

Climate Change Impacts and The Need for Adaptation

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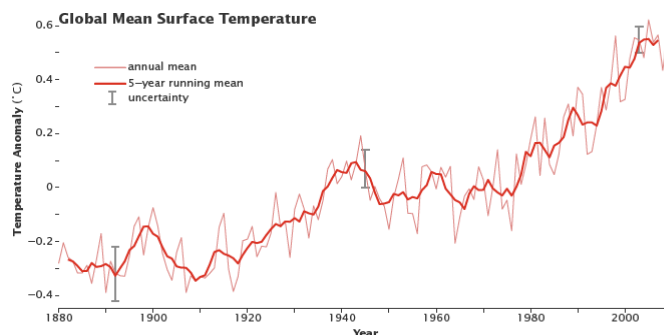
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As increased greenhouse gas concentrations drive temperature increases, and subsequent sea level rise, the frequency and intensity of extreme weather events is projected to increase – from heat waves, droughts and forest fires to floods, storms and heavy precipitation. These changes will in turn impact wildlife and flora, with natural habitats changing faster than species can adapt, leading to the extinction of certain species and/or the spread of invasive alien species¹³. The physical impacts of climate change will greatly vary from one region to another, depending on the existing local geographical conditions such as coasts, forests, mountains or urban areas. Some regions of Europe will experience more rapid changes than others and each region will be faced with different types of extreme weather events. Provides an overview of the different impacts of climate change by type of region in Europe. Broadly speaking, the main climate hazards and physical impacts associated with climate change are

Temperature increases

Average global temperatures have increased since the 19th century around the globe, raising the number of warm days and nights per year. This in turn brings more extreme weather events such as heat waves, extreme heat and even more frequent wild and forest fires the survey conducted among the LRAs for this study highlighted temperature increases as the most frequently physical impact of climate change already being experienced at local level.



Changes in Precipitation

One of the consequences from higher temperatures is that patterns in precipitation are changing. This translates in more frequent occurrence of extreme events such as droughts, floods, storms and heavy rainfall/ extreme precipitation or even landslides. LRAs responding to the survey indicated that changes in precipitation, extreme rainfalls, coastal storms and flooding are the second most frequently experienced phenomena. North-Western and Central European regions are expected to experience more frequent heavy precipitations and floods, as Southern regions will face more droughts. However, these impacts may also vary within the regions or over time, with periods of heavy precipitation followed by periods of water scarcity within the same region.

Melting ice cover

As a result of higher average temperatures, ice sheets, glaciers and permafrost are losing mass globally. In Europe, this translates in negative impacts primarily for the Arctic and mountainous regions. The latter will be hit particularly hard by climate change, as they are expected to experience a much higher increase in temperatures than the global average. This is projected to lead to very specific issues linked to decreasing snow levels and

mountain permafrost areas along with the extinction of local species (especially in the Alpine regions)

Rising sea levels

As a result of thermal expansion and glacier loss, sea level has risen since the beginning of the century, with higher average levels observed since the increases the risks of coastal erosion and flooding putting in danger coastal regions in particular. Most Coastal European regions are expected to experience more frequent coastal flooding and coastal erosion, linked to the rise in sea level and storm surges.



Indirect impacts

The above-mentioned climate change impacts could be heightened in urban areas as the built environment and high soil sealing create unique microclimates. This can affect air temperatures, wind direction and precipitation worsening the risks of, for example, heat waves and urban floods. In addition, the combination of changes, especially to temperature and precipitation, could alter the life cycles of different species and facilitate the spread of invasive alien species, pests, vector-borne diseases (i.e. those spread by insects, ticks, parasites etc.) or disease pathogens to new geographical areas. This in turn poses significant risks to plant, animal and human health

Socio-economic impacts

The physical impacts of climate change have very diverse socio-economic consequences that

differ by sector and region. Even within the same local area or region the same climate change impacts can be experienced very differently across sectors and social groups. Although, it is difficult to provide an exact mapping of all possible socio-economic impacts of climate change, examples of impacts in key sectors relevant for European LRAs include:

Health and social vulnerability

One of the main pathways through which climate change is going to affect economic systems is through impacts on human health and social vulnerability. In particular, climate change is likely to cause various health and safety risks such as: illnesses and mortality due to heat waves or cold spells; mortality, chemical hazards and poisoning due to extreme weather events, floods or wild fires; new illnesses and spread of communicable diseases due to changing patterns in the activity of pathogens, viruses and parasites.

Pathways through which climate change can contribute to the spread of diseases include:

- Air-borne diseases: Increased humidity could increase the risks of lower respiratory tract infections;
- Food-borne diseases: Higher ambient temperatures increase the replication cycles of pathogens for food-poisoning
- Water-borne diseases: Extreme precipitation can increase the risk and the amount of pollutants entering recreational coastal waters as well as overwhelm urban water treatment plants and raise the risk of disease outbreaks in the drinking water distribution systems;
- Vector-borne diseases and pathogens: Climate change can alter the life cycles of vectors and the reproduction rate of parasites

and viruses, reducing incubation periods and increasing transmission risks. Long-term seasonal changes can influence vector, animal and human activity and further affect the spatial-temporal distribution of diseases.

Agriculture, forestry and aquaculture

In the agriculture, forestry and aquaculture sectors, climate change is likely to affect crop yields, species reproduction and growth, water availability and the pathways for invasive alien species, diseases and pathogens. While these changes could bring about positive outcomes in some regions by allowing the growth of new species or extending crop periods, they could reduce productivity in other areas. The economic consequences of these changes include fluctuations in food prices, farm incomes and overall food security at regional, national or even global level. In line with this, the survey found that losses stemming from impacts on agriculture is the second most frequently mentioned socio-economic impact of climate change.

Energy

In the energy sector, a changing demand for energy is likely to be one of the main impacts of climate change. Temperature extremes can affect both the amount and periods for heating and cooling energy demand. Reduced water availability could affect the amount of power produced by thermal power generation (for example, fossil fuel, biomass or nuclear power plants rely on large quantities of water for cooling and their production could be interrupted due to water shortages). Combined, these shifting patterns for energy demand and supply can create risks for the overall stability of electricity networks during peak demand periods. Moreover, extreme weather events could cause physical damage to energy infrastructure resulting

in power cuts or safety hazards that can in turn jeopardise operations in other sectors of the economy.

Transport

Physical damages to infrastructure following extreme events are also a likely impact in the transport sector. Other impacts stemming from rising temperatures and heat waves would be problems of rail buckling and pavement deterioration. Such damage to the road, rail, water and air transport infrastructure could in turn disrupt the flow of goods and passengers with corresponding economic consequences across sectors and regions, especially if international transport networks are affected.

Tourism

Tourism is highly likely to be impacted by climate change. Rising temperatures, heat waves, sea level rise and coastal erosion could reduce the size of beach tourism in traditional European destinations (for example, Mediterranean). Similarly, changes in snow availability and higher temperatures could cause shrinkages in the size of ski tourism in traditional destinations (for example, the Alps). These impacts could result in the shift of these types of tourism to new locations or different periods of the years or give way to new types of tourism³⁷. For instance, mountainous areas at lower altitudes that experience shorter ski seasons are expanding the opportunities available for other touristic activities such as camping, mountain climbing or hiking.

Construction, housing and infrastructure

Some of the main competences of LRAs relate to the development of local infrastructure and land use. As a result of climate change construction is likely to see delays and increased costs following fluctuating weather conditions and extreme events

such as floods or landslides. Furthermore, building material requirements and construction codes are likely to evolve to address the changing weather conditions as rebuilding and repair demand might grow.

Water management and services

Although the impacts of climate change on sectors such as manufacturing or services

(particularly those other than tourism or health services) are less studied, they are likely to be the consequences of changes in primary economic activities such as labour productivity and energy demand or disruptions to transport networks. These changes could result in fluctuations of prices and qualities for manufacturing inputs, higher production costs as well as disrupted supply chains or interruption of services.

Adaptation measures

Table 1: Examples of the main climate hazards and potential adaptation measures

Climate Hazard	Potential adaptation measures
Increased temperatures and heat waves	Grey measures: <ul style="list-style-type: none"> - Cooling of indoor public spaces: improving thermal insulation, vertical greenery, shading of transparent openings, windows and displays, green/reflecting roofs. Green measures: <ul style="list-style-type: none"> - Increase and revitalization of green areas, parks and fountains in cities, notably to increase shade Soft measures: <ul style="list-style-type: none"> - Assessments of vulnerability to high temperatures - Heat-wave action plans (such as toll-free information and assistance numbers, meal delivery and home care)
Forest and wildfires	Green measures: <ul style="list-style-type: none"> - Agroforestry (a combination of trees and crop cultivation) can help reduce forest fires as it removes the dry vegetation most prone to fire at ground level. Soft measures: <ul style="list-style-type: none"> - Vulnerability assessments - Early warning systems
Droughts	Grey measures: <ul style="list-style-type: none"> - Improve irrigation systems in agriculture Green measures: <ul style="list-style-type: none"> - Water retention spaces in the form of decentralized lakes and ponds - Increase green areas in cities, which absorb and retain water Soft measures: <ul style="list-style-type: none"> - Early warning systems - Awareness raising on water consumption
Extreme precipitation and floods	Grey measures: <ul style="list-style-type: none"> - Sustainable drainage systems - Dikes and dams - Widen roadside ditches - Reduce and open sealed surfaces (i.e. artificial, impenetrable surfaces like tar) Green measures:

	<ul style="list-style-type: none"> - Green areas, green roofs, to help absorb excess water - Floodplain and wetland restoration <p>Soft measures:</p> <ul style="list-style-type: none"> - Early warning systems (assessing vulnerability and predicting floods)
Landslides	<p>Soft measures:</p> <ul style="list-style-type: none"> - Vulnerability assessments - Early warning systems
Permafrost and ice melting	<p>Grey measures:</p> <ul style="list-style-type: none"> - Maintenance and restoration of mountain cliffs <p>Green measures:</p> <ul style="list-style-type: none"> - Increase pastures and green spaces, which help regulate temperatures <p>Soft measures:</p> <ul style="list-style-type: none"> - Permafrost and glacier monitoring - Vulnerability assessments - Early warning systems - Promotion of insurance for inhabitants of risk-prone areas - Car free tourism / sustainable tourism
Coastal erosion	<p>Grey measures:</p> <ul style="list-style-type: none"> - Artificial dunes & dune rehabilitation - Seawalls - Sea dikes - Beach nourishment <p>Green measures:</p> <ul style="list-style-type: none"> - Wetland restoration <p>Soft measures:</p> <ul style="list-style-type: none"> - Assessment/ mapping of future erosion
Sea level rise and coastal flooding	<p>Grey measures:</p> <ul style="list-style-type: none"> - Flood barriers - Relocation of infrastructure to higher altitudes <p>Green measures:</p> <ul style="list-style-type: none"> - Restore and maintain wetlands, which can act as buffers <p>Soft measures:</p> <ul style="list-style-type: none"> - Vulnerability assessments - Include rising sea levels in future urban planning
Invasive alien species	<p>Grey measures:</p> <ul style="list-style-type: none"> - Underwater suction devices (to absorb invasive algae) <p>Green measures:</p> <ul style="list-style-type: none"> - Crop rotations to revitalize soils and prevent pest infection - Introduction of natural predators (like mollusks for algae), with caution on potential unwanted negative consequences <p>Soft measures:</p> <ul style="list-style-type: none"> - Identify the most problematic species - Track movements of species and put in place early warning systems
Diseases and pathogens	<p>Soft measures:</p> <ul style="list-style-type: none"> - Identify the most problematic vectors and pathogens - Track movement of vectors and pathogens and put in place early warning systems - Raise awareness and provide information on prevention measures

Table 2: Effect of climate changes on climatological variables

Higher maximum temperature, more hot days and heat waves	<ul style="list-style-type: none"> • Increased incidence of serious illness among elderly, children, the poor • Increased heat stress in livestock • Increased risk of damage to both monsoon and dry season crops • Increased crop pest and diseases • Increased energy demand and reduced energy supply reliability
Higher minimum temperature, fewer cold days, and cold waves	<ul style="list-style-type: none"> • Decreased cold-related human mortality • Decreased risk of damage to a number of crops • Increased risk to crops such as wheat and chickpea • Increased activity of some pest and diseases vectors
More intensive precipitation events	<ul style="list-style-type: none"> • Increased chances of local flood • Increased soil erosion • Increased loss of topsoil and nutrients • Increased pressure on relief
Increased monsoon precipitation variability	<ul style="list-style-type: none"> • Frequent dry spells during monsoon season • Extended dry spells and drought
Increased summer drying and associated droughts	<ul style="list-style-type: none"> • Decreased crop yields • Decreased water resources (quantity and quality) • Decreased surface water resources in rivers, tanks, ponds, etc. • Declining groundwater resources due to over exploitation
Increase in nor'westers during summers and peak wind intensities	<ul style="list-style-type: none"> • Increased risk to human life • Risk of infectious disease epidemics • Increased risk of wind-related damage
Increased incidence of events such as hail storms and whirlwinds	<ul style="list-style-type: none"> • Wind-related damage • Damage to irrigated summer crops • Damage to fruit trees such as mango and jack fruit

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