CLIMATE CHANGE, DISASTER RISK REDUCTION AND RESILIENCE

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Abstract: *Climate change increases the risks of instability in all its forms, and significantly affects the frequency and intensity of natural threats. In the last two decades, 90 percent of the world's major disasters were caused by events such as heat waves, floods, and weather-related droughts. The 2019 Disaster Risk Assessment for the Republic of Croatia for 10 out of 15 simple risks determined that climate change affected their occurrence. Climate change also affects complex risks, especially in urban areas. Therefore, when assessing the impact of climate change on the environment, it is necessary to consider the impact they have on disaster risks. Disaster risk reduction and climate change adaptation have a common area of interest, partly overlapping, and activities to strengthen resilience and to prepare a response system require joint efforts and cooperation.*
Keywords: *disaster risk reduction, climate change, risks, resilience, disaster*

Received: 13.07.2022. / Accepted: 16.09.2022.
Published online: 20.12.2022.

Professional paper
DOI:10.37023/ee.9.1-2.5

1. INTRODUCTION

From 1995 to 2015, 90 percent of recorded major disasters in the world (floods, storms, heatwaves and droughts) were linked to climate change. Climate change affected the frequency, intensity and duration of threats depending on weather conditions. According to the National Risk Assessment from 2019, climate change affects the occurrence of 10 out of 15 simple risks in Croatia. They affect: plant diseases, animal diseases, extreme temperatures, epidemics and pandemics, floods, open fires, snow and ice, droughts, land salinization and landslides (Disaster Risk Reduction Portal, 2019).

The response to the increased number of disasters in the world is the Sendai Framework for Disaster Risk Reduction, which links risk management, as well as reduction of risks to sustainable development. The goal is to prevent the emergence of new risks, reduce existing risks from disasters and manage the remaining risk, which will contribute to strengthening resilience (Sess: 2014-2015). This holistic approach is not limited to disaster management but implies continuous risk reduction.

Disaster risk reduction and climate change adaptation have a common area of interest. There are differences between these areas, but also convergence. Bringing together these areas and striving to achieve the same goal is most evident in focusing on increased climate-related dangers, climatic extremes such as floods, storms, landslides, droughts and others. Disaster risk reduction clearly emphasized the effects of climate on the increase of the risk of certain threats. There is a joint and multidisciplinary approach in searching for solutions and the development of horizontal and vertical cooperation with stakeholders. Climate-related disasters are impossible to analyze and discuss without taking into consideration climate change. However, it is not enough to focus only on activities after the disaster during the recovery and reconstruction phase. It is also important to act in the field of prevention, preparedness and mitigation which is the strongest link between disaster risk reduction and adaptation to climate change.

2. VISION AND STRATEGY

2.1. What is resilience

Measures and activities undertaken in the area of disaster risk reduction are linked to strategies aimed at strengthening resilience, a concept that has become key to sustainable development. Resilience at national and all other levels aims to ensure that shocks, stresses and dangerous events do not lead to a long-term gap in development, economic growth and progress. The concept of resilience has integrated various fields and is referred to in all recent international agreements related to disaster risk reduction as well as climate change adaptation. In Croatia as well, the Strategy for Adaptation to Climate Change in the Republic of Croatia for the period to 2040 with a view to 2070 (hereinafter: Strategy for Adaptation to Climate Change) has a development vision of "the Republic of Croatia resistant to climate change". The goal. i.e. resilience, is planned to be achieved by reducing the vulnerability of natural systems and society to the negative impacts of climate change and by strengthening the

ability to recover from these impacts (Adaptation Strategy 2020). The adoption of the Disaster Risk Management Strategy until 2030 with the vision of "Croatia more resilient to disasters" is also in the process.

The concept of resilience has its drawbacks. One of the biggest objections is the difficulty of measuring results. Critics emphasize the insufficient concreteness of the concept of resilience and the existence of multiple concepts and definitions (I. Sudmeier-Rieux 2014). The United Nations defined the term for the field of civil protection. Resilience means the ability of a system, community or society exposed to hazards to timely and effectively resist, absorb, adapt and recover from the effects of hazards, including the preservation and restoration of essential basic structures and functions. The community's ability to recover in relation to any hazard or event is determined by the degree to which it is equipped with resources and the ability to organize before and during the need (United Nations 2016). Resilience means functioning without compromising long-term prospects for sustainable development, peace and security, human rights and well-being for all. The focus is on the capacity, that is, the capabilities of the community, and not so much on vulnerability, as was the case before. Terminology agreed at United Nations level defines capacity as the combination of all strengths, attributes and resources available in a community, society or organization to manage and reduce risk and strengthen resilience. Capacity thus defined may include infrastructure, institutions, know-how, and collective attributes such as social relations, leadership and management.

Capacity building is one way to reduce short-term and long-term disaster risks. In addition to the capacity for disaster response, it is important to strengthen the capacity for ecosystem management, the capacity for a higher level of self-organization, as well as the capacity for all areas that lead to disaster risk reduction and strengthening resilience. By strengthening capacity, we can reduce vulnerability, the increased sensitivity of an individual, community, property or system to the effects of threats (United Nations 2016). Vulnerability can be determined by physical, social, economic and environmental factors or processes.

2.2. European strategies and visions

The European strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy presented by the European Commission at the end of 2018 places Croatia in three regions with regard to climate exposure. These are: Mediterranean, mountain and continental regions (European Commission 2018). This complex situation can increase the spectrum and number of risks in our area.

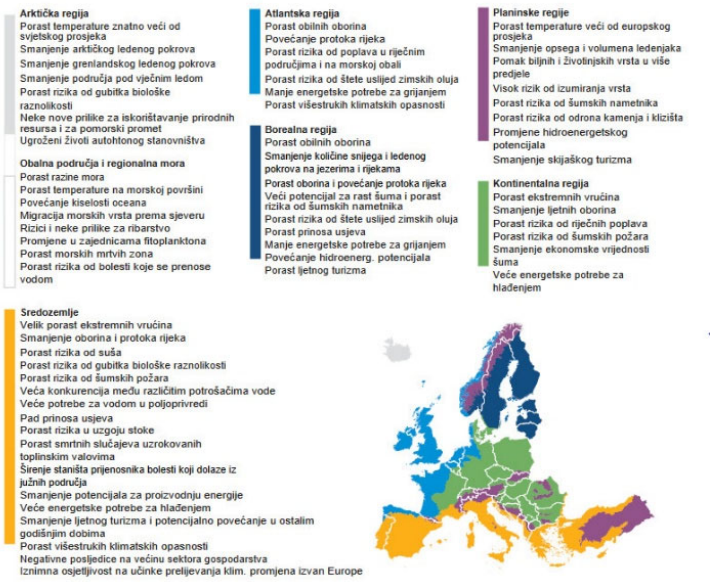

Figure 1. Consequences of climate change in Europe (Source: European Commission 2018)

The European Green Deal offers solutions to save the endangered environment and eliminate increased threats from natural disasters. Unlike the new EU climate change adaptation strategy, adaptation or disaster resilience are mentioned less. However, this does not reduce its impact on changes, and the Deal itself is called a growth strategy that will transform the European economy into a resource-efficient and competitive one by 2050 at the latest. It envisages the complete elimination of net greenhouse gas emissions because economic growth will no longer be linked to the use of resources that have led to climate change (European Commission 2019). Conservation and restoration of ecosystems and biodiversity mitigate natural threats. That is why the European Green Deal aims to strengthen the foundations for sustainable investments, and better integrate climate and environmental risks into the financial system, which will thus help increase resilience.

Creating a climate-resilient Europe – the EU's new Climate adaptation strategy aims to improve adaptive capacity and reduce vulnerability to climate impacts. It emphasizes the importance of knowledge about climate impacts and resilience, and the need for more and better data on climate-related risks and losses, which are important for making informed decisions. Data on climate-related risks and losses must include public and private losses due to climate change impacts such as loss of life, damage to infrastructure or commercial activities, as well as crisis response and recovery costs (Creating a Resilient Europe, 2021). The concept of resilience is mentioned more than 60 times in this strategy.

2.3. Croatian strategies for adaptation to climate change and disaster risk management

The strategy of adaptation to climate change in the Republic of Croatia for the period to 2040 with a view to 2070, as part of the assessment of the impact of climate change and vulnerability, also addresses the area of disaster risk reduction. It was pointed out that climate change can increase the probability of a disaster and increase its intensity. The main expected impacts with high or medium vulnerability are: landslides, floods, extreme temperatures, open fires, droughts, epidemics / pandemics and complex risks, especially in urban areas (Adaptation Strategy, 2020). The presentation of the impact and challenges of adaptation from this strategy in the area of disaster risk reduction has been supplemented and partially amended in the Disaster Risk Management Strategy until 2030.

The impacts and challenges of adaptation for the area of disaster risk reduction include "the exposure of the built environment and the probability of damage or loss due to a certain level of threat", and "increase in the frequency and intensity of floods and droughts" was also added. Issues related to construction and exposure of the built environment play a major role in disaster risk reduction. In addition, corrections were made to possible responses to reduce high vulnerability (**Table 1**).

Table 1. Adapted presentation of the impacts and challenges of adaptation to climate change in the field of disaster risk management (Source: Climate Change Adaptation Strategy in the Republic of Croatia for the period to 2040 with a view to 2070 (adapted))

Impacts and challenges causing high vulnerability	**Possible responses to reduce high vulnerability**
■ open space fires due to extended periods of high solar radiation and extended periods of high air temperature and longer dry periods ■ exposure of the built environment and the likelihood of damage or loss due to a given level of threat ■ increase in the frequency and intensity of floods and droughts ■ epidemics and pandemics, due to the way the disease is transmitted or the characteristics of the pathogen of the disease ■ increase in the extent of the health and socio-economic burden of the community due to the impact of risks caused by climate change	■ strengthening the competencies of key stakeholders in risk management related to climate change ■ strengthening the capacity to respond to major accidents and disasters ■ determination of multisectoral guidelines for actions related to climate change ■ expansion of the risk monitoring and assessment system using tools for monitoring risk indicators related to climate change ■ effective recovery from the consequences of major accidents and disasters ■ reducing community burdens after exposure to climate change-related threats

The management dealt with by the Disaster Risk Management Strategy is a complex process including national, regional and local levels of government and organizations operating at a horizontal level (civil society associations, companies, etc.). Disaster risk management means the application of policies and strategies that can be aimed at preventing emerging risks, reducing existing ones and managing residual risks. It also implies a contribution to strengthening resilience and reducing losses from disasters (United Nations 2016).

Climate change has influenced the greater acceptance of prospective and corrective risk management. Prospective risk management deals with activities and efforts to avoid the development of new or increased disaster risks and focuses on addressing risks that could develop if risk reduction policies are not put in place. On the other hand, corrective risk management deals with activities and efforts to remove or reduce existing risks. Although we

start from how risks can be influenced and effectively reduced, in the case of climate change, the process is long-term. Therefore, in addition to the, compensatory risk management including activities to strengthen both the social and economic resilience of individuals and societies is necessary due to facing a risk that cannot be effectively reduced. It applies to residual risk and includes preparedness, response and recovery activities and combines different financing instruments.

3. STRENGTHENING FINANCIAL RESISTANCE TO DISASTERS

3.1. Financial damages

Due to weather and climate extremes, damages in the 27 EU member states exceeded 487 billion euros in the last 40 years. This is significantly more than what the EU spends over two years on all its policies and programs. Germany, Italy and France had the highest costs caused by damages and Denmark, Austria and Luxemburg the biggest loss per capita.

From 2005 to 2014, Croatia was among the leading countries in the European Economic Area in terms of damages from natural disasters in relation to gross domestic product. According to the estimates of the NatCatService database, Croatia, Bulgaria, Romania and Latvia lead the way in terms of damages from natural disasters in relation to their GDP in the European Union (**Figure 2**). These are the data that European institutions rely on, which in general are not satisfied with the collection and availability of data on disasters.

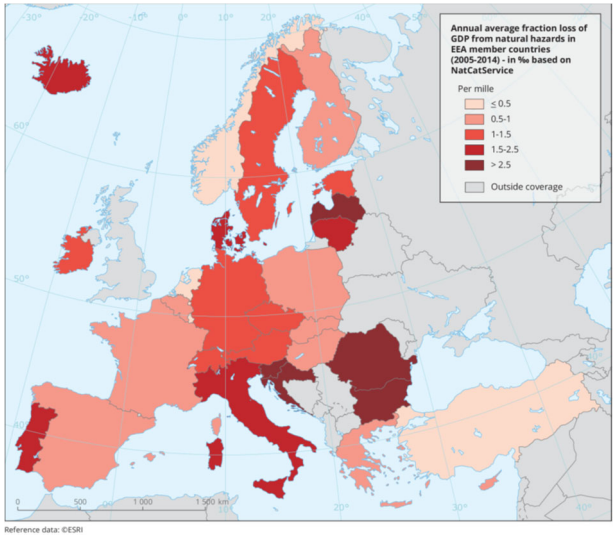

Figure 2. Average annual losses from natural threats for the countries of the European Economic Area from 2005 to 2014 (Source: https://www.eea.europa.eu)

The Register of reported damages from 2010 to 2018 maintained by the Ministry of Finance of the Republic of Croatia shows that the total amount of damages due to natural disasters in Croatia exceeded HRK 21 billion (EUR 2.8 billion). More than half of the amount was damage caused by droughts, floods and precipitation, and fires (**Figure 3**).

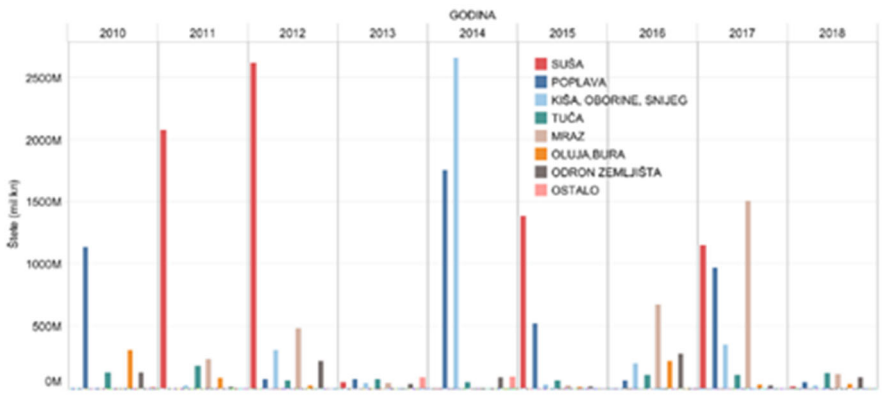

Figure 3. Damages due to natural disasters from 2010 to 2018 (Source: Register of reported damages of the Ministry of Finance of the Republic of Croatia)

The most damage due to natural disasters from 2010 to 2018 was reported by Primorje-Gorski Kotar County, Osijek-Baranja County, Virovitica-Podravina County and Vukovar-Srijem County (**Figure 4**.).

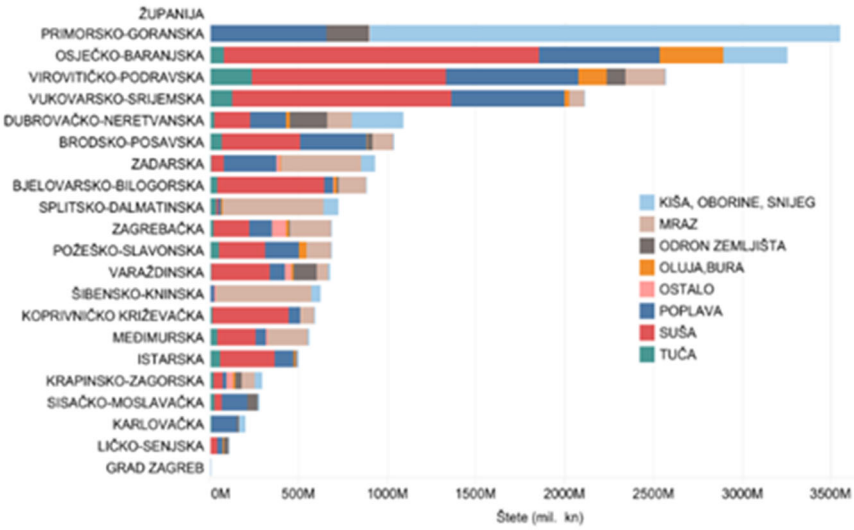

Figure 4. Damage from natural disasters by county from 2010 to 2018. (Source: Register of reported damages of the Ministry of Finance of the Republic of Croatia)

According to the data of the Register of reported damages, in 2011, Croatia had over two billion kuna damages (around EUR 265 million) due to droughts, and in 2012 as much as 2.6 billion kuna (around EUR 347 million). In relation to the number of inhabitants and GDP, the damage had more severe consequences than the catastrophic droughts in some developed European countries a few years later. Osijek-Baranja County, Vukovar-Srijem County and Virovitica-Podravina County suffered the most, i.e. the counties of the continental part of the country with developed agriculture.

Damage monitoring is important for correcting disaster and climate change policies, and also useful for both disaster risk assessment and strengthening financial resilience.

3.2. Strengthening resilience

Forecasts of climate indicators for the Mediterranean are worse than forecasts at the global level for most values. Climate experts for the Mediterranean region predict during the 21st century the following: increase in temperature, decrease in summer precipitation, increase in drought periods, both greater frequency and intensity of extreme events, increase in sea level and coastal flooding, as well as sea acidification due to increased amounts of carbon dioxide (Galeotti, 2020). Without mitigation of climate change, i.e. with expected warming of 3°C by the end of the century, forest fires and pest epidemics would be more frequent and severe. Due to the increased loss of biomass, the amount of carbon in the atmosphere would increase. The increase in warming would be accompanied by the reduced availability of water resources, which could reach 40% in the southern regions of Europe, and the lack of water and drought would affect agriculture, energy production and water supply. Mortality due to extreme heat would increase as much as 30 times (90,000 people per year compared to the current 3,000). Crop yields would fall by more than 10% in southern Europe, losses from river floods would increase sixfold. The increase in the risk of fire is greater in the lower latitudes of Europe. The PESETA IV study, which was carried out to better understand the consequences of climate change for the European Union, pointed out significant differences in risks between the north and south of Europe. Increasing global warming will bring more suffering to southern Europe due to high temperatures and water availability. Without mitigating climate change, human exposure to heat waves will increase 40 to 50 times in southern Europe, and about 30 times in other parts of the continent (Feyen, Ciscar, Gosling, Ibarreta, & Soria, 2020).

Therefore, strengthening resilience for Croatia as a country in the south of the European continent is more challenging. Models for four European regions – Mediterranean, Atlantic, Continental and Boreal show that the south of Europe can expect the most severe consequences due to droughts. The estimate of annual damages in euros at an average temperature increase of 1.5°C, 2°C and 3°C compared to the base year 2015 is shown in Figure 5. Vertical lines indicate climate uncertainty.

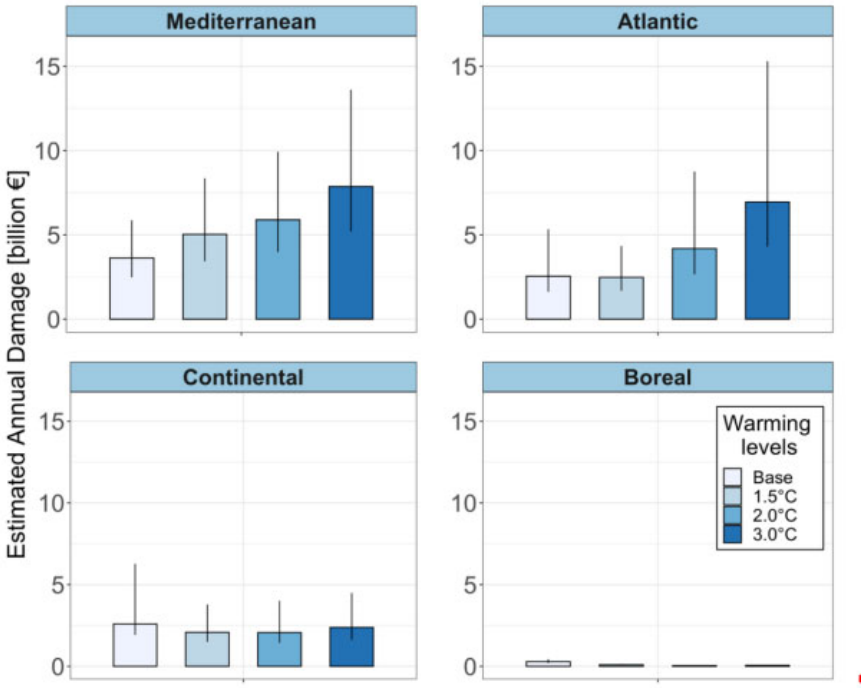

Figure 5. Annual damage due to droughts in billions of euros
(Source: JRC, Global warming and drought impacts in the EU)

As a country that belongs to both the Mediterranean and Continental region, Croatia can also expect: increase in extreme heat, decrease in summer precipitation, increase in the risk of river floods, increase in the risk of forest fires, decrease in the economic value of forests and increase in energy needs for cooling (European Commission 2018).

Due to the floods in 2014, according to data from the Ministry of Finance, Croatia suffered more than HRK 1.7 billion in damages (more than EUR 232 million). The PESETA IV study developed four adaptation strategies to reduce damages from river floods. These are: strengthening of the embankment system, construction of retention areas for flood water storage, measures to reduce damage to buildings and relocation to areas safe from floods (**Table 2**). For Croatia, as well as for most European countries, the most expensive thing is to do nothing in adapting to climate change.

Table 2. PESETA IV analysis results of four adaptation strategies to reduce damage from river floods at the EU level (Source: Climate Change Impacts and Adaptation in Europe, JRC PESETA IV final report (EUR 30180EN))

Savings / Adaptation strategies	Return of investment (per 1 EUR)	Reduction of economic damage (%)	Reduction of damage to the population (%)
Strengthening of the embankment system	2 – 2,9	41 - 68	41 - 65
Construction of retention areas	2,9 – 3,5	64 - 82	63 - 81
Measures to reduce damage to buildings	5,2	50	0
Relocation to areas safe from floods	1,2	17	16

Forest fires cost the European Union about 2 billion euros annually, and damage is beginning to be recorded in northern and central Europe as well. Since 1980, fires in Europe have burned more than 190,000 square kilometers of forest, which is the size of two Portugals. The record year in terms of damage in Europe was 2018, and in Croatia 2017. At that time, 67,343 hectares of forests were destroyed in 104 fires in our country. The acquisition of a new monitoring and notification system enabled a faster response, and the result is visible from

the data for 2019 (**Figure 6**), when, despite the greater number of fires, the size of the burned area is significantly smaller, and thus the damage.

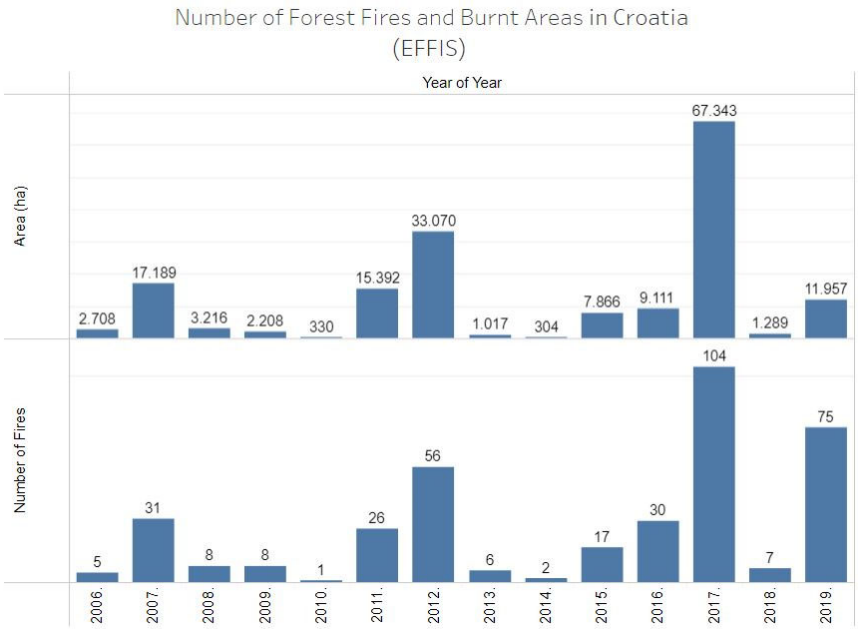

Figure 6. Number of fires and burnt areas

Disaster risk reduction and climate change adaptation are two practices that address increased disaster risk. Disaster risk reduction seeks to reduce the risk of natural and man-made disasters by reducing the exposure and vulnerability of people and property and increasing preparedness for such events, while climate change adaptation seeks to adjust reduce the potential negative effects of climate change on society in terms of climate extremes and gradual climate change. Despite their similarities, disaster risk reduction and climate change adaptation are strictly separated by institutional and administrative boundaries, although this does not exclude cooperation and information exchange.

Activities related to disasters and their consequences in Croatia are mainly EU-funded, and the country itself has very small reserves, mostly insufficient to repair damages caused by very high exposure to disasters (International Bank for Reconstruction and Development / The World Bank, 2021). As stated in the new EU strategy for adapting to climate change, resilience to the risks of climate change and natural disasters must be included in national fiscal frameworks. In addition to increasing the rate of household catastrophe insurance or public property insurance, this could significantly improve the management of insufficient finances in the face of future global warming.

Climate change adaptation measures do not make sufficient use of synergies with the field of disaster risk reduction. Better coordination at the national level could achieve better alignment of practices, norms, guidelines, goals, resources, and knowledge. Increased and improved communication and collaboration between those involved in climate change adaptation and disaster risk reduction enhances the learning process. Currently, climate change adaptation and disaster risk reduction use and apply the same terms, but still their meaning can be different, which confuses laymen and representatives of other professions. Linking knowledge enables better understanding, easier recognition, and research of overlapping areas, and would certainly have positive financial effects.

4. CONCLUSION

In the past decade, Croatia was faced with natural threats that caused enormous material damage. Risk assessments have established that, under the influence of climate change, threats have become more frequent and more intense. Building resilience is therefore an imperative for action highlighted in key development strategies. The forecasts of climate indicators for the Mediterranean, according to several experts, are worse for most of the observed values, and it is necessary to act intensively to mitigate climate change and reduce the risk of disasters. Our goal is common – to reduce the suffering of people, threats to their health, and to preserve both public and private property, preserve cultural assets and protect critical infrastructure. The path to that goal leads through environmental preservation, changes in the economy, but also through changing awareness of how the world around us is very vulnerable.

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