

# WATER IS COMING

SEA LEVEL RISE IN UKRAINE  
CAUSED BY CLIMATE CHANGE

Center for Environmental Initiatives Ecoaction



52A Saksahanskoho St, 01033 Kyiv

[ecoaction.org.ua](http://ecoaction.org.ua)

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## **WATER IS COMING**

SEA LEVEL RISE IN UKRAINE

CAUSED BY CLIMATE CHANGE

(executive summary)

*The purpose of this research is to demonstrate possible implications of sea level rise caused by climate change for Ukraine, to bring attention to the need for further research into current processes, and to encourage the government and cities to address climate change while taking actions to adapt to the existing environment. 2100 has been selected as the target year for the flood hazard area modelling (IPCC scenario – RCP 8.5). The modelling was performed using the highest expected sea level rise values that are scientifically valid taking into account vertical crustal movements and storm surge events. Two flood hazard areas were modelled. The calculations performed show that about 650,000 ha of land are at risk of flooding or 1 m ha if storm surge events are taken into account.*

### **Contributors:**

Oleksandr Holubtsov, PhD in Geography, Senior Research Officer, Geography Institute of the National Academy of Sciences of Ukraine, [golubtsovoleksandr@gmail.com](mailto:golubtsovoleksandr@gmail.com)

Anton Biatov, Analyst, Society for Conservation GIS, [anton.biatov@gmail.com](mailto:anton.biatov@gmail.com)

Oleh Selivestrov, Analyst, Society for Conservation GIS, [oleg.seliverstov@gmail.com](mailto:oleg.seliverstov@gmail.com)

Sofia Sadohurska, Coordinator of Climate Change Campaigns, Center for Environmental Initiatives Ecoaction, [sofia@ecoact.org.ua](mailto:sofia@ecoact.org.ua)

**Editors:** Anna Akermann, Sofia Sadohurska, and Iryna Stavchuk

**Proofreader:** Hanna Zavorotna

**Reviewers:** Kateryna Terletska, PhD in Physics and Mathematics, Institute for Mathematical Machines and Systems of the National Academy of Sciences of Ukraine (Kyiv), and Oleh Diakov, PhD in Geography, Project Manager, Regional Research Centre (Odesa).

**Design and Infographics:** Stanislav Kulynych

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## INTRODUCTION

Over these recent decades, it has become evident that climate change represents the major global concern threatening the existence of the mankind and the biodiversity on the Earth in general.

Research findings published by the UN Intergovernmental Panel on Climate Change ('IPCC') demonstrate that the global temperature of the planet has increased by 1 °C after the industrial revolution commenced. Even this seemingly slight temperature growth has already led to grave consequences reducing the ice cover, rising sea level, increasing the frequency of violent storms, tornadoes, rains, and droughts. These changes not only affect the environment, but also significantly impact human life, health and wellbeing worldwide.

The key reason behind the global warming is an increased concentration of greenhouse gas emissions as a result of human activities such as transport, industry, and agriculture, burnt fossil fuels, and increased area of logging and forest fires. Greenhouse gases accumulate the warmth of the sun in the lower atmosphere layers and prevent it from returning to the space, and, therefore, intensify the natural greenhouse effect. Greenhouse gas (carbon dioxide, methane and oxygen oxide) concentrations in the atmosphere reached unprecedented levels over past 800,000 years and continue to grow. Further, the process of global warming has been accelerating and doubled over past 50 years.

In 2015, the Paris Agreement was concluded to limit the global warming. The goals of the agreement are to limit the global temperature rise to 1.5 to 2 °C by the end of the XXI century. Each country is free to individually and voluntarily set its own contribution ('nationally determined contribution (NDC)) to the achievement of the global goal. The agreement requires that those contributions be 'ambitious,' 'fair,' and set to 'facilitate the attainment of the Agreement's goals.'

Recent research however shows that current emission-cutting commitments presented by the parties to the Paris Agreement could hardly promote the decrease in greenhouse gas emissions to the extent required to keep rise in global temperature below 2 °C. Just the other way around, average global temperature will further rise by 2.6 to 4.0 °C if current greenhouse gas emission levels are maintained.

In turn, Ukraine also significantly contributes to global warming and has not declared any intention to reduce its greenhouse gas emissions within next ten years so far. Last year, an independent panel group from Climate Action Tracker found Ukraine's nationally determined contribution to be critically unsatisfactory and increasingly lacking ambition. The current Ukrainian NDC allows for a 68% increase in emissions by 2030 compared to 2016. The rationale behind this is that Ukraine now demonstrates one of the lowest greenhouse gas emission levels compared to the 1990 baseline year — the times when the state acquired its independency. However, even the best case scenario under the Ukrainian Low-Carbon Development Strategy provides that emissions will reduce to the 2015 levels by 2050. Accordingly, even this scenario does not expect a large-scale decarbonisation of the economy.

Taking into account the current tendency for greenhouse gas emissions to grow, the world is likely to see the global temperature increased by 4 °C by 2100 compared to the preindustrial age. It is important that all countries including Ukraine set ambitious goals to cut greenhouse gas emissions because global warming already leads to catastrophic implications. Failure to limit rise in global temperature to 1,5 to 2 °C will result in, *inter alia*, a significantly higher sea level and dire economic consequences. The expected sea level rise will reach nearly one meter by the end of the century and more than ten meters over the two next centuries unless the governments take urgent measures to reduce greenhouse gas emissions.

Global sea level remained virtually unchanged for a good while — its minor fluctuations never exceeded 0.2 mm in annual terms over past 3,000 years. However, according to the Intergovernmental Panel on Climate Change, the average global sea level increased by almost 20 cm over the period from 1901 to 2010, and its growth is merely accelerating. Global sea level rise will primarily pose risks to coastal areas in many countries of the world.

Ukraine has a 2,500 km coastline and, therefore, our coasts will also suffer adverse effects of sea level rise.

In addition to the need for reduction in greenhouse gas emissions, we are now required to take measures to adapt to climate change and sea level rise effects. However, Ukraine virtually has no evident, scientifically valid and visualised data about sea level rise in the Black and Azov Seas. Research texts are incomprehensible for, and difficult to access by, the public and stakeholders. To get a clear vision of impacts of the issue for the coastal areas of Ukraine and to further develop adaptation plans for those areas, it is thus necessary to prepare visualised and easy-to-access research into sea level rise.

In view of the above, in this research we are **aiming** to set out framework goals for further forecasting of implications of Ukrainian territories potential flooding caused by sea level rise driven by global warming.

The focus is placed on the territory of Ukraine, in particular, coastal areas in southern Regions of our state. The analysis is composed of two phases: 1) modelling the potential flood hazard area taking into account a number of additional factors influencing sea level (vertical crustal movements, impacts of revolving storms and storm surge events) and 2) modelling risks to human activities in the flood hazard area.

**Key objectives of the research are:**

- To model the potential area of flooding of the Ukrainian coasts of the Black and Azov Seas as at 2100 based using accessible and open sources and data;
- To determine the areas of vulnerable human activities that are subject to risks associated with flooding;
- To preliminarily assess risks for, and losses to, the economy, social sector and conservation using accessible and open sources and data; and
- To visualise potential implications of Ukraine's territory flooding caused by sea level rise using open maps.

This paper represents the executive summary of the project deliverables. **The entire text** setting out in detail preconditions for the conduct of the research, the modelling techniques, the impacts of sea level rise for the Ukrainian coast, and our recommendations is available at <http://ecoaction.org.ua/voda-blyzko-report.html>.

**The interactive map is available at:** <http://ecoaction.org.ua/projects/sealevel/index.html>

## FLOOD HAZARD AREA MODELLING

Whatever are global scenarios for the management of greenhouse gas emissions, we should expect to a greater or lesser extent intensive global warming and resulting rise in global sea level. The issue of global sea level rise is relevant to our state too. Ukraine is washed by the Black and Azov Seas that are connected to the global sea through a system of straits. Ukraine has a 2,500 km coastline.

For the purposes of modelling the flood hazard area, the research makes provision for three major factors:

1. Global sea level rise driven by global warming;
2. Vertical crustal movements; and
3. Season-related surge events and storms.

### CAUSES OF SEA LEVEL RISE

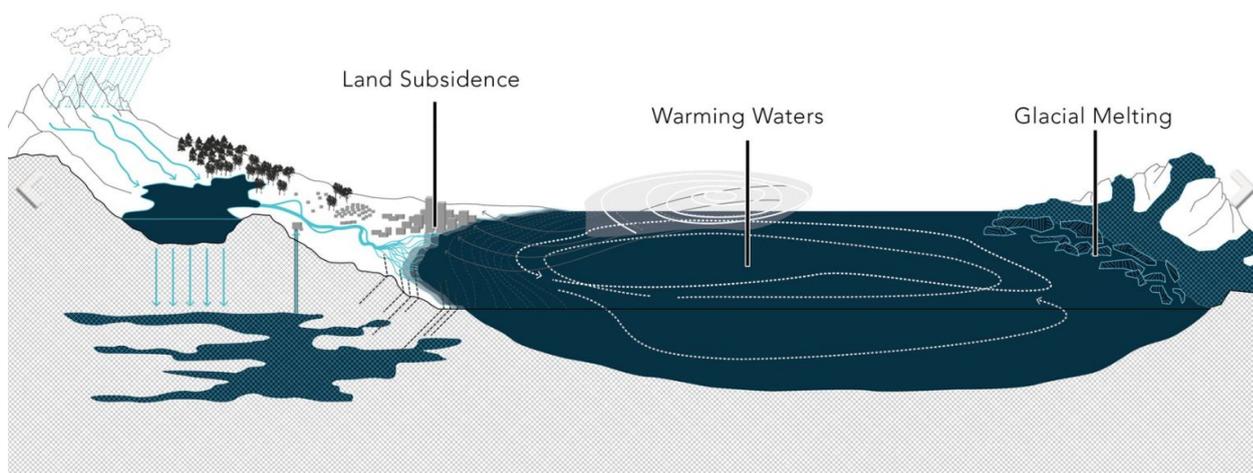
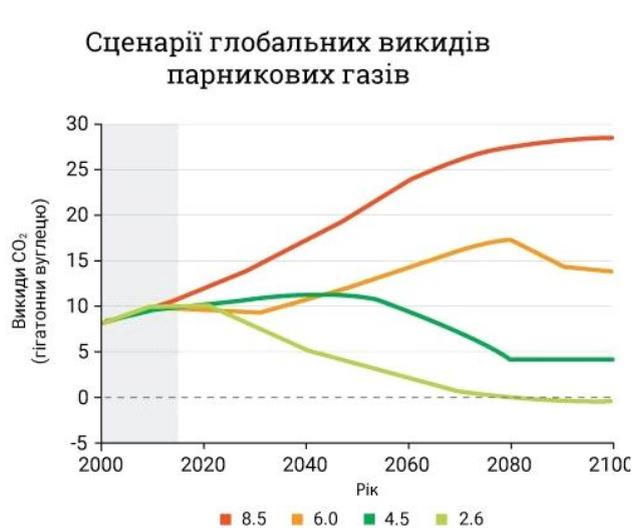


Image source: <https://architizer.com/projects/sea-change-boston/>

The first two factors contribute to the establishment of a long-standing water level. The third one causes short-term rises in sea level.

Locally, risks of a certain area flooding will also depend on microtopography aspects, the existence of obstacles serving as barriers to surge events and waves, such as dense development or plants, and the nature of the above-water and underwater coast curves, the composition of geological materials, etc. These factors were left unattended in the modelling of sea level rise and relevant risks due to the absence of accessible reliable data.

The flood hazard areas were modelled using values determined and substantiated as part of previous research conducted both at global and regional levels in respect of the Black and Azov Seas. **2100** was taken as the modelling target year. **For 2100, the highest forecasted value for sea level rise is 0.82 meter** according to a scenario **suggesting very high greenhouse gas emissions (RCP 8.5.)**. A representative study demonstrates a **0.46-meter rise in sea level for the Black and Azov Seas**, which is in line with global estimates.



The flood hazard areas were modelled based on an analysis performed using Shuttle Radar Topography Mission Digital Elevation Model (SRTM DEM), an open digital terrain model. For flat terrain areas of Ukraine, data precision falls in the range of 10 meters, which is close to the accuracy of measurements made using topographic maps plotted in a scale of 1 to 50,000 that are normally recommended for the purposes of preliminary calculations in the planning of projects at the regional level. SRTMs were therefore used to attain the main goal of the research — to conduct the preliminary risk analysis and to report the problem.

Following the modelling, two flood hazard areas were obtained:

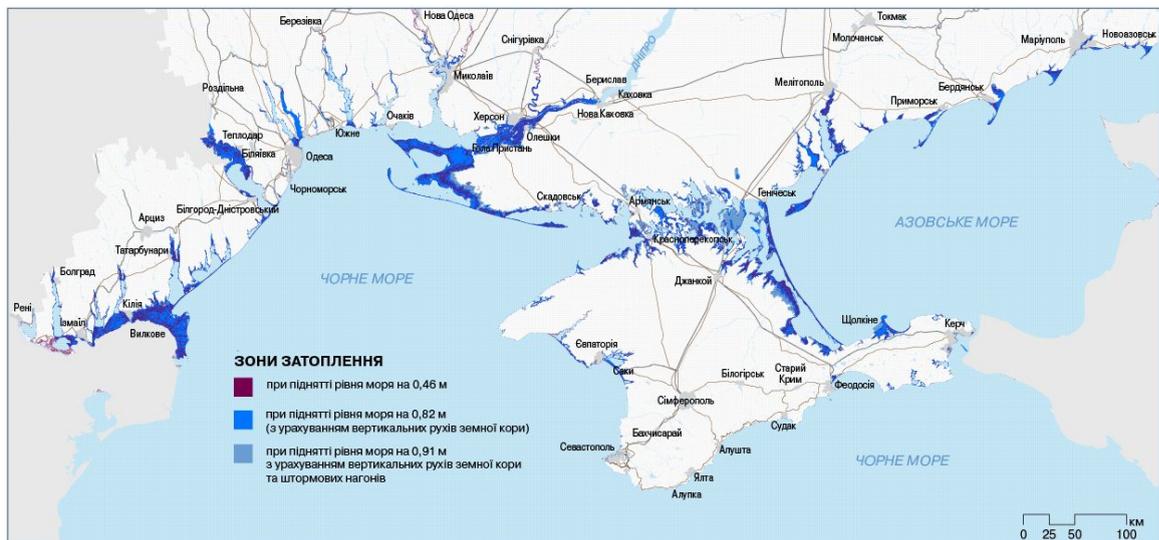
- **Area I**, which is persistent in its nature with a conditionally stable water level. The area is modelled based on the highest valid value of global sea level rise — **+ 82 cm annually by 2100 in accordance with the highest greenhouse gas emissions scenario**. This value is adjusted by and consistent with a map reflecting current crustal movements and surface up and down movements and stable surface areas.
- **Area II**, which is seasonal in its nature, results in short-term fluctuations (rising) in sea level. Values (both observed and estimated) of surge events are quite different between survey points at the Black and Azov Seas. The flood hazard area is calculated using maximum surge values: **+ 91 cm at the Black Sea coast and + 79 cm at the Azov Sea coast**.

Accordingly, if global sea level rise forecasts for 2100 are well substantiated, the aggregate short-term rise in water level **would exceed the existing level by 223 cm** driven by surge events in certain areas of the Black Sea coast.

Coastal territories in the South of Ukraine will suffer intensive impacts from sea level rise. The calculations performed suggest that territories with a total area of approximately 1.5 m ha (of which 800,000 ha are territories without any water bodies) or up to 1.8 m ha (approximately 1.1 m ha without any water body) if sea surge effects are taken into account will be flooded by 2100. Crimea (the northern part of the peninsula), the Kherson Region (territories between the Dnipro Estuary and the Tendra Gulf), and the Odesa Region (the Danube Delta) will be affected the most.

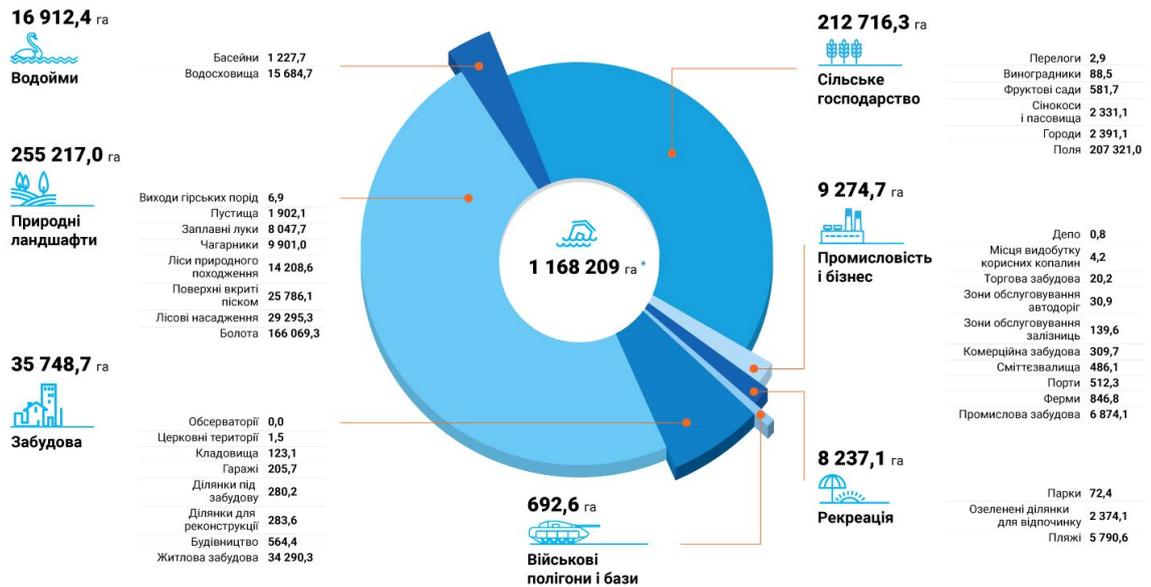
Potential flooding impacts were determined using data from OpenStreetMap (OSM) and other open sources. OSM proved to be the easiest to access and the most complete information source compared to others. Data of the State Land Cadastre, the State Cartographic Fund, local development plans, and urban planning documents are difficult to access both in organizational and technical terms, and do not allow for a smooth cover of the coastline. Given that OSM is a volunteer, crowd-funding project, it is impossible to obtain geodata for the entire territory covered by the research with necessary level of territory mapping precision. Volunteers engaged in the implementation of the project managed to fill the 'gaps' to the maximum extent

possible and corrected measurement errors in respect of the potential flood hazard area. However, there still remain unidentified territories that were omitted from the analysis.



## SEA LEVEL RISE IMPLICATIONS FOR UKRAINE

### Структура затоплених територій щодо землекористування загалом

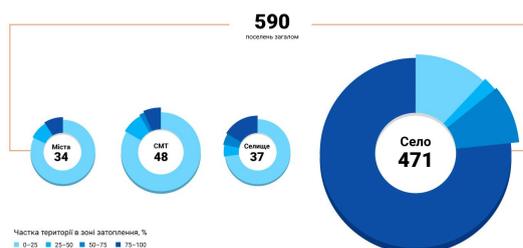


\* Без урахування великих водойм та територій, по яких дані відсутні

### Population and populated areas

In southern Regions of Ukraine, population is primarily concentrated near coastal cities in the north Black Sea region and the southern coast of Crimea. The social and economic sectors will face serious problems with potable water, droughts, intensification and increased occurrence of violent weather events such as storms, hurricanes, and floods, that will accelerate erosion processes at the coastline. Global warming will also affect coastal and marine ecosystems serving as livelihoods for population in these regions. All this worsens the direct impact — potential flooding of certain regions as a result of sea level rise and surge events that would lead to the displacement of population and the reconstruction of infrastructure and cities.

#### Аналіз площ затоплення територій населених пунктів

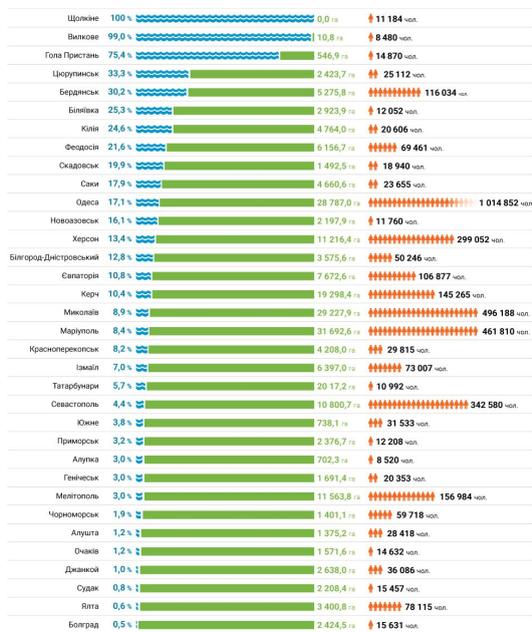


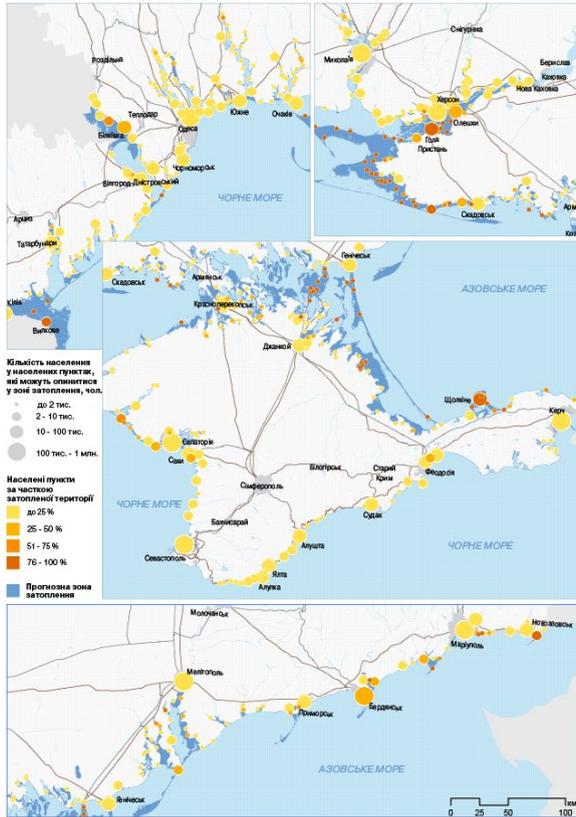
The forecasted flood hazard zone will cover, either in full or in part, **590 populated areas**, including **62 villages** and **six cities and towns** that could be entirely covered by the estimated flood hazard area (Vylkove, Hora, Shcholkinе, Sedove, Zatoka, and Lazurne)

**34 cities** are at risk of flooding (a part of their territory could be flooded), including Odesa, Kherson, Mykolaiv, Mariupol, Berdiansk, Melitopol, and Kerch.

The number of population residing in populated areas that are at risk of flooding (with a share of territory that could be flooded of 75 to 100%) exceeds **75,000 people**.

**Аналіз площ затоплення території населених пунктів.**  
Міста у зоні затоплення

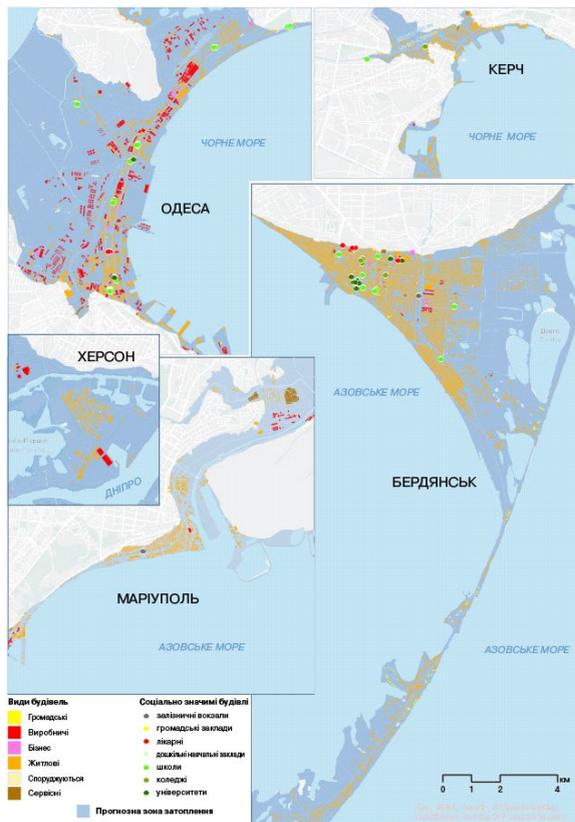




*Number of population residing in populated areas that are at risk of flooding*

**Buildings and important social facilities**

A total of **approximately 52,000 buildings** are at risk of flooding with 13,587 buildings in the Zaporizhia Region, 10,082 buildings in the Odesa Region, 8,862 buildings in the Kherson Region, 7,532 buildings in the Donetsk Region, 3,592 buildings in the Mykolaiv Region, and 8,181 buildings in the Autonomous Republic of Crimea. The major share of these are various residential buildings. 47,000 various residential buildings will be flooded. Important social buildings that are at risk of loss include 52 schools, four preschool facilities, 11 universities (including premises of the Berdiansk State Pedagogic University and the Odesa University of the Ministry of Internal Affairs), 13 hospitals, and six railway and bus stations.



*Buildings and important social facilities (as exemplified by certain cities)*

### **Infrastructure**

Failure to comply with land use regime in protected coastal areas such as illegal development and agriculture significantly increase threats associated with coast destruction. It should be noted that protected areas have been suffering intensive development these recent years. Increased levels of ground waters will reduce the lifetime of non-flooded buildings and infrastructure, and will affect the quality of waters used for commercial and household purposes.

The transport infrastructure will lose 5,500 km of hard-surface roads, including 213 km of international roads and 105 km of national roads. 850 km of railways are at risk of flooding. Electrical power networks will suffer a significant loss with approximately 700 km of power transmission lines to be destroyed.



### *Roads, railways, and power transmission lines that are at risk of flooding*

The flood hazard area also covers various stations (15 stations, six railway stations, one bus station and one depot) and 53 ports, including the Odesa, Mariupol, Berdiansk, Kerch, Ochakiv and Feodosiia Commercial Sea Ports, the Chornomorsk Sea Port, the Yuzhnyi Sea Port and others, including river ports and port stations in Mykolaiv, Izmail, Kiliia, and Reni.



### *International and national roads, ports, stations and terminals*

## **Economy**

Economy of southern Regions will incur significant losses and damages. Approximately 200,000 ha of agricultural land, more than 40,000 ha of forest land, and almost 10,000 ha of industrial land with 1,917 commercial and production buildings will be flooded.

The North Crimean Channel is also at risk of flooding. The potential flooding threatens to the Black Sea Shipyard, the Feodosiia Marine Engineering Plant, Zalyv Shipyard, Dzerzhynskiy Steel Works, Azovstal Iron and Steel Works, etc.



(Chornomorskyi District, Crimea), Mirmekii (Kerch, Crimea), Borysfenida village on the Berezan Island, the most ancient Greek settlement in the North Black Sea region (Mykolaiv Region), etc.



### *Recreation and entertainment infrastructure*

#### **Environmentally hazardous sites**

Facilities that are, according to the forecast, at risk of flooding, include 626 environmentally hazardous sites that require a special attention. This category includes industrial sites (455), a depot (1), ports (12), waste disposal sites (13), water treatment facilities (36), cemeteries (59), military bases and military training centres (85), which, if flooded, could result in the contamination of sea waters with pollutants and affect the environmental condition of adjacent territories.

The most hazardous sites that are at risk of flooding include Azovstal Iron and Steel works, which is ranked among TOP-100 air polluters in Ukraine, acid settlers at Krymskyi Tytan plant that already caused an environmental disaster in the North of Crimea, port oil terminals, etc.

#### **Natural landscapes and conservation sites**

Among natural landscapes a special attention should be brought to aquatic landscapes such as water bodies and water courses affected by sea level rise. The largest water courses exposed to risks include river courses of the Danube, Dnipro and Dniester rivers (including numerous lakes, dead stream branches and branches in deltas), the Dnipro-Buzkyi, Dnistrovskyi, and Sasyk (Kunduk) Estuaries, the Tuzla Estuary Group, the Khadzhybei, Kuialnyk, Tilihul, Molochnyi Estuaries and others, Lakes of Kahul, Kuhurlui-Yalpuh, Katlabuh, Kytai, Sasyk-Syvash and others. There is a total of **approximately 5,000 various water bodies**.

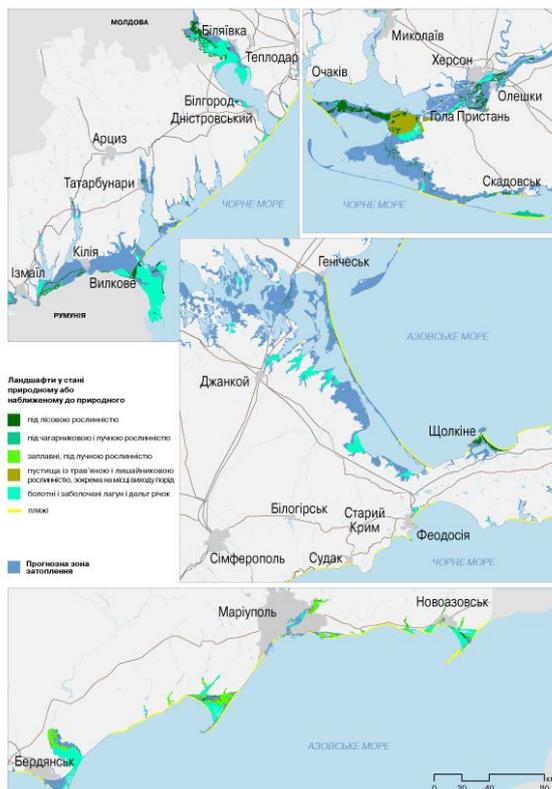
Ecosystems that undergo significant transformation as a result of flooding and saturation should also include wetlands, inducing **13 wetland sites of international importance** protected by the Ramsar

Convention. They include, in particular, Aquatic-cliff complex of Cape Kazantyp, Tendrivska Bay, Eastern Syvash, Bilosaraiska Bay and Bilosaraiska Spit, Obytochna Spit and Obytochna Bay, etc.

Sea level rise would adversely affect other sea coast natural landscapes. In particular, at risk are estuary ecosystems in the North Black Sea region, sand splits of the Azov Sea, Syvash bays, many harbours along the coast, and marine ecosystems. Most of them represent sites protected by the Bern Convention on the Conservation of European Wildlife and Natural Habitats and require special protection and conservation measures.

The Black and Azov Seas' coasts, which are at risk of flooding caused by sea level rise, serve as habitats for many endemic species of flora and fauna that do not occur in any other place in the world and are on the Ukrainian endangered species list. Sea coast community habitats are also important resting places for dozens of rare migrating birds during their travels from the North to the South.

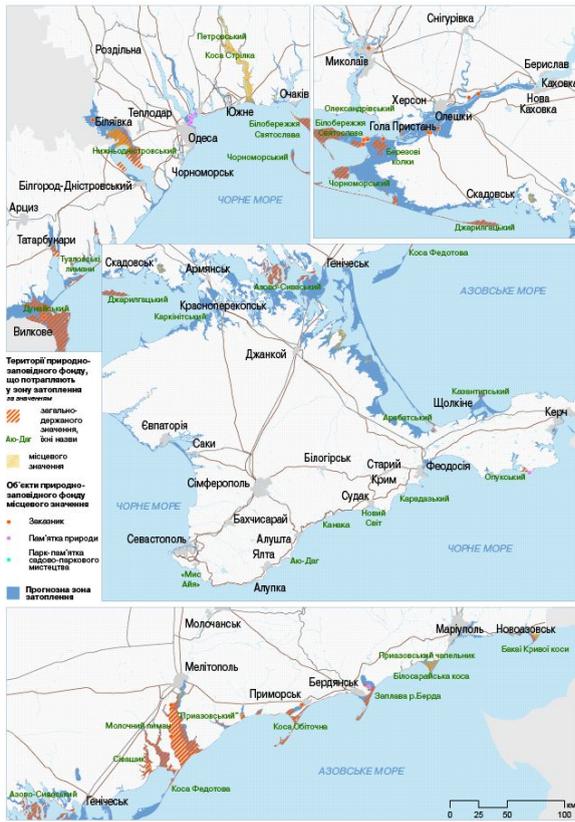
Anthropogenic pressures such as unregulated recreation, development, agriculture and industrial exploitation of the coast area will to a significant extent limit the ability of these ecosystems to adapt to climate change and sea level rise.



### *Landscapes in natural and nearly natural conditions*

Such a high level of biodiversity requires the creation of many conservation sites in the coastal areas of the Black and Azov Seas. Most of them are, whether fully or partially, at risk of expected flooding. A total of **98 conservation sites**, including two biosphere reserves, four natural reserves, and seven national natural parks, are at risk of flooding.

A special focus should be placed on **31 sites of Ukraine's Emerald Network** that are at risk of flooding as a result of sea level rise.



*Sea level rise impacts on the conservation sites in the South of Ukraine*

## CONCLUSIONS AND RECOMMENDATIONS

The findings of this research show that sea level rise driven by climate change could seriously affect the Ukrainian coastal areas. Coastal territories in the South of Ukraine will suffer intensive impacts. The calculations performed suggest that territories with an area of approximately 1.5 m ha (of which 800,000 ha are territories without any water bodies) and up to 1.8 m ha (approximately 1.1 m ha without any water body) if sea surge effects are taken into account will be flooded by 2100. Crimea, the Kherson Region, and the Odesa Region will be affected the most.

This publication considers the worst case scenario providing for the most critical consequences corresponding to rise in global temperature by 4 °C by 2100 and a 1-m increase in sea level. This scenario will materialise unless the countries significantly raise their greenhouse gas emission-cutting commitments. However, research findings show that all the countries in the world should actively take measures to phase out fossil fuels and to shift to 100% renewable energy by 2050 if we want to limit global temperature rise to 1.5 to 2 °C. If we stay on the track of the 1.5 to 2 °C warming, sea level rise will be a third as much compared to the warming by 4 °C.

Climate change and the resulting sea level rise are problems that now require active actions at all levels – international, national, and local. The Paris Agreement, as ratified by Ukraine in 2016, provides for two mutually reinforcing solutions to address global warming, which solutions relate to the taking of mitigation and adaptation measures.

The first approach is based on the development of greenhouse gas emission-reduction mechanisms and is the first step towards addressing climate change and its implications.

Among policies Ukraine should determine **to mitigate climate change (to reduce greenhouse gas emissions)** a special attention should be brought to:

- **Setting an ambitious greenhouse gas emission-reduction goal, in particular, submitting an intention to revise its Nationally Determined Contribution (NDC) under the Paris Agreement as soon as possible.** Ukraine's emissions will increase nearly twofold with the current goal. There is, however, no economic rationale for such weak commitment given that the government's Strategy for Energy Development until 2035 provides for reduction in emissions to the 2010 levels and decrease in the share of coal with parallel increase in the share of renewable energy (RE) up to 25%.
- **Adopting national or regional policies on the energy sector shifting to 100% renewables by 2050,** which will allow for a significant reduction in greenhouse gas emissions. The economic and technical feasibility of the transition has been proved by a number of studies conducted by Ukrainian and international research and public organisations. In 2018, four Ukrainian cities — Zhytomyr, Chortkiv, Lviv, and Kamianets Podilskyi — announced their decisions to shift to 100% renewable energy by 2050.
- Increasing the funding of national and regional energy efficiency programmes, especially in the housing sector, up to one per cent of the total budget allocations, and proceeding with the **energy efficiency** improvement reform; gradually raising energy consumption standards for new buildings and ensuring control of compliance with such standards.
- **Abandoning subsidies for fossil fuels** and securing instead a national policy towards ongoing support of energy efficiency and clean technology development.
- Supporting emission-reduction measures as contemplated by the **Low-Carbon Energy Development Strategy** as part of a scenario entitled 'Energy Efficiency, Renewable Energy Sector, Modernisation and Innovations, and Market and Institutional Transformation,' which will allow for a 71% reduction in emissions by 2030 compared to the 1990 levels.
- Introducing **market mechanisms to reduce greenhouse gas emissions** (Emission trading schemes (ETS) for large polluters and/or the Carbon Tax (CT) for other types of polluters) while ensuring the proper use of accumulated budget funds designated for taking greenhouse gas emission-reduction

measures). Both tools should be implemented in parallel and must be tied together. It is necessary **to raise the carbon tax rate**<sup>85</sup>, which will encourage industrial business to cut their emissions.

- Imposing a differentiated tax on greenhouse gas emissions from private cars to collect money from polluters and to promote purchases of cars with low or medium greenhouse gas emission levels;
- Increasing allocations from the state and local budgets for the development of public transport and bicycle infrastructure;
- Ensuring **the training of skilled personnel** that will be able to operate the new emission reduction system and to work in the energy efficiency, renewable energy and related sectors.
- Ukraine should **actively and publicly participate in international negotiations on climate change**. As one of the first countries that ratified the Paris Agreement, Ukraine should take climate leadership and further encourage other states to raise their emission reduction ambitions, and promote international cooperation on climate change.
- At the local level — **developing and implementing local greenhouse gas emission reduction plans**. In particular, cities can be encouraged to, among other things, actively participate in the Covenant of Mayors. Parties to the Covenant develop Sustainable Energy and Climate Action Plans (SECAP) that contain planned measures and actions to reduce CO<sub>2</sub> emissions by at least 40% by 2030.

The abovementioned measures will allow for reduction in greenhouse gas emissions, but the issue of **adaptation to climate change** is equally pressing. These recommendations are primarily purported to make this issue relevant and to prepare the planning of research and adaptation works at both national and regional levels.

#### **At the national level:**

- To develop a national **Strategy for Coastal Areas Adaptation to Climate Change** subject to forecasted sea level rise for Ukraine and resulting possible implications, and to develop an Adaptation Action Plan for Coastal Territories of Ukraine;
- To develop **sectoral strategies for concerned industries** (industry sector, agriculture, tourism, etc) **adaptation** to forecasted implications of sea level rise.
- To develop a precise plan for implementation of Section 3.6 of the Action Plan for implementation of the **Concept of Implementation of the State Policy on Climate Change for the Period until 2030**: ‘ensuring the planning of construction and renovation of civil, industrial, engineering and transport facilities at the Black and Azov Seas subject to forecasted flood hazard maps under different global sea level rise scenarios’;
- To approximate relevant regulations to those of the EU: Under the EU Association Agreement, Ukraine committed to develop the state policy on marine environment protection in accordance with the European principles. In particular, Ukraine is required to consider the issue of sea level rise when developing the national **Marine Strategy** as part of implementation of the EU Marine Strategy Framework Directive;
- To develop mechanisms of reservation and withdrawal of land for the purposes of restoration of natural ecosystems in sea coastal areas;
- To allocate state funding for more detailed **research into forecasted sea level changes** based on more precise sea coast landscape maps; to ensure regular updates of such forecasts using updated international and local data, models, and instruments; and to make forecasting deliverables easily and freely accessible;

- To establish a **specialized research institution** that would conduct targeted research involving the forecasting of hydrometeorological and environmental conditions of the Black and Azov Seas, physical oceanography and ecology of marine and river systems using modelling techniques, and represent the interests of Ukraine before international research programmes;
- **To create a detailed digital terrain model (DTM)** for territories that are at risk of potential flooding; to provide free access to data; **to update digital topographical models (DTMs)** for territories that are at risk of potential flooding and to keep them updated;
- To raise **awareness of governmental experts** responsible for making decisions on regional development about possible risks associated with sea level rise;
- To ensure that **risks are highlighted in educational programmes** of higher education establishments for relevant specialities; and
- To hold a **meeting of the Interdepartmental Commission on Implementation** of the UN Framework Convention on Climate Change to submit the deliverables of the research.

#### **At the regional level:**

- To conduct **research into**, and to make **forecasts of, changes in sea level rise for the coastal area of a specific region** while taking into account local factors such as aspects of the geomorphic structure, land drainage, barriers, microclimate, etc; to regularly update forecasts; to use updated international and local data, models, and instruments as part of forecast updating; and to make results freely accessible;
- To consider risks arising from sea level rise **in spatial planning as part of the development of draft plans** for development of territories of regions, districts, or consolidated local communities (CLCs);
- **To raise awareness** of experts of regional administrations responsible for decision-making in development planning about potential risks; **to introduce the process of reporting** risks to visitors of museums and national parks as part of permanent programmes, exhibitions, and tours; to raise **awareness of reporters** about potential risks and to ensure that such risks are highlighted as part of educational and information regional events and in national and regional public media.