



Adaptation to climate change



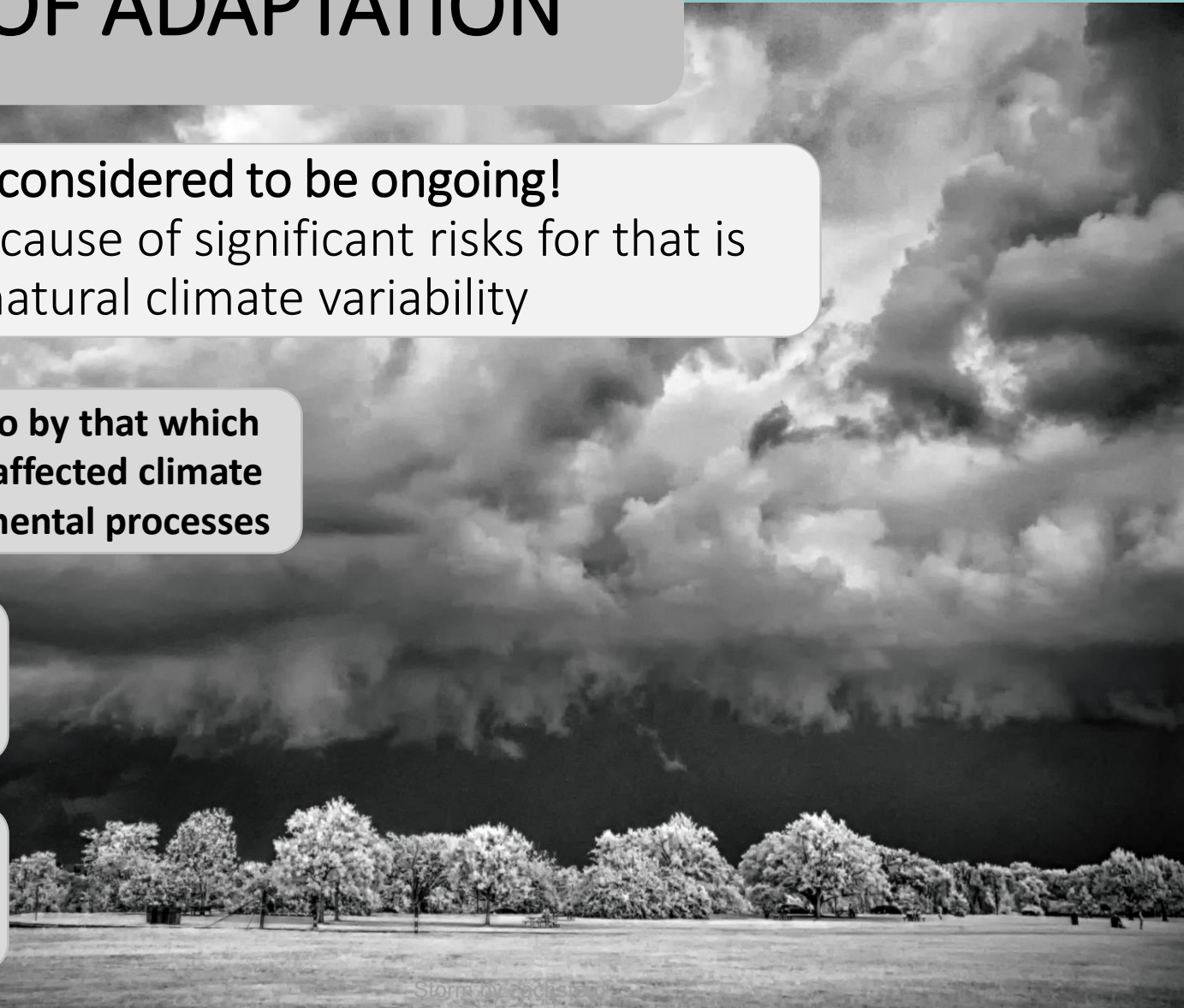
CONCEPT OF ADAPTATION

Climate change is considered to be ongoing!
Weather conditions is the cause of significant risks for that is determined by natural climate variability

We are threatened not only by climate change but also by that which would be named as a natural, non anthropogenically affected climate or extreme climatic events caused by natural environmental processes

Drought or intense precipitation, heat waves or unusual cold, storms, floods, whirlwinds, hail and other cataclysms are still climatic phenomena

These climatic phenomenons may be caused by natural climatic processes and they always have existed and will exist in the future



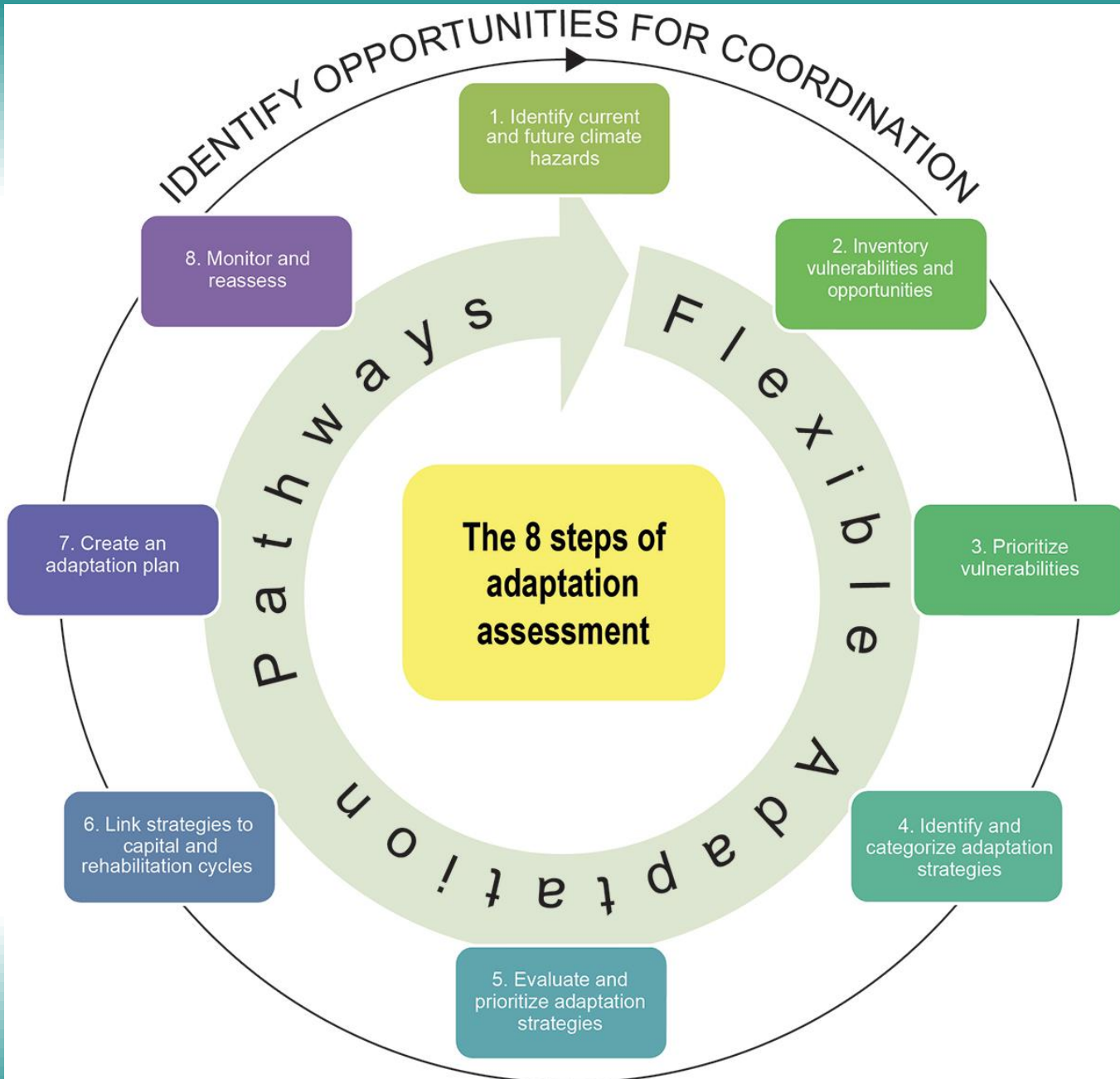
For example, in 2012 about 905 natural disasters were reported, of which 93% were related to climatic phenomena:

- **45% meteorological events (storms)**
- **36% hydrological events (floods)**
- **12% climatological events (heat waves, forest fires etc.)**
- **7% were of geophysical origin (earthquakes, volcanic eruptions)**

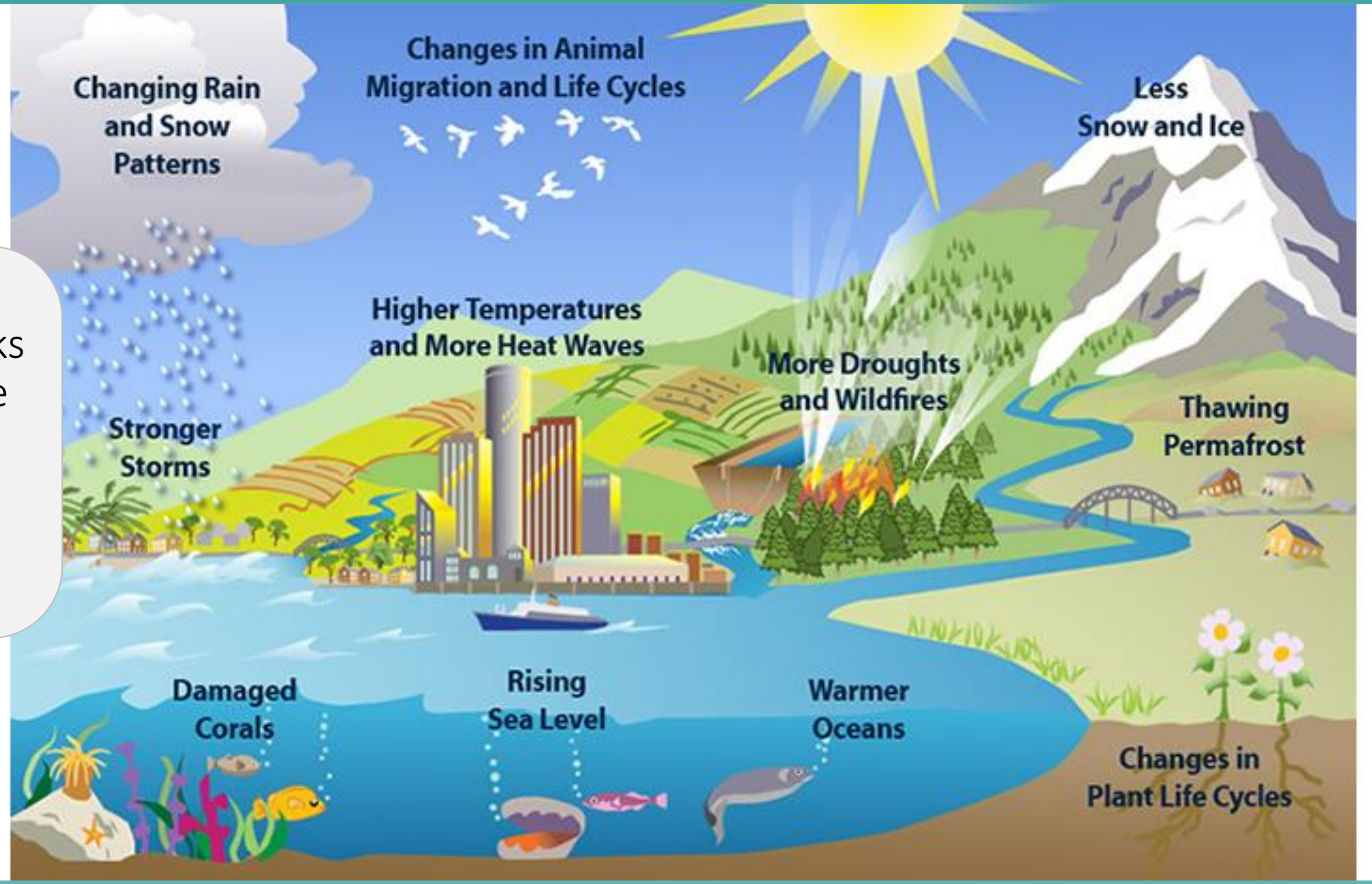
During 1980-2011, 14% of all natural disasters were of geophysical origin

Thus, to ensure the quality of surrounding environment and to reduce the effects of destructive climatic phenomena it is important to implement adaptation: **to adapt to climate change and natural climate variability**





It is important to provide decision-makers with cutting-edge information on the state's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge



Possible environmental risks of climate change that have to be assessed at the planning of adaptation

Adaptation can be defined as adjustment of natural or man-made systems in order to reduce potential damage or to exploit potential benefits caused by climate change or natural climate variability

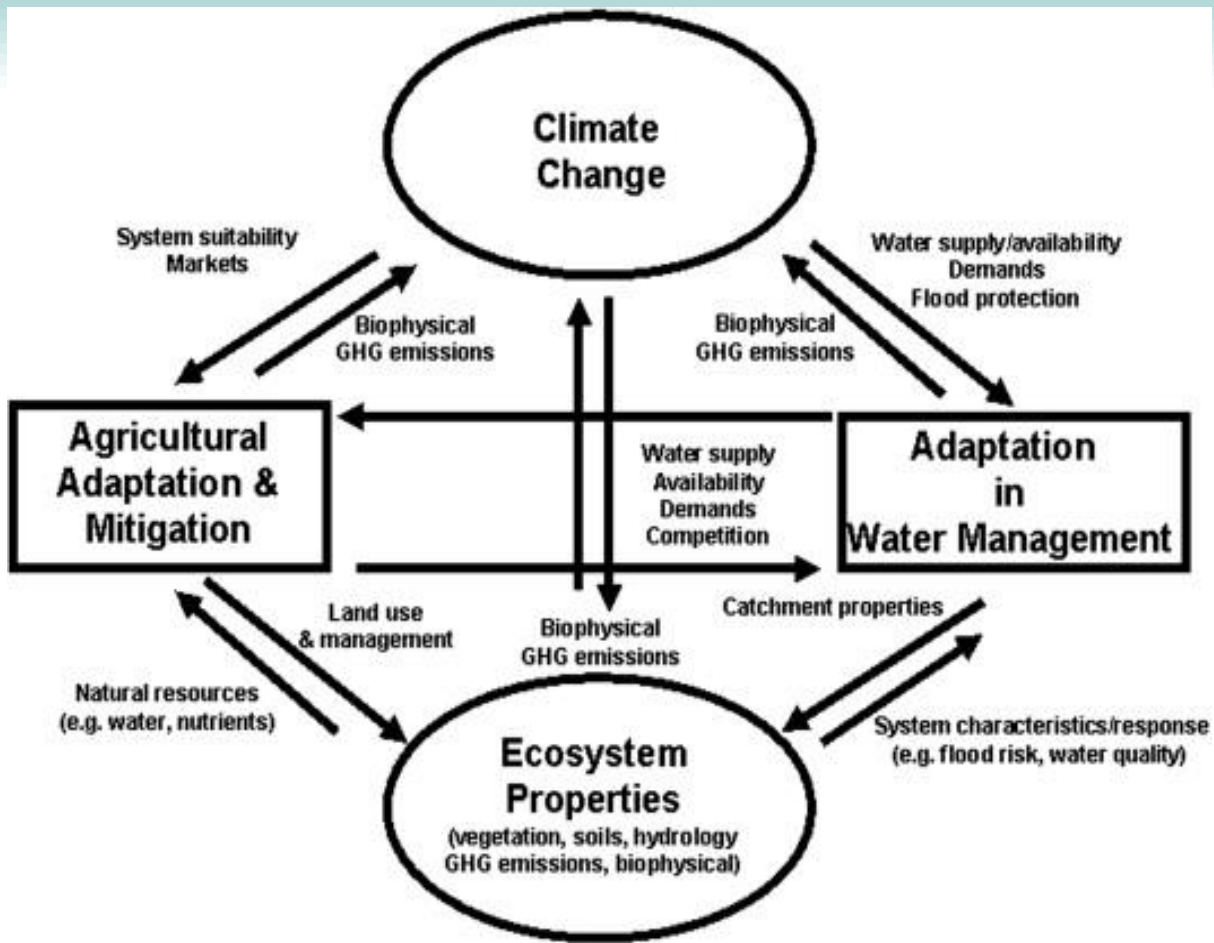
Adaptation is the first step in the political decision-making (at national - European - international level); however, it is a new type of policy which still is under development

On the other hand, adaptation aims to certain actions to ensure that people, economy and natural environment is protected from climate risks

Adaptation policy and action programs are some of the elements of sustainable development

It can be declared that today's climate adaptation concepts are based mostly on the knowledge and oral historical traditions that have existed for centuries





It is important to identify alternatives of development



Although adaptation is a new concept, basically protection and adaptation to climate risks have began by splitting off from the natural environment:
a man became less dependent on cold when learned to use fire



Creation of dwelling significantly reduced the dependence of humans on environmental conditions; the need to protect themselves from such risks as floods contributed to the urban and industrial development

If currently one of priorities of the environmental policy of the European Union is Floods Directive and its implementation, then protection against floods, creation of dwelling in way to protect people and habitat from floods have been one of preconditions for successful development of the human communities

Up-to-date development of technologies, management system of society and structured approach to problem solving requires development of new methods to reduce the risks caused by climate change or climate variability

The concept of adaptation is clearly linked to the sustainable development **policy** and is mentioned in the UN Framework Convention on Climate Change, the Kyoto Protocol and other international legislation documents

Adaptation aims to reduce the risks that can appear, e.g., from floods which occur with a probability once in 100 years – the aim is to avert risks rather than to act after the disaster has already occurred

Thus, concept of adaptation includes care for the society as a whole, not just a certain group of the electorate, while taking into account potential impacts and risks

Risks caused by climate change are so significant that for their solution international community has mobilized, but at the same time, if the climate change mitigation is largely dependent on the cooperation of governments in accordance with the mutual agreements, adaptation is dealt as a set of objectives and actions largely on national level (in each country)

INTERNATIONAL LEVEL

UN, IPCC, World Bank, European Union

NATIONAL LEVEL

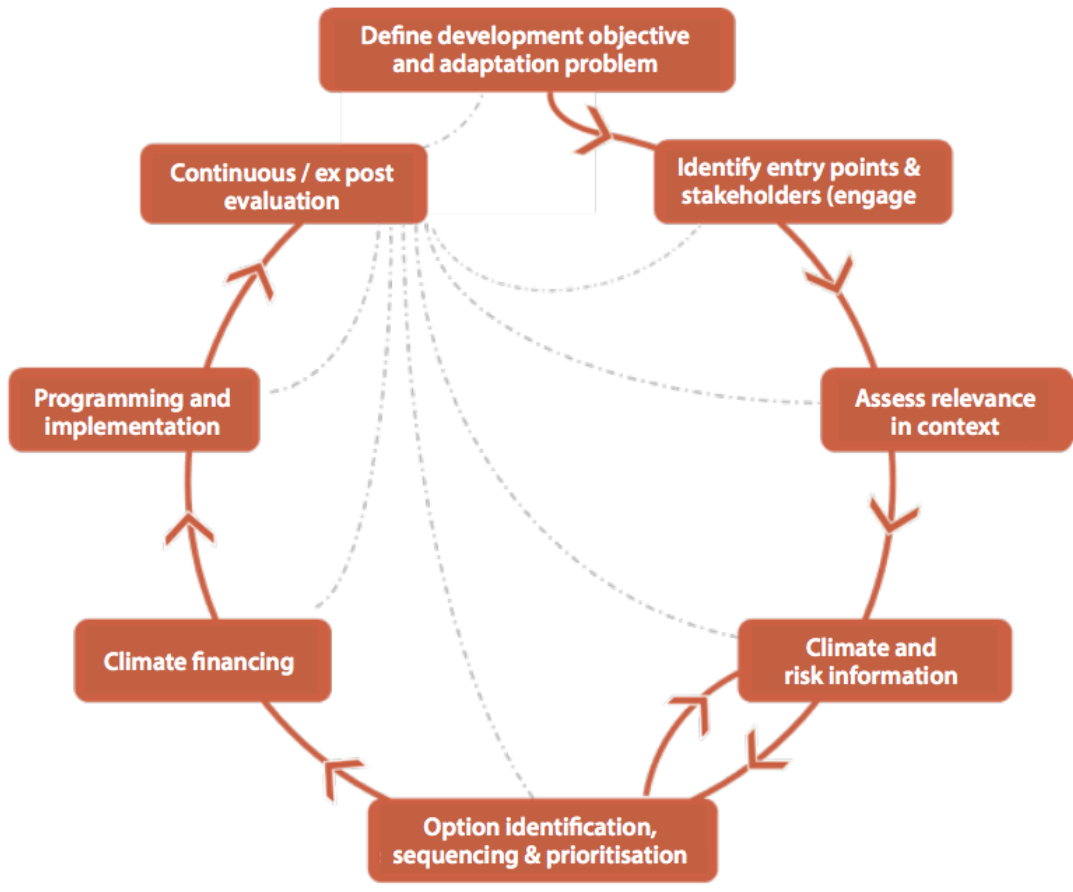
Ministries of finances, economics, prosperity, universities, institutes, state environmental agencies etc.

LOCAL LEVEL

Municipalities, political organizations and NGO, enterprises, farmers, schools, professional associations

Participants of adaptation policy development and implementation

Adaptation policy is one of elements of the global environmental policy and it is related to climate change mitigation policy, respectively, climate change mitigation and adaptation are integrally linked



Increase of up-to-date topicality of environmental problems brings forward climate policy as one of the essential elements of political process

As climate policy is an important actuality of the European Union Member States and begins to become topical also in Latvia, then adaptation issues are becoming increasingly important on a local level as well

To promote planning and implementation of adaptation planning and implementation it is important to cooperate on all policy-making and implementation levels

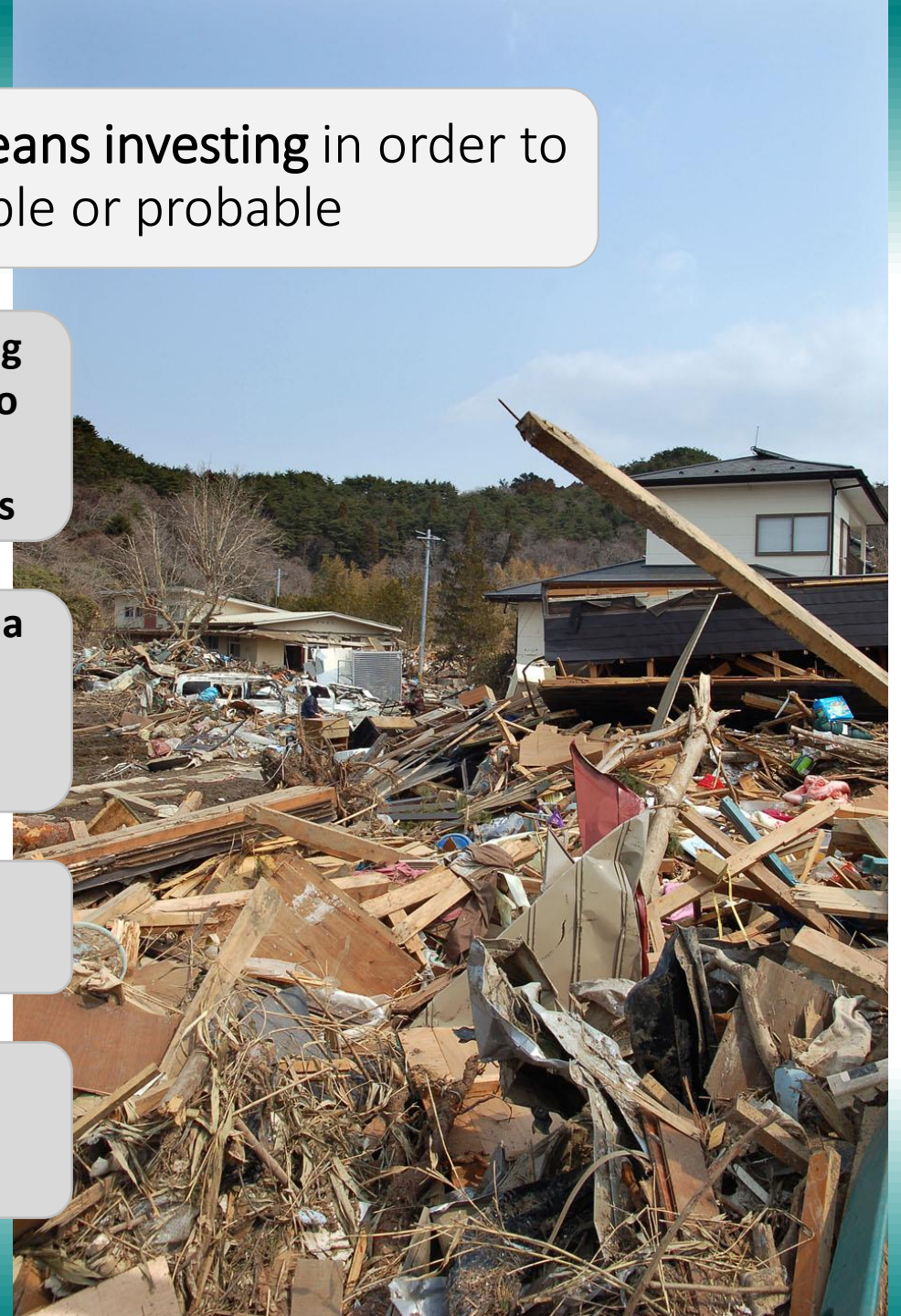
At the same time, **adaptation inevitably means investing** in order to minimize the risks that are possible or probable

Climate change is happening, as well as events and influences of strong storms are inevitable, also risk of floods can be estimated; however, to justify the need for actions and adoption of decisions it is critically important to assess the risks caused by climate in economic categories

Exactly the complexity of economical assessment of climate change is a key factor that is critically important for discussions with the society about the climate policy objectives, as well as for justification of specific supportive investment projects

The issue is complicated by the fact that there are impacts which are difficult to estimate in monetary categories, e.g., loss of biodiversity

However, there are plenty types of climate risks which impacts and potential costs can be estimated quite accurate, for example, land loss in coastal erosion



It is possible to distinguish **several types of adaptation**, depending on the response to climate change risks and depending on the actions that provide adaptation:

- 1) **Autonomous adaptation**
- 2) **Planned adaptation**
- 3) ***Post factum* adaptation**
- 4) **Preventive adaptation**



Autonomous adaptation

Adaptation takes place without a conscious decision in the implementation of policy, but in response to actual changes in climate

Planned adaptation

Adaptation takes place in response to actual effects, for example, measures against floods

Post factum adaptation

Preventive adaptation

Adaptation ways depending on the approach used

Adaptation takes place before the climate change occurs in accordance with the decisions made, eliminating or reducing risks

Tasks of adaptation can be accomplished by combination of different instruments aimed to reduce sensitivity, to ensure climate risk management or to conduct proactive risk reduction:

- 1. Social environment, environmental protection measures**
 - 2. Improvement of infrastructure**
 - 3. Technological solutions**
 - 4. Integrated management of natural resources**
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- 5. Changes of institutional system, education or behavior**
 - 6. Financial services, including risk transfer**
 - 7. Information systems to provide early warning**



Approaches to adaptation to climate change for risk reduction – **limitation of sensitivity and dependence on weather conditions** (adaptation activities and examples):

- **Development of human resources:**
 - Enhancing access to education, health care, safe habitat, social assistance system
 - Reduction of income inequality and marginalization

- **Reduction of poverty:**
 - Improved availability of local resources
 - Disaster risk management
 - Social assistance networks

- **Residential security:**
 - Improved infrastructure
 - Participation in decision-making
 - Access to the latest technological solutions

- **Reduction of climate disasters' risks:**
 - Information on risks
 - Early warning systems
 - Access to water and power supply
 - Building security
 - Storm risk reduction
 - Adjustment of transport infrastructure

- **Spatial and land use planning:**
 - Residence place quality assurance
 - Planning of floods and other risks in certain areas
 - Development of protected areas
 - Urban planning solutions
 - Restriction of marginalization

- **Management of ecosystems:**
 - Protection of wetlands and urban green areas
 - Coastal afforestation
 - Management of water resources

Approaches to adaptation to climate change for risk reduction –
technological solutions and adaptation systems (adaptation activities and examples):

• **Policy and adaptation management at national level:**

- National and local adaptation strategies and action programs
- Economic diversification
- Urban adaptation
- Disaster risk reduction programs and actions' planning
- Management plans of water resources and coastal areas

• **Improvement of legislative system:**

- Land use zoning
- Construction quality control
- Legislation that promote disaster risk reduction
- Legislation that promotes risk insurance
- Legislation that promotes technological progress

• **Initiatives of economic sector:**

- Climatic risk insurance system (governmental guarantees)
- Evaluation of ecosystem services
- Promotion of resource-saving



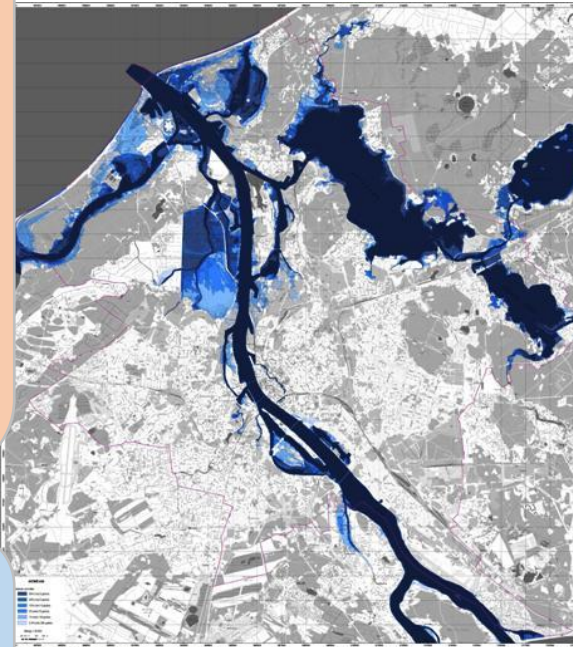
Approaches to adaptation to climate change for risk reduction – technological solutions and adaptation systems (adaptation activities and examples):

• **Development of technological solutions for adaptation:**

- Mapping of dangers and risks
- Early warning and forecasting system
- Coastal defense structures
- Anti-flood solutions
- Improvement of construction practice
- Improvement of transport and road infrastructure
- Security of power supply and information technologies

• **Adaptation in agriculture, forestry:**

- New crop species and their use solutions
- Traditional application of knowledge
- Irrigation and water saving
- Thermal insulation and cooling solutions



Current and potential impact of hydrological processes caused by climate change in the area of Riga city

• **Use of ecosystem resources:**

- Environmental recultivation
- Afforestation
- Green infrastructure (parks, green roofs etc.)
- Ecological corridors and networks

• **Education and research:**

- Risk mapping
- Warning and forecasting systems
- Climate education system
- Continuing education
- Climate risk research

ADAPTATION POLICY

Adaptation policy was initiated by international actors and it is defined by global threats of climate change and increasing risks caused by natural disasters, for example:

- **Increase of global average temperature**
- **Impacts on ecosystems in all continents**
- **Rise of world ocean's water level**
- **Increased incidence of extreme natural disasters**
- **Rising sea levels and coastal threats**

- **Impact on human health and well-being**
- **Impact on agriculture and forestry**
- **Impact on biodiversity and ecosystem services**
- **Impact on regional development**
- **Impact on urban development, planning and construction**
- **Impact on migration**

Important element of global adaptation policy is mitigation of such negative effects that extend across national interests and abilities

A serious problem is such as threat of ocean islands' flooding, because in this case both, threat of sea level rise and effects of extreme events, combined

Other field of activities in global adaptation policy are actions to mitigate the effects of climate change on population migration

All natural observations and models of climate change reveal significant risk of precipitation reduction, for example, in North Africa, where the risks are merging with population growth and political instability that is a major threat not only to regional, European, but also worldwide development



Specifics of climate policy and adaptation policy are following: their beginning started at international level and it is important to solve adaptation tasks at **governmental level**:

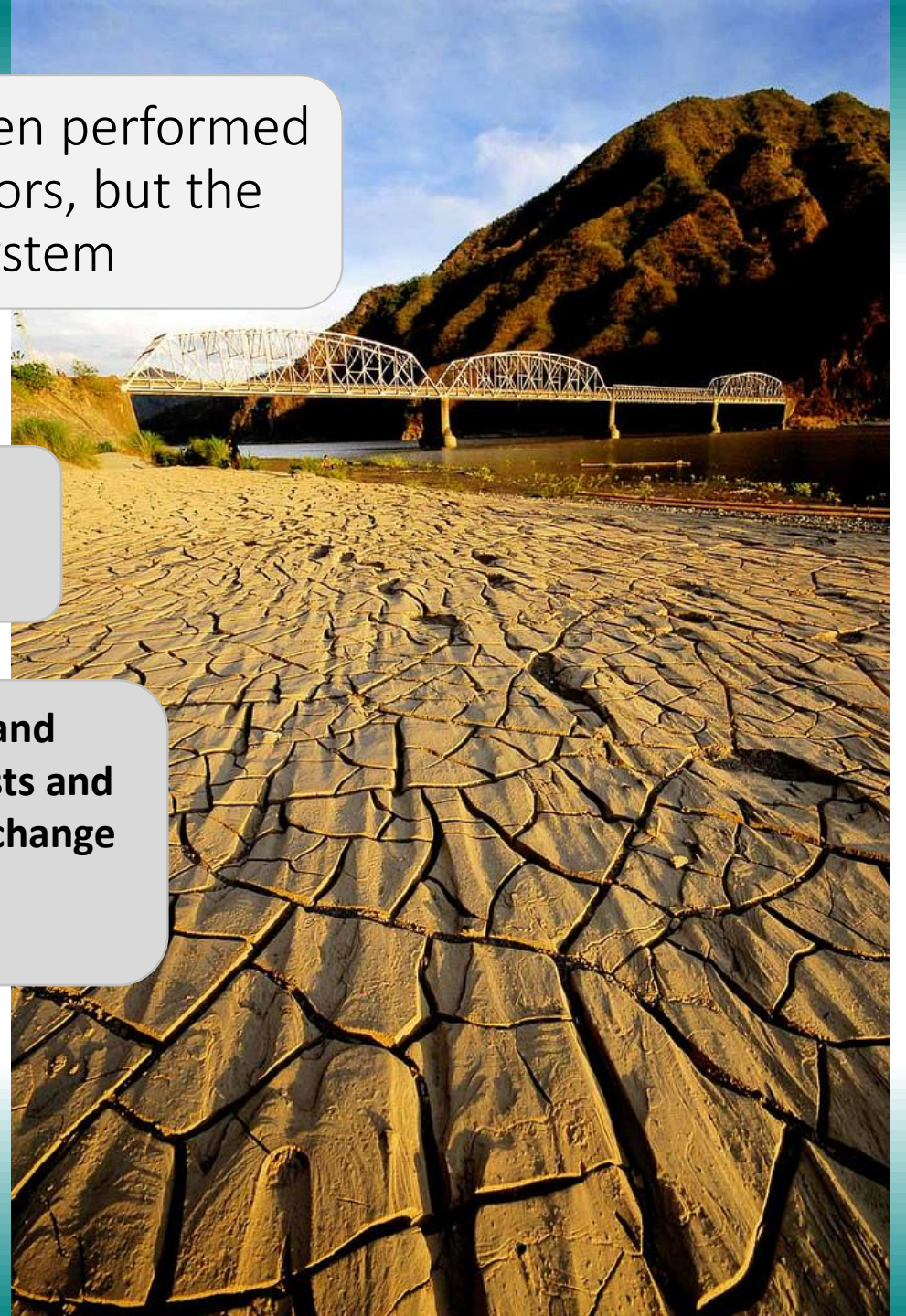


- **Adaptation (preventive) measures allows to lower costs and gives immediate results (especially for agriculture)**
- **Uncertainties, risks and benefits makes it difficult to understand the benefits of adaptation policies to individuals of society, therefore, they have to be dealt at governmental level**
- **Information, knowledge, training most successfully can be provided if they are integrated into national politics**
- **Help in case of disasters overlaps individual or regional capabilities and should be solved at least at national level**
- **Elaboration of solutions and guidelines require experienced competences**
- **Provision of adequate capacity (financial and human resources)**
- **Planning and development of infrastructure**

Today, identification of risks more or less has been performed in policy planning documents of separate sectors, but the most detailed – in the civil protection system

It is important to include climate change risks in the national public security system, developing a system of monitoring and drawing up regularly updated maps of risk objects

This would facilitate and prevent the process of risk identification and evaluation (including financial), improve the system of various forecasts and scenarios, including those systems which are associated with climate change impacts on various natural ecosystems and biodiversity, human health and well-being assessment



The main instruments of adaptation policy are: governance (including risk management as the most important), determination of the main directions (including the role of national governments, municipalities, private sector etc.), and creation of adequate insurance system



Uncertainties still arise due to the functions of the Kyoto Protocol in development of funding mechanism of adaptation measures (for example, Adaptation Fund)

Adaptation policy should become as economically justified amendment to necessary climate change mitigation measures

In addition, adaptation should be seen as most necessary component of sustainable development, integrating the sectoral policies with research, technology transfer, public engagement and rise of informative level, as well as rapid and reasonable improvement of capacity

The first major international document which was related to the risks of climate change was the **UN Decision 1/CP.10** about the Buenos Aires program work on adaptation and response measures

It states that in addition to already approved adaptation measures (such as flood dams, sluice installation, cleaning of river beds, coast strengthening etc.) innovative activities and technological development have to be stimulated

This could be done through the carbon market development, various funds, multilateral financial institutions, successful functioning of international emissions trading etc.



During the 12th session of the UN Framework Convention on Climate Change and the 2nd session of the Kyoto Protocol member states (in November, 2006, held in Nairobi, Kenya), **the Nairobi five-year work program** on climate change impacts, caused vulnerability and adaptation measures was adopted

In 2013, the **Warsaw's international mechanism** to contribute in success of minimizing losses caused by climate change was established, but in 2015, the United Nations Conference on Climate disaster risk reduction took place

An important turning point is the UN Conference on climate policy (COP 2015) in Paris, in 2015

Within the framework of European Community the basic legislative acts are elaborated to ensure the policy on climate change adaptation implemented by the EU Member States, the whole EU and the regions (such as the Mediterranean etc.)

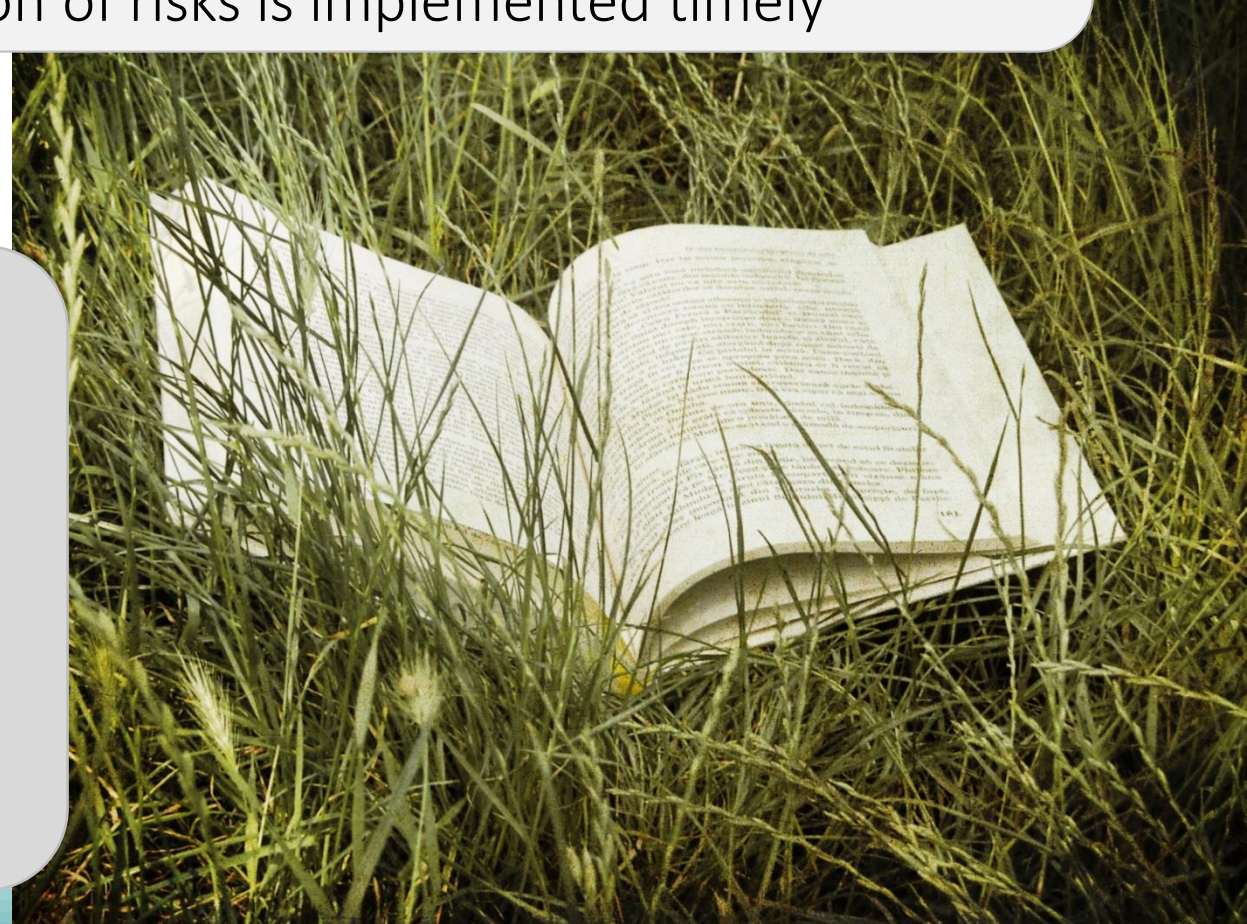
European Commission's Green Paper on adaptation to climate variation is expressing the view that it is necessary to develop adaptation policy at all levels (national, regional, local), integrating instruments of policy and implementation in the main economic sectors with particular attention to:


- **Water management and water supply**
- **Healthcare**
- **Agriculture**
- **Regional planning**
- **Energetics / electric power**
- **Transport**
- **Ecosystems**
- **Assessment of environmental impacts and strategic environmental assessment**
- **Civil systems and early warning systems to strengthen the provision of preventive measures**

The Green Paper underlines that the aim of adaptation to climate change policy is to reduce risks and losses caused by natural disasters and climate variability **cost-effectively**, as well as to explore the potential benefits that would be obtained by society and ecosystems if prevention of risks is implemented timely

The Green Paper sets out the following priorities:

- **Early action to develop adaptation strategies in sectors and areas where current knowledge is the weakest**
- **Integration of global adaptation needs into the EU's external relations and the establishment of a new international partnership**
- **Elimination of lack of knowledge or failure of adaptation regarding research and exchange of information at EU level**
- **Establishment of European monitoring group to analyze coordinated strategies and actions**






As the next political document of the EU
the **White Paper** was elaborated

EU White Paper provides an assessment of adaptation to climate change, highlighting the need for adaptation strategies and action programs to be justified through the economic analysis of planned activities

However, as the main achievement the recommendations on a national level adaptation strategies are stated, as well as development of the EU strategy for adaptation to climate change



The aim of the EU adaptation strategy is to enhance national stability to climate change, to improve the preparedness and ability to respond to climate change on local, regional, national and EU level by developing a harmonized approach and coordination of activities

Among the main instruments to achieve the objectives of adaptation are the national-level adaptation strategies can provide adaptation and prioritization of the activities and investments, as well as a common approach to the development and harmonization between national adaptation strategies and national risk management plans

The EU supports the exchange of good practice among member states, regions, cities and other stakeholders

In adaptation strategy the particular attention is paid to actions in urban areas as well as adaptation measures for integrating EU policies and programs to ensure the «climate readiness» of EU

Spheres in which adaptation planning integration is critically important are following:

- **Sea waters**
- **Forestry**
- **Transport**
- **Inland waters**
- **Biodiversity**
- **Migration and mobility**

Adaptation strategy focuses on knowledge about adaptation and research programs improving elaboration of national and regional adaptation strategies

In order to stimulate innovations and to support the introduction of innovative technologies in the market, which helps to adapt to climate change, the knowledge and competence is needed

The planned actions are as follows:

- **1st action**: To encourage the member states to adopt comprehensive adaptation strategies
- **2nd action**: To use the funding of the instrument LIFE to support capacity and to increase the intensity of activities in Europe's adaptation (2013-2020), especially in support of coastal and flood management etc.
- **3rd action**: To support adaptation in cities, primarily, calling municipalities for voluntarily commitment to adopt local adaptation strategies and to carry out awareness activities



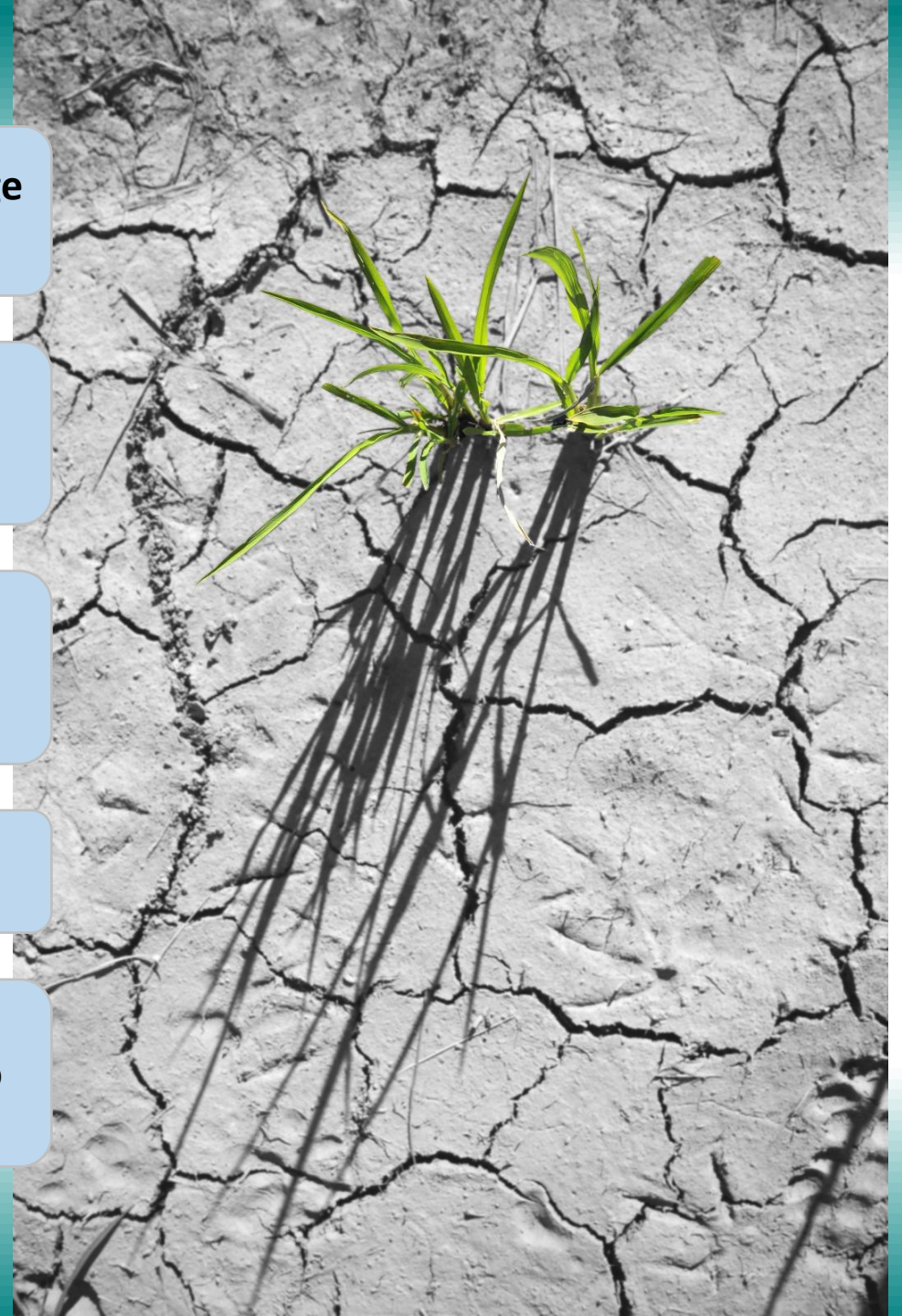
- **4th action**: To provide science-based information on climate change and its impacts

- **5th action**: To continue the improvement of the internet site Climate-ADAPT to become as a «one-stop agency» in relation to information on adaptation at the European level

- **6th action**: To contribute to the common agricultural policy, cohesion policy and the common fisheries policy for climate change challenges

- **7th action**: Provision of sustainable infrastructure

- **8th action**: To support the insurance and other financial products that improve the investment and stability of business decisions to climate change



The EU Directive on Flood Risk Assessment and Management has been adopted to create a flood risk management, thereby minimizing the adverse effects of floods on human health, environment, cultural heritage and economic activities

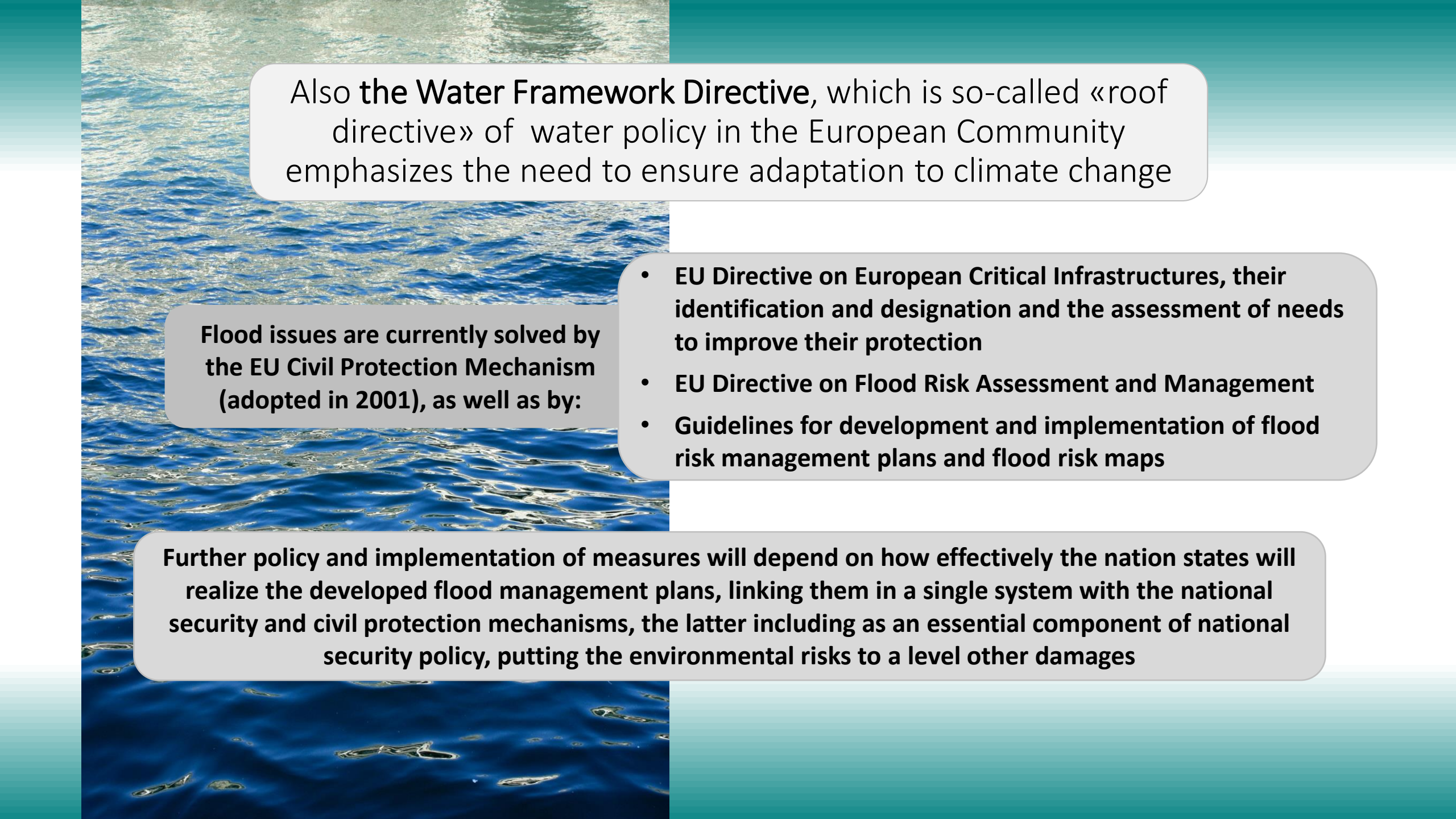


Floods are natural phenomena which can not be prevented, however, due to the human activities and climate change impact flooding events and adverse effects of floods are increasing

The directive states that to avoid flooding in a certain area and to reduce their negative effects, it is appropriate to elaborate flood risk management plans

Flood risk management plans should take into account the specific characteristics of the regions

Flood risk management plans include measures that are connected with natural processes such as maintenance and/or restoration of wetlands in order to give space to the rivers wherever possible and to promote appropriate land use and agricultural and forestry practices throughout the river basin



Also the **Water Framework Directive**, which is so-called «roof directive» of water policy in the European Community emphasizes the need to ensure adaptation to climate change

Flood issues are currently solved by the **EU Civil Protection Mechanism** (adopted in 2001), as well as by:

- **EU Directive on European Critical Infrastructures, their identification and designation and the assessment of needs to improve their protection**
- **EU Directive on Flood Risk Assessment and Management**
- **Guidelines for development and implementation of flood risk management plans and flood risk maps**

Further policy and implementation of measures will depend on how effectively the nation states will realize the developed flood management plans, linking them in a single system with the national security and civil protection mechanisms, the latter including as an essential component of national security policy, putting the environmental risks to a level other damages

The European Commission's declaration «Addressing water scarcity and drought problem in the European Union» in addition to increasing risk of floods, heat waves and drought periods identifies as a problem as well

During 1976-2006 drought-affected areas and the number of people has increased by almost 20%

For example, in 2003 drought affected over 100 million people and one third of the territory of the EU - it has been estimated that the economic losses caused are about 8.7 billion euros

During these past thirty years, drought expenditures are measured in 100 billion euro; the annual average costs for this period increased by four-fold



Flood barriers on the Thames (UK)

ADVICES IN SOLUTIONS OF ADAPTATION

Adaptation plans (strategies) and the action programs are designed for international and national levels, but the most important are those activities which have implication not only on political decision-making, but are acting on a place: in a municipality, enterprise, farm



On the other hand, without a national policy and common objectives, as well as financial instruments the results can not be gained

It is also important to raise public awareness about why adaptation is necessary and why daily work planning is so important

**Important resource in development of adaptation options is
the EU Climate Change Adaptation Platform**

**On this platform information is available on theoretical concepts
of adaptation challenges at different levels, as well as examples of
how adaptation issues are already being solved**

**Legislative framework for adaptation solutions in specific areas of
activities (water management, forestry, protection against floods
and other climate risks) are provided regularly updated
by the European Commission**

**Thinking about the adaptation solutions, it is important to
remember that the problems are not the same in various regions,
and the information and networking platforms offer extensive
information about similar problems and solutions which
have proven to be topical in Latvia**





As the first important step in the development of adaptation measures identification of **primary risk objects and groups of inhabitants** can be considered, respectively, what will be affected first of all by climate change/natural variability in a given location

Risk objects and population groups may be, for example, a house built on a floodplain, a school which may be endangered by floods in case of collapsed flush dam, or a care house due to the impact of a heat wave on the health of its inhabitants

Accordingly, it is necessary to conduct the risk assessment of damage, which can be expressed as a number and to evaluate possible economic loss or impact on human health and well-being

In development of any proposals for adaptation measures critical stage is public information and the establishment of a common understanding of need for planned measures

In Latvia, the need for adaptation to climate change policy is governed by the requirements of the EU Adaptation Strategy, the EU Floods Directive, the Water Framework Directive and other policy documents of EU level

Laws and regulations establish the state responsibility not only for elaboration of strategies but also for adopting and implementation of action programs

Adaptation policy in the country is necessary for achievement of sustainable development, and climate change issues should be integrated into the further development of planning documents at national level (National Development Plan) and also in sectoral development plans

In achieving of the goals significant assistance is provided by other Baltic Sea region countries, particularly, Germany and Norway, as well as active involvement of Latvian scientists in international cooperation

Climate change adaptation issues need to be taken into account in the assessment of the impact on environment, territorial planning, management plans of river basins, development strategies and sectoral plans etc.

The aim of scientific research is **to ensure reasonable decision making** and research is required for both, fundamentally important knowledge management and for answers to the current everyday issues:

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- **Environmental and ecological long-term monitoring and investigation of climate change impacts for development of predictive models**
 - **Climate change impacts on surface and ground water resources**
 - **Climate change assessment and economic evaluation**
 - **Economic and social assessment of climate change impacts and adaptation activities**

- **Full cycle of climate risk management related to climate change, taking into account the role and impact of these risks or benefits on individual sectors of the economics, biodiversity, protected areas, ecosystem services, public health**
- **National significance information mechanism of climate change**
- **Impacts of climate change on forests, crops, natural fish populations, fishery**

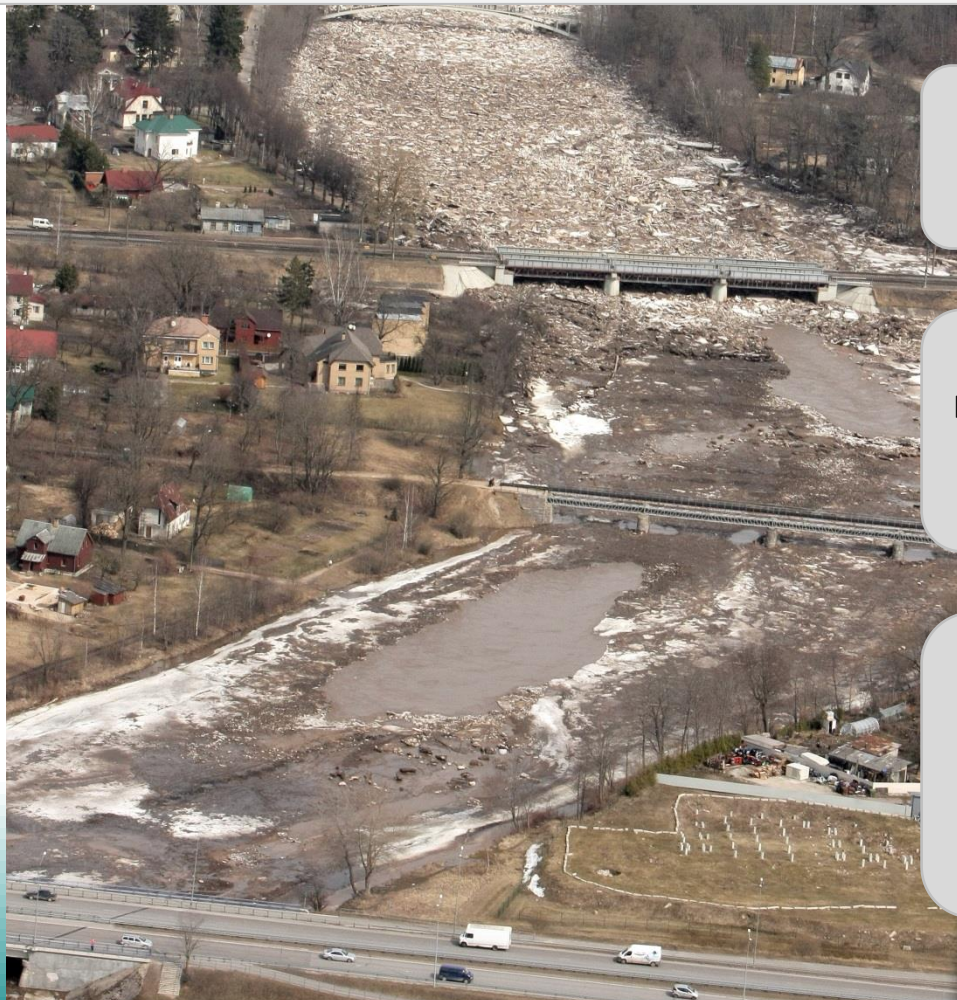
- **Adaptation solutions for agricultural, forestry and development of other sectors of economics in the context of climate change**
- **Development of solutions for energy, construction and other sectors affected by changing climate; changes in building norms, safety solutions etc.**
- **Development of climate policy indicator system and evaluation system of effectiveness of adaptation policy and measures**

Greatest part of population in Latvia and other countries are living in urban areas; in cities the major cultural and material values are concentrated as well; also a major part of the industrial production and trade is located in cities – hence **adaptation solutions for the urban environment need to gain special attention**

Despite the existing level of comfort, climate variability/change impacts in the urban environment can be particularly catastrophic as for example floods

In planning and design, it is important to focus on the future rather than the present situation, creating areas and buildings where people are exposed to higher comfort and lower risk of climate variability

Adjusting not only buildings but also outside space and infrastructure to foreseen changes and, thus, taking into account potential demands of society, valuable properties will be developed, risk to health will be reduced and insurance costs will be lowered



Ice jam in the River Ogre, in April, 2013 (Flickr: Latvijas ārmija)

In urban areas particularly dangerous are the effects of floods and therefore **flood mapping** is very important, respectively, identification of areas that may be threatened by various types of flood risks in different periods of the year:

- **Rainwater floods**
- **Wind tides floods**
- **River flooding**
- **Combined flooding**

In case of Riga, such flood mapping has been carried out and it allows to assess high-risk areas in the city and, therefore, can contribute to flood prevention and adaptation to reduced risk of floods

At the same time, development of flood mapping is only the first step of adaptation to the flood risks

It is important not to build buildings and infrastructure in flood zones and river flood plains, as well as to protect the areas by flood engineering constructions



Floods in Riga, in July, 2010 (Flickr: David Holt)

Flood risk can be greatly reduced by **planning adjustment of natural water bodies**, creating artificial water bodies in parks and green areas to capture rainwaters well as to ensure the retention or accumulation of water during floods to reduce the level of water



It is important for flood risk mitigation to create a **water-permeable ground cover and a storm water system separated from the municipal sewage system**

Important adaptation set of adaptation tasks is associated with the use of extreme rainfall and economical utilization of water resources during longer periods of drought in summer, which can be achieved by collecting and using rain water for watering green areas of cities

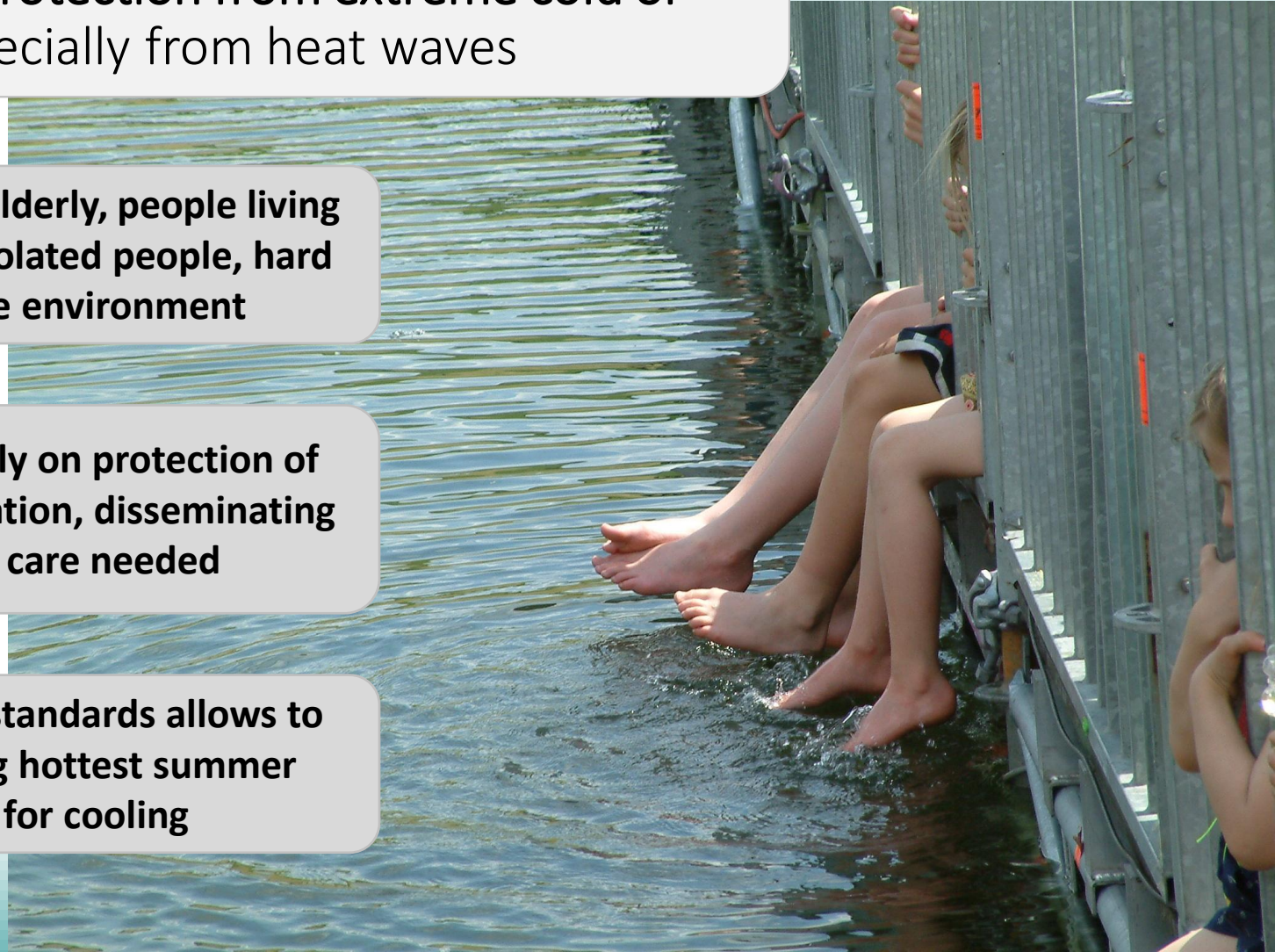
For drought mitigation it is recommended to develop solutions that enable to purify waste water from households and to use it for other household purposes, including watering of green areas or in toilets

Particularly for urban environment it is an important issue of **people protection from extreme cold or heat**, especially from heat waves

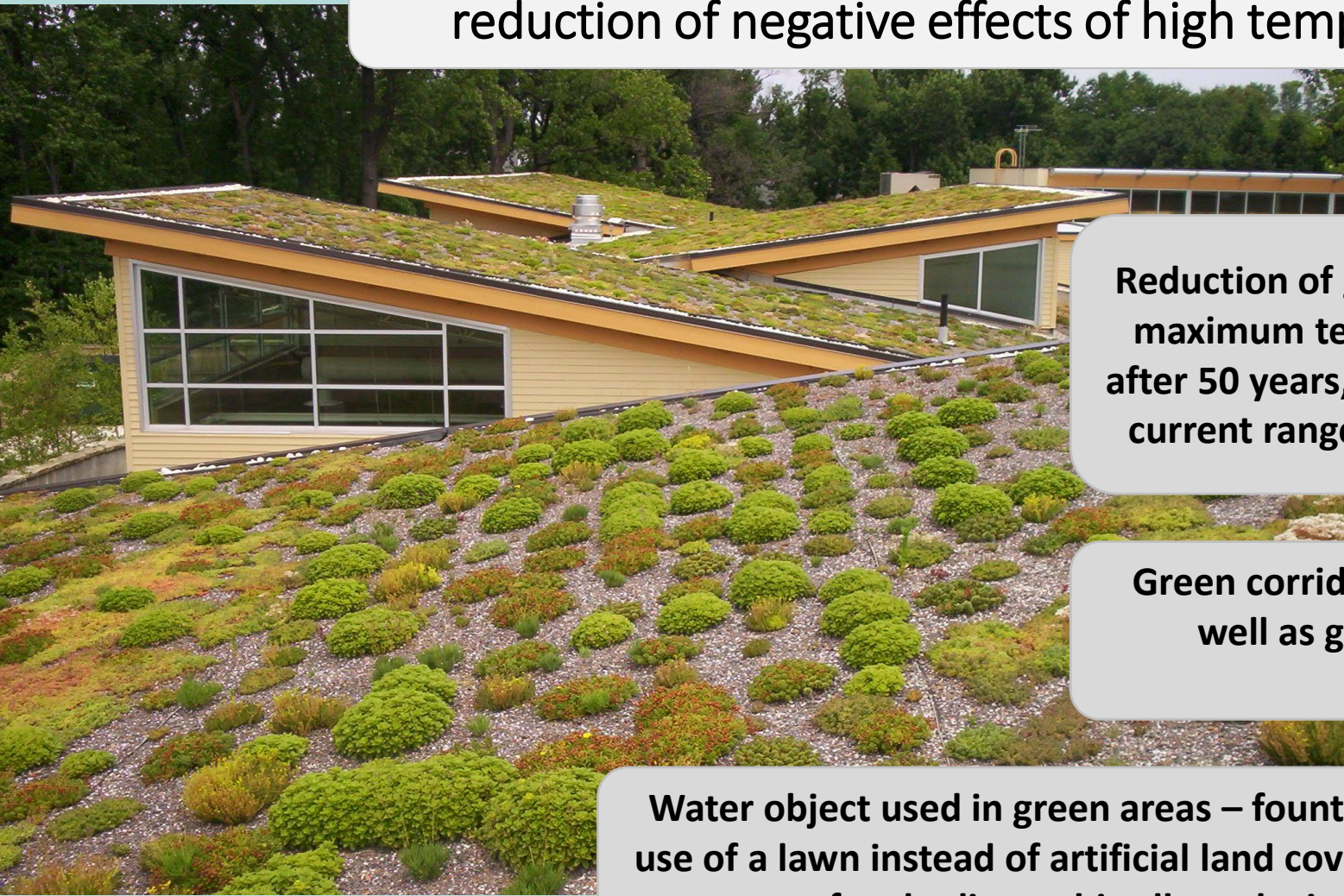
Most seriously to climatic extremes are exposed elderly, people living in socially disadvantaged environment, socially isolated people, hard workers outdoors or indoors in inappropriate environment

Adaptation programs should be targeted primarily on protection of high-risk population, promoting reduction of isolation, disseminating information, ensuring assistance and other care needed

At the same time, development of construction standards allows to plan a pleasant microclimate in buildings during hottest summer months, minimizing energy consumption for cooling



In urban environment, it is important to develop solutions for reduction of negative effects of high temperature in summer



Reduction of green area by 10% can result in an increase of maximum temperature on the ground's surface by 8,2 °C after 50 years, while increase of green areas by 10% ensures current range of maximum temperature range up to 2080

Green corridors, small open areas, trees in the streets, as well as green roofs and walls ensure substantially cooling evaporative effect

Water object used in green areas – fountains, pools, ditches, ponds and watercourses; use of a lawn instead of artificial land cover; use of trees not only for aesthetic, but also for shading – this all results in cooling of environment in summer

Climate change for planners, architects and developers gives tremendous opportunities to build or transform urban buildings and open space in accordance with improvement of quality of living environment affected by climate change

The aim of spatial planning in climate impact mitigation is water, integration of open areas and built environment, using green and water areas for development strategies to be achieved, for example, as follows:

- Creating a high quality opened for inhabitants green areas, which are interconnected, well-irrigated and which has ecological, recreational and flood water storage functions
- Placing water bodies (fountains, pools, ditches, ponds and watercourses) in green areas
- Developing urban environment of water or blue areas - rivers, lakes, ditches, canals
- When planning shading and the location of objects in order to reduce excessive exposure to the sun during summer and taking into account the need for light and heat in winter
- Developing urban passive ventilation, consisting of buildings and street layout and morphology, where cooler air flows in summer and winter leewards are harmonized



It is necessary that spatial planning provides security against **the Baltic Sea coastal erosion and river bank erosion**



- **In coastal sections affected by erosion, including settlements, to prevent of new, state or municipal important infrastructure development**
- **To prevent construction of new real estate properties in coastal areas affected by erosion**
- **To use anti-erosion measures for coastal protection**
- **Greater use of geographic information systems in creating risk maps, environmental risk management and spatial planning and development**
- **To use historical experience**
- **To evaluate the usefulness of polder lands**

Work and planning specifics of municipalities creates challenges and problems to be overcome in order to ensure adaptation to climate change at the local level in **planning of territories and regional development:**

- **The need to educate employees, politicians of local municipalities to create awareness and to develop capacity of the population to justify the needs for actions to be taken**
 - **To work in partnership of municipalities in cooperation with households, private sector and viable projects**
 - **To determine the most sensitive areas and spheres of climate change impacts and critical limits which if being exceeded can endanger inhabitants or infrastructure**
 - **To identify climate change risks using the latest models and scenarios**
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- **In decisions of development to use the information for climate risk affected areas and processes**
 - **To avoid activities that in future can make even more difficult adaptation process to climate change**
 - **Regularly overlook the adaptation strategies and measures**



Agriculture, forestry, fishery, hunting and other spheres are highly dependent on climatic conditions, and in Latvia adaptation planning development is dependent on the effects of climate change that still needs to be identified and understood

Agricultural production firstly is affected by precipitation variability, particularly drought periods, and solutions to mitigate such impacts can include choice of crops species less sensitive to drought choice and plant cultivation in irrigated areas

On the other hand, drowning of agricultural crops in warm, wet winters can be prevented by maintaining agricultural lands and renovating drainage systems supplementing them by wetlands or sedimentation ponds

Research of cultivable crops and agricultural practices and development of proposals is one of the most topical challenges for researchers

In parallel with the agricultural development of technological solutions it is needed to take care of how to reduce soil erosion, use of plant protection substances and plant nutrient leaching to surface waters, creating wetlands, sedimentation ponds or reed beds



Also in forestry the key question is about the choice of forest care technological solutions, as well as adaptation in forest care plays a great importance


First recommendation is to avoid complete deforestation areas and to remove tree residues from wood felling areas to reduce the amount of biomass exposed to mineralization

It is important to follow the moisture and unfrozen soil conditions suitability for forest technologies, including the good felling practice near watercourses taking into account seasonality

Cutting of trees should be carried out when there is the lowest water runoff and it is important to build and properly exploit the forest roads, and to comply with forestry technologies suitable for moisture and unfrozen soil conditions

In the emissions trading sector the key factor will be increase of wood used for heat production, but in spheres outside the emissions trading sector, it will be not only wood, but the whole biomass obtainable from agricultural activities and applicable for production of heat, power and biofuels





In fishery sector there is a need to reduce overgrowth of water bodies limiting nutrient leaching, as well as it is important to recultivate rivers which are habitats of salmonids

For development of natural fish populations it is important to reduce nutrient run-off and point pollution sources

In pond farms it is recommended to focus on the warmth-loving species and it is expected that the majority of Latvian fish species will increase their productivity

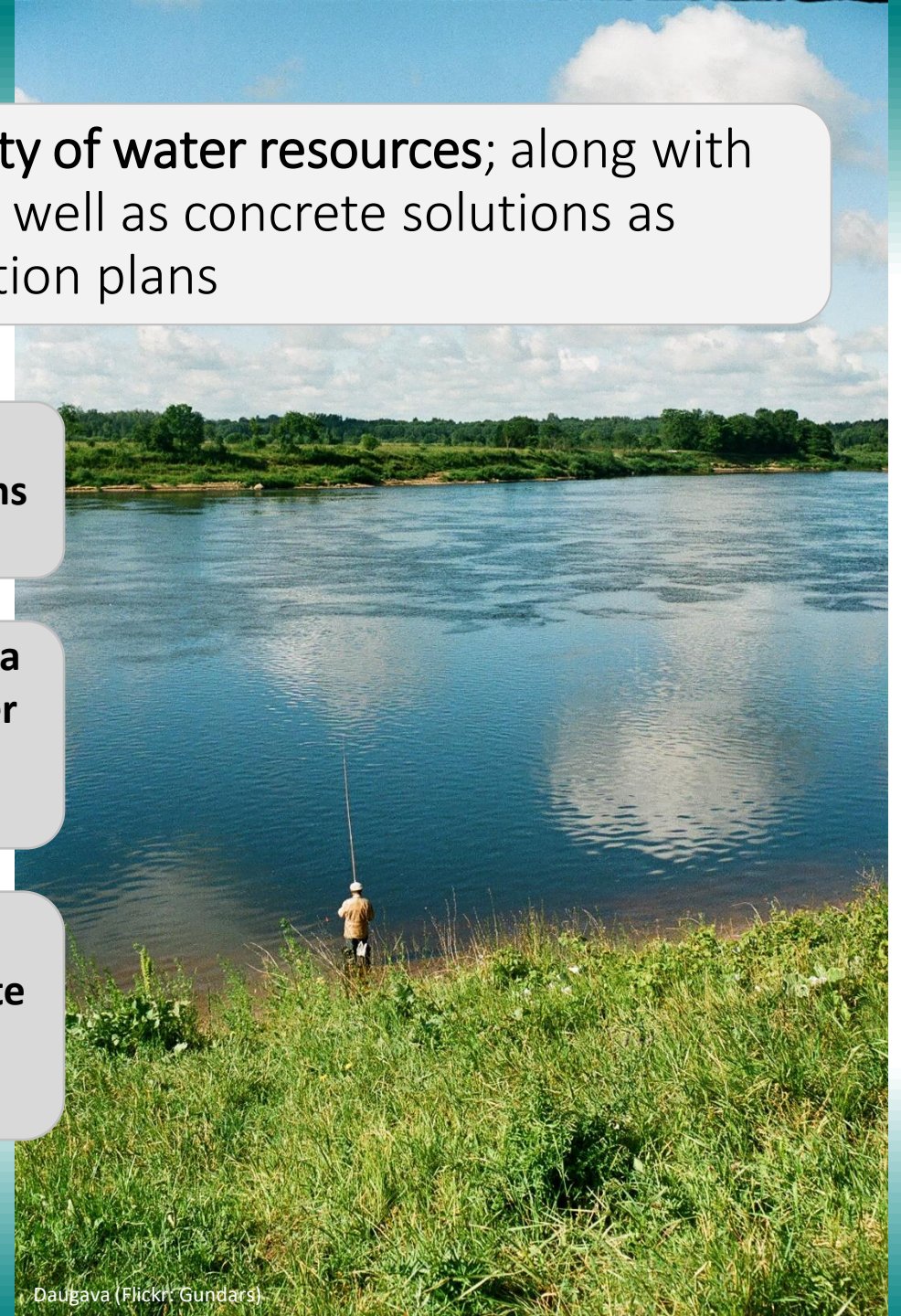
For restoration of natural habitats it is important to strengthen the fight against overgrowth of inland water bodies, to remove the excess of plants from rivers and to recultivate rivers

Climate change can affect both, **quantity and quality of water resources**; along with that solutions in water management include as well as concrete solutions as conceptual water conservation plans

For example, it is necessary to establish a sewerage network and constructions for extreme rainfall drainage, to built storm water systems separately from urban waste water systems

It is important to ensure high efficiency of sewage treatment plants in a changing climate conditions, paying particular attention to waste water discharges depending on seasonality, as well as variations of low-water or high-water periods

In cities it is possible to build the natural drainage – using green roofs and areas of water retention and infiltration to reduce the load of waste water disposal system, as well as to provide a natural rainwater infiltration and surface runoff by the spatial planning



For adaptation it is necessary to create a **water supply systems** that are able to operate in low-water periods, as well as to regulate underground water resources in drought conditions – it is essential to elaborate management of extreme rainfalls caused by flood water

For water-saving provision it is necessary to review the costs of water use in accordance with all criteria, because estimated risks are not included in water costs, but at the same time they are taking into account full water life cycle (extraction, production, supply, collection etc.)

It is important to improve the efficiency of sewage treatment plants - to establish requirements for discharges of waste water depending on seasonality and the low-water or high-water periods

During low-water periods should be set lower pollutant exposure limits

Is necessary to ensure implementation of water quality monitoring programs that should also include monitoring of climate change impacts



It is important to **include monitoring of climate change** into National Environmental Monitoring Program, focusing also on mutual evaluation of impacts and corresponding indicators and analysis not only of environmental, but also of social and economic indicators

A strategies or concepts of solutions reducing the loads caused by households without centralized sewer systems should be elaborated

Water quality modeling with recognized methods and models in international practice is an important activity to plan the management of water resources

It should be noted that production of power by hydropower plants will be less intensive in summers due to the risk of drought, but may increase in winters due to more intensive precipitation

In small hydroelectric power plants strict comply with the minimum rates of water flow should be taken into account in order to reduce the negative impact on fish populations



Thank you
for the attention!

