivers, and forests (nature-based solutions)
Restoration of wetlands, rivers, and forests (nature-based solutions)

02

WATER RESOURCES

drought **water shortage**

Efficient water use +
water retention and accumulation in landscapes

03

ENERGY

heat + **peak loads**

Greater grid resilience +
backup power for critical facilities

04

TRANSPORT

heat **intense flooding**

Road and transport infrastructure resistant to temperature deformation and downpours

05

AGRICULTURE

drought **soil degradation**

Water-saving agricultural technologies + restoration of irrigation and shelterbelts

06

PUBLIC HEALTH

heat (heatwaves)

Heatwave action plans +
cooling centres

Cascading Risks

When one risk triggers another

Climate hazards rarely act in isolation: a disruption in one sector can trigger a **chain reaction** in others. For example, extreme heat simultaneously triggers a peak in energy consumption, driven by of air conditioning, while overheating power grid. This can cause grid failures that shut down water utility pumping stations and disrupt medicines storage in hospitals. The resulting **multiplier effect** leads to total community damages, far exceeding the consequences of the initial weather event.

The study did not model cascading risks quantitatively, but the results show a number of important cross-sectoral links.

CLIMATE HAZARD

For example, extreme heat

INITIAL IMPACT

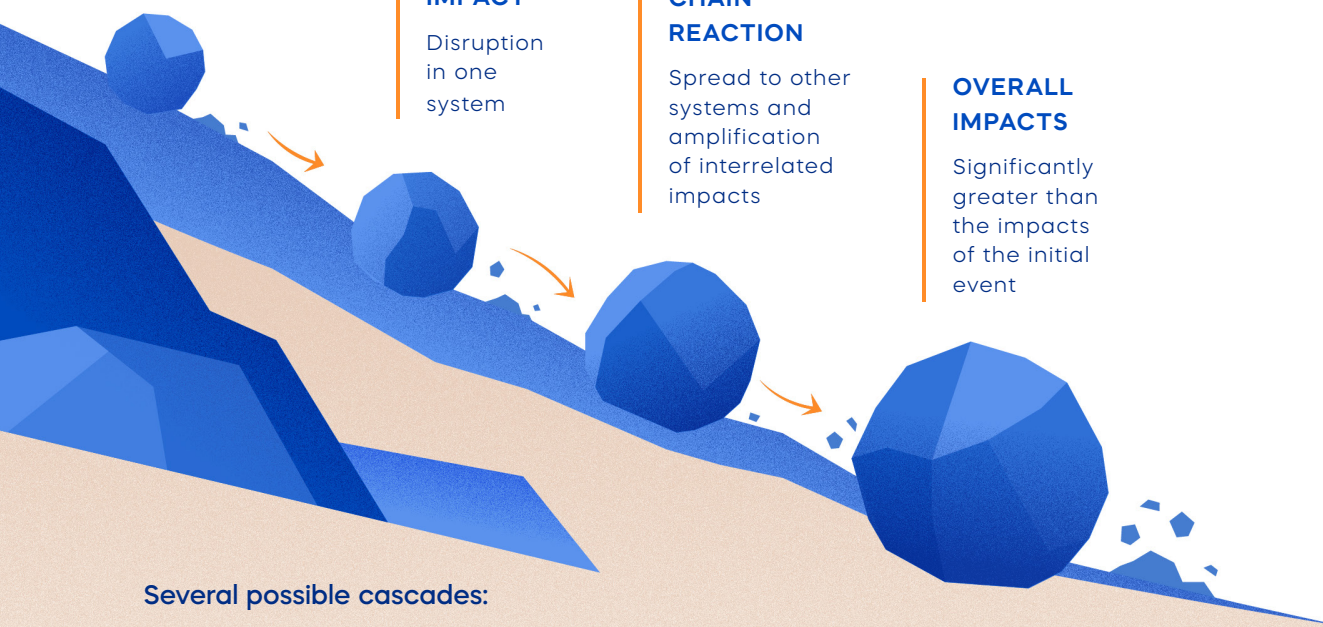
Disruption in one system

CHAIN REACTION

Spread to other systems and amplification of interrelated impacts

OVERALL IMPACTS

Significantly greater than the impacts of the initial event



Several possible cascades:

01 **Heat** → power supply disruptions → shutdown of pumping stations → water supply disruptions

02 **Intense precipitation** → flooding → damage to roads, housing, drainage, and social infrastructure facilities

03 **Water shortage** → consequences for the population, agriculture, and ecosystems → increased pressure on energy and fire safety

06

Climate Change Adaptation Priorities

Climate risk and vulnerability assessment provides the foundation for shifting from isolated response measures to systematic adaptation. Climate risks must be accounted for in development and recovery strategies, local budgets, spatial planning, civil protection plans, and sectoral programmes.

To ensure the climate resilience of the Odesa Region, five strategic priorities have been defined. They integrate recovery, economic development, and the protection of people and ecosystems into a comprehensive regional governance system.

01

INTEGRATE ADAPTATION INTO RECONSTRUCTION AND STRATEGIC PLANNING

02

ENSURE WATER SECURITY AND CLIMATE RESILIENCE OF ECOSYSTEMS

03

PROTECT PEOPLE AND ENSURE THE CONTINUITY OF CRITICAL SERVICES

04

DEVELOP A CLIMATE-RESILIENT LOCAL ECONOMY AND INFRASTRUCTURE

05

CREATE AN EFFECTIVE SYSTEM OF REGIONAL ADAPTATION GOVERNANCE AND MONITORING

01 Integrate adaptation into reconstruction and strategic planning

Climate resilience must become a cross-cutting criterion in the design and financing of reconstruction projects, the spatial planning of communities, and the development of local budgets. To this end, it is necessary to develop local adaptation programmes and integrate climate risks into master plans, building regulations, and projects to restore damaged or outdated infrastructure.

Local adaptation programmes must translate identified risks into specific actions: designate responsible implementers, timelines, budgets and funding sources, necessary reserve resources, and performance metrics. This makes it possible to link adaptation not to individual projects, but rather to the long-term development of communities.

02 Ensure water security and climate resilience of ecosystems

Water security requires a shift to active water-balance management, combining engineering and nature-based solutions. Priorities include water reuse, identifying and accounting for alternative sources, revitalizing and clearing small rivers, and restoring wetlands, estuaries, and shelterbelts, which help retain moisture in landscapes.

This approach is complemented by measures to reduce water losses and increase territory drought resilience: modernizing water supply and irrigation systems, protecting drinking water sources, safeguarding water protection zones, combating erosion, and promoting local water accumulation. Nature-based solutions also support the water balance, ecosystem health, and landscape's resilience to prolonged dry periods.

03 Protect people and ensure the continuity of critical services

Protecting the population must be aimed primarily at mitigating negative health impacts and ensuring the uninterrupted operation of healthcare, energy, water supply, social services, and transport during extreme events. This requires operational heatwave action plans, accessible and barrier-free cooling centres, population early warning systems, and targeted support for temperature-vulnerable households.

The early warning system must be multi-channel and accessible to different population groups. A single digital channel is not enough: up-to-date contact details, accessible message formats, regular drills, and realistic evacuation plans are needed. These must take into account the availability of transport and the possibility of assisting people with limited mobility.

Continuity of critical services is a particular priority. Medical and social facilities, water supply systems, and other critical facilities must be provided with backup power, water, communications, and the necessary cooling systems. Business continuity protocols and the required duration of autonomous operation must also be prepared.

Support for the population must account for the actual combination of their needs: health and housing conditions, income level, access to cooling, transport barriers, care needs, and dependence on the uninterrupted operation of critical services. Belonging to a particular social or gender group may be a signal for need assessment, but not the sole basis for determining vulnerability level.

04 Develop a climate-resilient local economy and infrastructure

Adaptation of key sectors of the economy and infrastructure should help maintain their resilience amid rising temperatures, aridity, and other climate impacts.

For agriculture, the priorities are water-saving and soil-conserving technologies, modernization and greater efficiency of irrigation, the use of drought-resistant crops, and restoration of shelterbelts. In livestock farming in particular, stable water supply, ventilation of buildings, and protection of animals from heat stress are important.

In forestry, the main focus should be placed on reducing wildfire danger and increasing the plantation resilience to drought. Measures include early fire detection, creation of mineralized firebreaks, ensuring access to water for firefighting, and a gradual shift in the species composition of plantations toward more drought-resistant and less flammable species.

For energy, important measures are thermal retrofitting, the development of distributed generation, energy storage systems, and backup power. Such solutions reduce the load on the power system during temperature extremes and increase its resilience to outages.

A separate area is the building adaptation to elevated temperatures. It involves taking climate risks into account in building codes and standards, energy retrofitting of housing, and solutions to prevent premises from overheating.

For transport infrastructure, standards need to be updated to account for elevated temperatures and intense precipitation. This includes, in particular, the use of heat-resistant road materials, modernization of storm drainage, and reinforcement of erosion-prone areas.

Rising temperatures also require adaptation of working conditions. For people who work outdoors, it is important to provide special work schedules during extreme heat exposure, ensure access to water, shade, and the possibility to take breaks in cooled premises.

05 Create an effective system of regional adaptation governance and monitoring

Effective adaptation requires coordination between sectors, stable funding, and regular evaluation of results. At the regional level, it is advisable to establish a cross-sectoral working group under the Regional Military Administration, attract grant and international funding to support communities with low capacity, develop regional adaptation indicators, and introduce annual action monitoring and review.

Adaptation funding must not be only project-based and short-term initiative. Systemic measures require long-term funding combining local, region, state, and donor resources, including funds for the subsequent maintenance of the infrastructure and services.

Monitoring should assess not only the number of documents adopted, but rather projects implemented, or equipment purchased. It is important to track actual results: population coverage, accessibility of assistance, continuity of critical services, and actual vulnerability reduction.

This requires data that enable linking climate impact to the infrastructure integrity and people's living conditions. At the community level, this includes information on housing temperature conditions, access to autonomous power, cooling, and water supply, receipt of early warnings, accessibility of evacuation, interruptions in the work of medical and social institutions, and the results of assistance provided. At the regional level, such data should help identify territories and sectors where high climate impact is compound with significant social sensitivity and low adaptive capacity.

FROM INDIVIDUAL MEASURES — TO SYSTEMATIC ADAPTATION

10 Priority Steps for the Next 3–5 Years

The assessment results make it possible to identify first-priority steps that serve the foundation for the Odesa Region's systematic adaptation to climate change. They include planning, population protection and critical services, water security, restoring natural systems, adapting infrastructure and the economy, public participation, and monitoring results.

01 Develop and adopt the Climate Change Adaptation Strategy of the Odesa Region with clear goals, responsible implementers, timelines, budgets, and performance indicators.

02 Introduce heatwave response protocols in communities: create a network of accessible cooling centres, ensure prompt public early warning, and define the procedure for protecting the most vulnerable people.

03 Ensure the continuity of critical services — equip hospitals, water utilities, and social facilities with backup power, autonomous water supply, and cooling systems.

04 Introduce targeted support for vulnerable groups, in particular, allocate dedicated technical and financial assistance for the energy retrofitting of housing and the shading of households with an elevated level of thermal vulnerability.

05 Enhance the water security of the region by introducing accounting and protection of drinking water supply sources, encouraging water reuse, and modernizing the worn-out water supply network.

06 Restore natural landscapes capable of retaining water, by implementing nature-based solutions for the revitalization of small rivers and the restoration of wetlands, estuaries, and shelterbelts.

07 Increase the infrastructure climate resilience by integrating mandatory heat- and flood-protection requirements into projects to rebuild buildings, roads, and storm sewers.

08 Adapt agriculture and forestry through the introduction of water-saving agricultural technologies, drought-resistant crops, and expanded fire-protection measures for forest areas.

09 Ensure meaningful public participation by including representatives of IDPs, women, veterans, and individuals with limited mobility in adaptation decision-making processes at the community level.

10 Introduce a system for monitoring adaptation results containing regional indicators and an annual review of measures based on the data obtained.

From Risk Assessment to Action

The assessment provides a foundation for the next stage — the transition from identifying climate risks and vulnerabilities to planning and implementing adaptation measures.

The study results can be used in developing the Adaptation Strategy of the Odesa Region, local programs, recovery plans, and sectoral programs. The identified priorities must be translated into specific measures and projects with responsible implementers, timelines, budgets, and funding sources.

Further integration of adaptation measures into long-term planning must be combined with regular monitoring of their results. What matters is not only the number of measures implemented, but also their accessibility, the continuity of critical services, and the actual reduction of vulnerability.

HAVE QUESTIONS OR WANT TO LEARN MORE?

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