ECOSYSTEM-BASED DISASTER RISK REDUCTION IMPLEMENTATION FOR INCREASED RESILIENCE TO WATER-RELATED NATURAL HAZARDS

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Abstract: *Natural hazards related to water, e.g., hydro-meteorological events cannot be prevented. These hazards generate a majority of disasters globally. Although there is significant uncertainty regarding their occurrence in the future, the current body of knowledge indicates changes in frequency that will very likely increase the disaster risks. With no intention to discuss and elaborate on various threats to security and ecosystem services approaches definitions, an overview of the ecosystem services' role in local, national, regional and global disaster risk reduction is presented. The role of Eco- DRR in hydrometeorological disasters risk reduction and environmental security is supported by the synthesis of the elaborated contemporary policies, conventions and frameworks. As indicated for selected river basin, there is a rationale to increase Eco-DRR implementation in the policies and legal framework to reinforce sectoral cooperation and improve disaster risk management.*

Key words: *hydrometeorological hazards, Eco-DRR, water-related DRR, Natural Water Retention Measures, flood risk management*

(introductory lecture of the forum - work by invitation)

1. INTRODUCTION

Water-related disasters generated by hydrometeorological hazards have increased recently according to Centre for Research on the Epidemiology of Disasters (CRED) and UN office for Disaster Risk Reduction (UNDRR) report (CRED UNDRR, 2019). Document provide analyses of data available in the CRED Emergency events database (EM-DAT) and comparison for two time periods, i.e., 1980-1999 and 2000-2019. Results indicate significant increase in total number of disasters for later period, number of flood events, storms, droughts, high temperature, etc. In order to be recorded as a disaster in EM-DAT, an event must meet at least one of the following criteria: 10 or more people reported killed, 100 or more people reported affected, declaration of a state of emergency and call for international assistance *(ibid).*

Disaster is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources (UNDRR terminology, 2016). Disaster risk is compound of hazard (magnitude and frequency), exposure (people and their assets) and vulnerability (Estrella and Saalismaa, 2013). Changes in frequency of hydrometeorological hazards become reality and uncertainty of future intensity is still high. Thus, water related disaster risk reduction (WRDRR) complexity multiply and the main goal of DRR, i.e., preventing new, reducing existing and managing residual risk at the global level is advocated by Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR), to reduce disaster risk and losses in lives, livelihoods and health in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

Ecosystems (ES) and their services (ESS) interlinkage with DRR is integrated in SFDRR and consideration and incorporation of integrated environmental and natural resources management approach is recommended. SFDRR priority 1: Understanding disaster risk (article 23) specify that "Policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment, and Priority 3: Investing in disaster risk reduction for resilience (article 30-g) articulate mainstreaming of disaster risk assessment, mapping and management into rural development planning and management of, inter alia, mountains, rivers, coastal flood plain areas, drylands, wetlands and all other areas prone to droughts and flooding, including through the identification of areas that are safe for human settlement, and at the same time preserving ecosystem functions that help to reduce risks *(ibid).*

The role and significance of ecosystem services for integrated river basin management resulted in identification of measures that increase river basin capacity to retain water (Natural Water Retention Measures-NWRM), decrease flood risk and contribute to achievement of EU Water Framework Directive environmental objectives in the Tisza River Basin (Matic et al.,2021).

As elaborated in following this paper explains rationale for Ecosystem-based disaster risk reduction (Eco-DRR) better integration in the Disaster Risk Management Plans for areas prone to hydrometeorological risks and justify NWRM and Eco-DRR comparability that increase resilience to water -related disasters..

2. ECOSYSTEM SERVICES AND WATER-RELATED RISKS AND DISASTERS

Ecosystems services (ESS) are benefits provided by ecosystems (terrestrial and aquatic various categories) to human societies. There is increasing body of knowledge that indicate higher risks to water related disasters in areas with decreased ESS (e.g., development of human settlements in floodplain areas). Indeed, ESS higher level of service and proper management increase resilience to hydrometeorological hazards. Despite the ecosystems approach is illuminated in last decades by transposition in global, regional and national policy and legal frameworks, the ecosystem services approach and implementation span from ancient times to present. It is known by communities around the world, such as the centuries-old protection forests in Switzerland, and has been documented by scientists for decades (Estrella and Saalismaa, 2013).

2.1. Ecosystem services and hydrometeorological hazards

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2.2. Eco-DRR

Ecosystem-based disaster risk reduction (Eco-DRR) is the sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim of achieving sustainable and resilient development (Estrella and Saalismaa, 2013). Since Eco-DRR definition inauguration it has been used by scientific and practitioners' communities in all sectors relevant for DRR management.

Table 1: ECO-DRR selected examples *(excerpted from Sudmeier-Rieux et al., 2019)*

Ecosystems	Hazard Mitigation
Mountain forests vegetation on hillsides	Floods reduction by peak runoff control Drought mitigation Erosion reduction Increased slope stability
Wetlands Floodplains Lakes and Riverine	Flood control Reduce speed and volume of runoff Realise wet season flows during drought periods

Data exhibited in table presents some of the ES benefits and their HESS (flood reduction, drought mitigation, runoff speed and volume reduction) that contribute to hazard mitigation. In addition, they often contribute to multihazard DRR, mountain forests and hillsides vegetation mitigate peek runoff and landslides due to slope stability.

Difference of the same hazard impact and disaster magnitude du to area cover by forest on the island of Hispaniola (divided by Haiti and Dominican Republic) during the intense rainfall (24–25 May) and Tropical Storm Jeanne (mid-September) in 2004 is enormous as elaborated in Estrella and Saalismaa, 2013. Total causalities for two disasters are 5,419 and 702, on Haiti and Dominican Republic, respectively. Difference in the GDP and human poverty index between countries are tremendous and very likely contribute in disasters magnitude during the 2004. Total area covered by forests in Dominican Republic (1,972,000 ha, 40.8%) and Haiti (105,800 ha, 3.8%) is tremendous (*ibid*).

2.3. Eco-DRR implementation limitations, issues and constrains

Eco-DRR as a part of DRRM is a complex and demanding, requires multidisciplinary teams' commitment to cooperation, horizontal and vertical linkage, and system thinking. Example presented in preceding clearly underline that misunderstanding, single sector approach, lack of hydrological processes understanding at the local and regional level very likely generate devastating disasters.

This ecosystem based approach should not be viewed as a single solution to risk reduction. It should be part of a larger disaster risk management strategy and should always be complementary to other essential risk management measures and activities. Like all DRR activities it reduces risk but doesn't remove risk (Estrella and Saalismaa, 2013).

Not all hazards can be effectively mitigated by ecosystems, which is for instance the case for earthquakes (Sudmeier-Rieux et al., 2019). When it comes to hydrometeorological hazards like floods, the magnitude of flood event can be limiting factor and Eco-DRR or similar ecosystem based approaches (NWRM) are more suitable for mor frequent events of lover magnitude. Integration with the existing /future grey infrastructure should be considered whenever is possible, e.g., retention of water at the large dams' reservoirs catchment will decrease sedimentation and water amount discharge.

In addition to before mentioned, space availability and land price might be limiting factor in urban and peri urban areas. Even it the rural areas with low population density, lack of effective legal framework or its implementation at the local level without support of local population and political will should be consider as a constrain. With respect to local level it is very important to have comprehensive understanding of natural features to avoid purely copy paste with respect to DRR planning.

3. ECO-DRR, WATER RETENTION AND RISKS

The regenerative potential of the social and natural systems envisaged in the aligned intergovernmental agendas will be better understood, and progress will be accelerated, by incorporating systemic risk and systemic opportunity into the design of policies and investments across all scales. Figure 1 depict the main objectives of contemporary DRR given the characteristics of systemic risks in different domains (UNDRR, 2019).

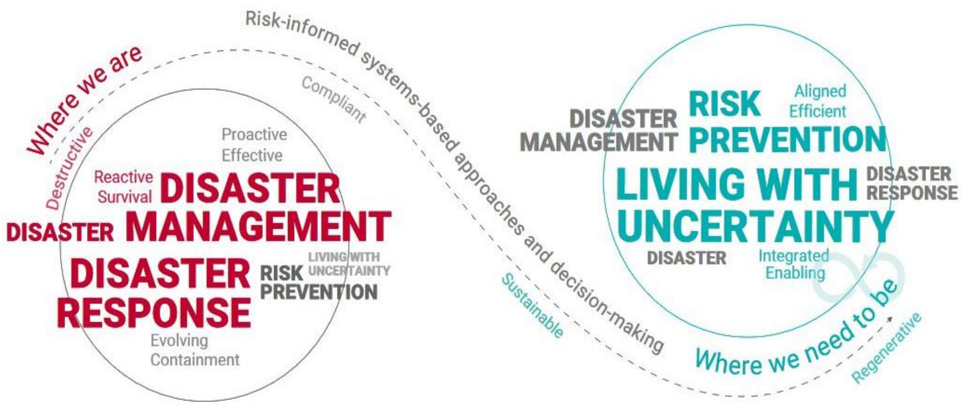

Figure 1. Innovation curve" – from destructive to regenerative approaches "
Source: (UNDRR, 2019)

SFDRR (2015) transpose ESS in number of its priorities, goals and targets. Over 190 countries report their transposition advancement in national DRR policies and legislation (strategies, laws, by laws, action plans, etc) transposition. It is not quite clear to which extent systemic approach depicted at the Figure 1 is implemented in DRR plans.

Secondly, when it comes to hydrometeorological hazards there is always uncertainty with respect to extreme events (floods, droughts, heavy rainfall, etc) frequency and magnitude, regardless all advancement in technology. These uncertainties might have adverse effects on planning processes due to overestimation or underestimation of future events estimation.

Solution based on ecosystem services (ESS) concept for water - related disaster risks reduce vulnerability and exposure by regulating natural phenomena extremes. They are characterized by multi- benefits, multidisciplinary approach and are consider as a no regret, win -win measures (Estrella and Saalismaa, 2013; Sudmeier-Rieux et al., 2019, European Commission, Directorate-General for Environment -EU DGE, Jaritt, N., Williams, H., Hanus, A., et al., 2016).

3.1. Natural Water Retention Measures

Natural Water Retention Measures (NWRM) are multi-functional measures that aim to protect and manage water resources using natural means and processes, therefore building up Green Infrastructure, for example, by restoring ecosystems and changing land use. NWRM have the potential to provide multiple benefits, including flood risk reduction, water provision, groundwater recharge, etc. As a result, they contribute to achievement of the key EU policies such as the Water Framework Directive (WFD) and the Floods Directive (FD) among the others (EU DGE, Jaritt, N., Williams, H., Hanus, A., et al., 2016). Some of the NWRMs are: retentions, reforestation, buffer strips, natural terracing, etc. Given the NWRM scope and goals their location and selection require hydrological and environmental analyses.

Despite definitions used by different sectors for ecosystems solutions (Nature Based Solutions, EbA, Eco-DRR, etc) NWRM overlapping with Eco-DRR concept and strong interlinkage in water -related disasters is no doubtful.

3.2. NWRM application at the Tisa River Basin

The largest sub-basin of the Danube River Basin-the Tisza River Basin (Figure 2) drains an area of 156,869 km² is shared by Tisza countries (Ukraine, Slovakia, Romania, Hungary, and Serbia) and can be divided into two main parts: the mountainous Upper and the Lowland Tisza Basin. Its transboundary water resources management is built on the Tisza countries co-operation within the scope of the International Commission for the Protection of the Danube River (ICPDR) Tisza Group.

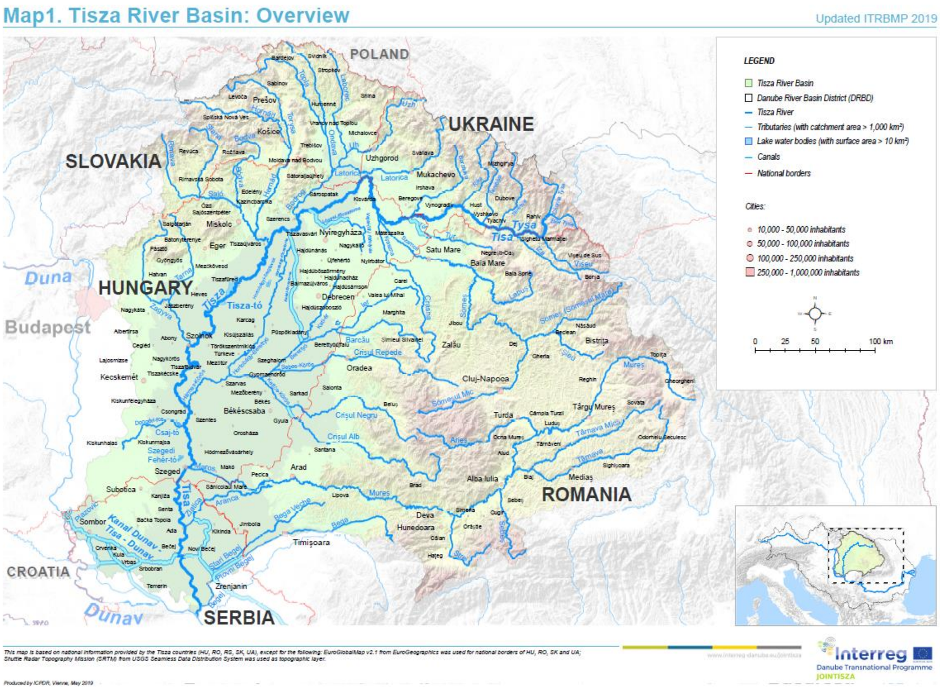

Figure 2. Tisza River Basin overview
Source: (ITRBMP 2019)

Updated ITRBMP 2019 incorporates elements of the flood risk management plan – flood risk reduction measures reported by Tisza countries through ICPDR DANUBE GIS database following the procedures. As a subcategory of these measures Tisza countries collected data and information and reported the potential identified “win-win” measures associated to flood risk management that might lead to achieve the objectives of EU WFD in the Tisza River Basin (TRB).

Tisza countries proposed measures that are based on national official data included in river basin and flood risk management plans at the level of river basin, sub-basin, and river district, the most effective approach for water management based on the natural geographical and hydrological unit for integrated river basin instead of administrative or political boundaries.

Total number of “win-win” measures included in the ITRBMP 2019 (Endorsed by Tisza Countries Ministries Memorandum of Understanding signature in September 2019) is 65 with 36 measures being identified as a NWRM and other measures that advocate for increase of retention capacity (Matic et al., 2021). Figure 3, subcategories of NWRMs identified by Tisza Countries.

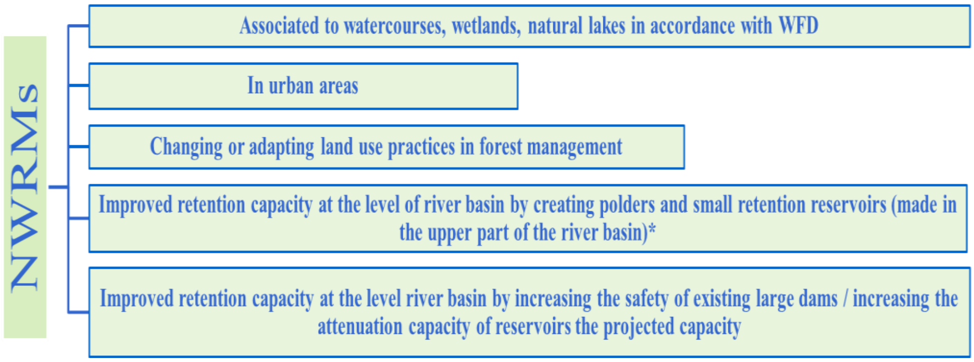

Figure 3. NWRM subcategories for flood risk management within the TRB
Source: (ITRBMP 2019)

4. CONCLUSION

The rationale for Eco-DRR concept implementation will result in resilience to water -related natural hazards. The contemporary DRR at the global level SFDRR 2015 advocates for ecosystems and their services consideration in DRR at local regional, national and transboundary level. Implementation of the Eco-DRR should not be viewed as a single solution to risk reduction and effective cross-sectoral cooperation, diverse stakeholders’ interactions, participatory approach, and update of plans. Since it is multidisciplinary approach comprehensive understanding of the natural features, social aspects, policies, and constrains is mandatory for improved DRR. Interaction between Eco-DRR and NWRM concepts and objectives to support increase in resilience to water related natural hazards is evidence based for Tisza River Basin flood risk management.

Different definitions and concepts (Eco-DRR, NWRM, NbS, EbA, etc) based on ecosystems, their services and benefits might result in low level of acceptance among practitioners and general public, combined with confusing statement that this is a new approach, although majority of measures all implemented for centuries around the world at the local level. In some publications they are advocated as the wizard stick, with no clear message on constrains, with respect to low probabilities events, land ownership, potential space limits in urban areas, etc. That might increase scepticism and rejection among stakeholders and decision makers, despite the great number of benefits that are evident. Eco-DRR concept for low probability high magnitude events should be considered as a support for grey infrastructure. More research, better monitoring of already included and applied ecosystem based concepts will increase their integration in policies at the national level.

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