The RESIN Adaptation Options Library

Here, we set out the background to the library and how it may be useful to you in your work on climate change adaptation. Please read this if it is your first time using the library.

Detailed information of each type of information tab:

GENERAL shows the basic information (e.g. co-benefits, hazard, type, region etc.). Co-benefits indicate if the group or the measure has effect in different hazards or if it has additional benefits that are not analysed in the Library (e.g. effects on the energy consumption, biodiversity, etc.)

COST gives the quantitative economic performance: benefit cost ratio (BCR). If the BCR is higher than 1 then the measure or group is beneficial. If the BCR is lower than 1 then the measure or group is costly. Comments are also displayed to help interpreting the cost-efficiency. At measure level the average (avg), minimum (min) and maximum (max) cost-efficiency are presented. These statistics are calculated with the information hosted in the studies level (at study level the user will find a unique BCR value). The number of studies and number of papers represent the amount of literature reviewed and for which the information is extracted (gives an idea of the material that supports the efficiency numbers). At study case level, the all components that are used for the BCR calculation are presented: direct investment costs (investment expenditure, annual operating and maintenance costs and costs of administrative implementation of adaptation measures), indirect costs, overall benefits (monetary, environmental, social, health). For each component the time horizon (identifies the number of years over which results are considered) and the discount rate (identifies whether and at what rate, results have been discounted) is also presented. All the data at this level are expressed in US$ 2015.

HEAT gives the quantitative environmental performance: effectiveness (e.g. how much the air temperature is reduced thanks to an adaptation measure). If the effectiveness is positive, then the measure or group is effective. If the effectiveness is negative, then the measure or group is not effective. However, it should be highlighted that the performance of the measures depends on a wide range of local factors. Thus, the given figures should be taken as guidance values. The two most important elements of the effectiveness are the VARIABLE (e.g. air temperature) and UNIT (e.g. ºC) in which this is assessed. As in the cost layout, at measure level the average, minimum and maximum effectiveness are presented. At study case level, the components that are important for the effectiveness calculation are presented: scenario (the scenario that are compared for the effectiveness calculation are explained: negative scenario vs positive scenario); the time horizon shows the time frames in which the effectiveness is measured (the effectiveness will be different depending the time frame); Type describes the dimension of the measure, classifying in different types of measures (Huq, I.R., S. et al., 2014) (e.g. Ecosystem Based Adaptation); Scale is the implementation scale of measure (e.g. building, street …); Region refers to the Climatic region(s) to which the option is applied, each region has similar climate change characteristics and derive from a cluster analysis of 8 climate change variables (ESPON, 2011) (e.g. Mediterranean); Location is the place where the study has been carried out (e.g. London); Authors name the author(s) of the study or work analysed and the publication year.

FLOOD gives the quantitative environmental performance: effectiveness (e.g. how much the runoff is reduced thanks to an adaptation measure). As in heat, if the effectiveness is positive, then the measure or group is effective. If the effectiveness is negative, then the measure or group is not effective. However, it should be highlighted that the performance of the measures depends on a wide range of local factors. Thus, the given figures should be taken as guidance values. At measure level the average, minimum and maximum effectiveness are presented. At study case level, the components that are important for the effectiveness calculation are presented: scenario (the scenario that are compared for the effectiveness calculation are explained: negative scenario vs positive scenario); the rainfall is the amount of rainfall simulated for the effectiveness assessment (the effectiveness will be different depending the rainfall amount); Type; Scale; Region; Location; Authors.

VULNERABILITY gives quantitative information regarding vulnerability (defined as 'the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard' (UNISDR 2009) of the adaptive measures. Low values of 'Sensitivity' represent low susceptibility to the effect of a hazard and therefore low vulnerability, on the contrary, high values of sensitivity indicate high susceptibility to a given hazard. In this tab 'Capacity' represents how much a given measure contributes to increase the adaptation capacity, which will help to reduce the risk towards a hazard. At measure level the average (avg), minimum (min) and maximum (max) of 'Capacity' and 'Sensitivity' are presented. At study case level additional information is given such as type, scale, region, location and authors.

ORGANISATION provides information related to the parties involved (responsible stakeholders, external stakeholders, beneficiaries, target stakeholders) and the easiness of implementation of a measure, given as, feasibility and barriers of the implantation and maintenance of the adaptation option. At measure levels the number of cases and number of paper are listed. At study case level, the above-mentioned information is gathered plus the type of funding used to implement the action, the parties involved, and general information such as the hazard, scale, region, type etc.

General overview of Hazards

Heat

Temperatures across Europe are rising. Over recent decades, warming has been particularly strong over the Iberian Peninsula, central and north-eastern Europe and mountainous areas (EEA 2017). Herring et al (2013) identified that climate change has 'greatly increased' the risk of extreme heatwaves occurring'. There is no universal standard definition of a heatwave, although they are generally regarded as periods of extremely high temperature that exceeds a certain threshold for a set number of days (the threshold can be defined though the percentile: three-day running maximal temperature exceeds the thresholds of the 95th percentile, AEMET).

The library groups the adaptation measures that can reduce heat into 15 themes which are further split into 45 specific adaptation measures. The effectiveness of each measure is given in different variables. Across the literature, the most recurrent variables are:

Air Tº is the most recurrent category in the literature.

Mean radiant temperature (MRT) is a measure of the average temperature of the surfaces that surround a particular point, with which it will exchange thermal radiation. If the point is exposed to the outside, this may include the sky temperature and solar radiation. MRT is a better indicator for outdoor thermal comfort

Surface Tº refers to the temperature of surfaces in a specific space or element (pavement, building roof, etc.). The surface Tº can be a better method to determine the cooling effect of vegetation.

Fluvial Flood

River floods are a common natural disaster in Europe, and — along with storms — are the most important natural hazard in Europe in terms of economic damage. They are mainly caused by prolonged or heavy precipitation events and/or snowmelt. River floods can result in huge economic losses because of damage to infrastructure, property and agricultural land, and indirect losses in or beyond the flooded areas, such as production losses caused by damaged transport or energy infrastructure. They can also lead to loss of life, especially in the case of flash floods, and displacement of people, and can have adverse effects on human health, the environment and cultural heritage. Large areas throughout Europe have been affected by flooding since 2000, many of them even multiple times. According to the NatCatSERVICE database, almost 1 500 flood and wet mass movement events happened in EEA member countries in the period 1980–2013, with more than half of them since 2000. These floods have resulted in over 4 700 fatalities and caused direct economic losses of more than EUR 150 billion (based on 2013 values), which is almost one-third of the damage caused by all-natural hazards. Less than a quarter of these damages were insured (Source: EEA).

Global warming is projected to intensify the hydrological cycle and increase the occurrence and frequency of flood events in large parts of Europe. Overall, storm surge levels in Europe are projected to increase on average by around 15% by 2100 under a high-emissions scenario and climate change will result in higher seas not only driven by sea level rise, but also by increased storminess. (Source: Vousdoukas et al., 2016)

Pluvial Flood

Flooding is perhaps Europe's most high-profile climate change hazard due to the visible and damaging impacts that it creates. There are several main types of flooding that affect Europe, including flooding from rivers and streams (fluvial flooding), surface water flooding (pluvial flooding).

Pluvial flooding, which occurs when an extremely heavy downpour of rain saturates drainage systems and the excess water cannot be absorbed, is increasingly becoming a threat to European cities and urban areas. Indeed, Pluvial flooding (along with groundwater flooding) accounted for the highest number of recent flood events occurring since 2000 in Europe's Member States have produced maps for current exposure to this hazard, as reported under the Floods Directive (European Commission "Handbook on Flood mapping in Europe").

Sea Level Rise and Storm Surge

Changes in global mean sea level (GMSL) result from a combination of several physical processes. Thermal expansion of the oceans occurs as a result of warming ocean water. Additional water is added to the ocean from a net melting of glaciers and small ice caps, and from the disintegration of the large Greenland and Antarctic ice sheets. Further contributions may come from changes in the storage of liquid water on land, in either natural reservoirs such as groundwater or man-made reservoirs.

In Europe, the potential impacts of sea level rise include flooding, coastal erosion and the submergence of flat regions along continental coastlines and on islands. Rising sea levels can also cause saltwater intrusion into low-lying aquifers, thus threatening water supplies and endangering coastal ecosystems and wetlands. Higher flood levels increase the risk to life and property, including to sea dikes and other infrastructure, with potential impacts on tourism, recreation and transportation functions. Low-lying coastlines with high population densities and small tidal ranges are most vulnerable to sea level rise, in particular where adaptation is hindered by a lack of economic resources or by other constraints.

Damage associated with sea level rise is mostly caused by extreme events, such as storm surges. Of most concern are events when the surge coincides with high tidal levels and increases the risk of coastal flooding owing to extreme water levels. Changes in the climatology of extreme water levels (i.e. the frequency and height of maximum water levels) may be caused by changes in local mean sea level (i.e. the local sea level relative to land averaged over a year or so), changes in tidal range, changes in the local wave climate or changes in storm surge characteristics. Climate change can both increase and decrease average wave height along the European coastline, depending on the location and season.

Changes in storm surge characteristics are closely linked to changes in the characteristics of atmospheric storms, including the frequency, track and intensity of the storms. The intensity of storm surges can also be strongly affected by regional and local-scale geographical features, such as the shape of the coastline. Typically, the highest water levels are found on the rising limb of the tide. The most intense surge events typically occur during the winter months in Europe.

The most obvious impact of extreme sea level is flooding. The best known coastal flooding event in Europe in living memory occurred in 1953 when a combination of a severe storm surge and a high spring tide caused more than 2 000 deaths in the Netherlands, Belgium and the United Kingdom, and damaged or destroyed more than 40 000 buildings. Currently, around 200 million people live in the coastal zone in Europe, as defined by Eurostat. Coastal storms and storm surges can also have considerable ecological impacts, such as seabird wrecks, disruption to seal mating and pupping, and increases in large mammal and turtle strandings (EEA).

Drought

Large areas of Europe have been affected by droughts over the past 50 years, and pressures on European water resources have increased in the past decades.

Therefore, future conflicts between human requirements and ecological needs are likely to increase. These conflicts are most critical and intensify during severe and extensive droughts. The primary cause of any drought is a deficiency in rainfall, but also increased human demand for water is an important factor.

The main impacts of droughts include water supply problems, shortages and deterioration of quality, intrusion of saline water in groundwater bodies and increased pollution of receiving water bodies (i.e. there is less water to dilute pollutant discharges) and drops in groundwater levels. Droughts have major economic impacts.

The latest climate change scenarios suggest significant summer drying across many parts of Europe, especially in the south. These scenarios also suggest lower rainfall in other seasons and increased variability. These patterns of change suggest that over the coming decades Europe is likely to suffer more frequent meteorological droughts. This may be further exacerbated due to generally elevated temperatures increasing the demand for water (EEA).

Wind Storms

Wind storms are atmospheric disturbances that are defined by strong sustained wind. They can range from relatively small and localised events to large features covering a substantial part of the continent.

Wind storms can lead to structural damage, flooding and storm surges, which may be caused either by the wind itself, in particular short gusts, or by accompanying heavy precipitation. These events can have large impacts on human health and on vulnerable systems, such as forests, as well as transport and energy infrastructures (EEA Report No 1/2017).

The studies project the following (EEA Report No 1/2017):

- Recent studies on changes in winter storm tracks generally project an extension eastwards of the North Atlantic storm track towards central Europe and the British Isles.
- Climate change simulations show diverging projections on changes in the number of winter storms across Europe. However, most studies agree that the risk of severe winter storms, and possibly of severe autumn storms, will increase for the North Atlantic and northern, north-western and central Europe over the 21st century.