Impact of nature based solutions for flood risk management on soil and agricultural development - EU consideration and Serbian prospective

Stričević, Ružica; Srđević, Zorica; Đurović, Nevenka; Lipovac, Aleksa; Kapović Solomun, Marijana; Zupanc, Vesna; Potočki, Kristina

IMPACT OF NATURE BASED SOLUTIONS FOR FLOOD RISK MANAGEMENT ON SOIL AND AGRICULTURAL DEVELOPMENT - EU CONSIDERATION AND SERBIAN PROSPECTIVE

Ružica Stričević[a]*, Zorica Srđević[b], Nevenka Đurović[a], Aleksa Lipovac[a], Marijana Kapović Solomun[c], Vesna Zupanc[d], Kristina Potočki[e]

[a]University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Zemun, Serbia
[b]University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića, 8 21000 Novi Sad, Serbia
[c]University of Banjaluka, Faculty of Forestry, Bul. Stepe Stepanovića 75A, Bosnia and Hercegovina
[d]University of Ljubljana, Biotechnical Faculty, Jamnikarjeva 101, Slovenia
[e]University of Zagreb Faculty of Civil Engineering, Savska c. 16, Zagreb HR-10000
*Corresponding author: sruzica@agrif.bg.ac.rs

Abstract

Throughout history, floods have played one of the most important roles in soil formation, maintenance and modification of soil fertility. Flooding of rivers left mud full of organic matter in the fields, salts were washed out of the soil, and a large amount of water was retained in the soil profile. Urbanization on the banks of rivers, regulation of water flow, and construction of dams for flood control narrowed river beds and increased hydraulic flow, resulting in greater concentration of flood waves during floods and shortened flood control times. Since the beginning of the 21st century, numerous large floods have occurred across Europe. Various climate models suggest an increase in the frequency and intensity of future flood events. Dams were built to accommodate flood waves with a return period of 50 years on smaller watercourses and 100 years on large rivers. Floods with higher return periods may or may not occur at all. In this respect, dams are no guarantee that towns and agricultural land can be successfully protected from flooding, so their enhancement is questionable. In recent decades, there has been extensive debate about the use of agricultural land for flood protection of cities and industrial areas, about the cost of land and agriculture. Since private property is involved in both cases, a compromise solution should be found that satisfies all parties. The main theme of the COST project LAND4FLOOD is to consider all aspects of flood risk management and land management, such as.: geographical, hydrological and hydraulic, ecological (soil pollution, compaction, water retention, ecological services, habitat restoration), agricultural (agricultural development in the area reserved for temporary water retention), economic (how to compensate damages or provide incentives for flood retention, public subsidies), public participation (how to ensure the participation of landowners), property rights issues (how to allow temporary flood retention and what does it mean for agricultural use) and sociological. The aim of this paper is to present some reflections on flood risk management and its implications for land and agricultural development in the EU, as well as some considerations on the implementation of the NBS in Serbia from the perspective of flood protection, land protection and agricultural development..

Keywords: Soil, Flood, Nature-based solutions, agriculture, LAND4FLOOD

INTRODUCTION

In recent decades, climate-related extreme events have increased in Europe, with hydrological events, in particular, outweighing flood risks, causing damage and placing an increasing burden on national economies (Kron et al., 2019; EASAC, 2018). Various climate models suggest an increase in the frequency and intensity of future flood events across Europe (IPCC, 2018). Dams have been built to accommodate flood waves with a return period of 50 years on smaller watercourses and 100 years on large rivers. Floods with higher return periods may or may not occur. Many European countries have already experienced severe floods on large rivers (Kundzewicz et al., 2017), as shown by this summer flood in Germany and Belgium. Therefore, dams are no guarantee that cities and agricultural land can be successfully protected from floods, which makes their valorisation questionable. In recent decades, there has been extensive debate on the use of nature- based solutions (NBS) for flood risk management, including the use of agricultural land for flood protection of cities and industrial areas at the expense of land and agriculture (Hartman et al., 2019; Bridges et al., 2021). Since private property is involved in both cases, a compromise solution should be found that satisfies all stakeholders (Thaler and Hartman, 2016; Alvarez et al., 2019). The main theme of the COST LAND4FLOOD project is to consider all aspects of flood risk management and land management, such as: economic issues (e.g., how to compensate for or incentivize flood retention services); property rights issues (e.g., how to allow temporary flood storage on private land); issues of public participation (e.g. how to ensure the involvement of private landowners) as well as issues of public subsidies (e.g., how to integrate/mainstream flood retention in agricultural subsidies). (https://www.land4flood.eu/land4flood-project/; Löschner et al., 2021; Kaufman et al., 2021; Slavíková et al., 2020). The aim of this paper is to present some considerations on flood risk management and its impact on land and agricultural development in the EU and surrounding countries, as well as some considerations on the implementation of NBS in Serbia from the perspective of flood protection, land protection and agricultural development.

NATURE BASED SOLUTIONS: IMPLICATION ON SOIL AND AGRICULTURE

Floods are natural phenomena that affect settlements, human activities and ecosystems. In order to prevent adverse effects on nature, economy and society, appropriate measures must be found and applied. Flood risk management aims to reduce the impact of floods (EEA, 2017). Ensuring risk management measures such as prevention (spatial planning so that the space reserved for flooding by the river/sea is not consumed), protection (dams and other structures, flood management) and preparedness (forecasting and communication, awareness raising, education and information, early warning) are often cited as the most effective approach in the EU and surrounding countries (Geaves and Penning-Rowsell, 2016). Although technical and engineering methods and measures still prevail in many countries, a new approach to flood management based on natural solutions (NBS) has been introduced in recent decades. These solutions for risk reduction and adaptation in river

basins include Natural Water Retention Measures (NWRM), which include: Interception (retention of water in and on plants), increased transpiration of plants, enhanced soil infiltration, ponds and wetlands, and reconnection of floodplains. These measures have the potential to reduce extreme runoff, helping to offset extremes (Hartman et al., 2019). In addition, floodplain restoration is considered NBS, i.e., creating more space for the river, restoring degraded terrestrial ecosystems (grasslands, croplands, and forests), and retaining water in the upper part of the watershed.

If we look at NBS from the perspective of applicability, this means that all measures involve the use of private land for temporary water retention to mitigate the flood e for the benefit of others (mostly cities). However, some measures include improving infiltration rates by ploughing under, cross-cutting, applying farm manure to increase organic matter to improve soil structure, installing a water borehole or drainage system, and the like. Various stakeholders are involved in the implementation of these measures, such as policy makers, planners and Non-Governmental organisations, who may have different views on problems and desired outcomes (Posthumus et al., 2008). The European Commission and many academics advocate NBS, often framed positively in terms of 'solutions', 'win-win' or 'no-regret' options. However, recent articles have also criticised the NBS for promoting a utilitarian approach with neoliberal values (such as a focus on quantifiable benefits, profit, quick economic returns and growth), but ignoring inherent social and environmental inequalities and injustices, and the associated negative societal consequences (Kaufman et al, 2020), e.g., changing property values, displacing residents who can no longer afford these costs to areas with lower quality housing, ultimately increasings community segregation, etc.

A study conducted in United Kingdom on the perceptions of local stakeholders and farmers found that they can only contribute to flood risk management if landowners go beyond good agricultural practice and take measures to reduce runoff from agricultural land for the public good by implementing runoff retention measures such as water storage ponds, and they should be compensated for the additional costs involved (Posthumus et al., 2008). However, stakeholders should be informed and advised by experts on appropriate measures and establish demonstration sites that clearly show how the measures can make a difference.

In Austria, there are significant ongoing processes to shift certain flood risk management tasks and responsibilities from the national to the local level. The new policy direction underlines the importance of linking actors at the same and different levels, especially between the local and the national level. The main work of local actors relates to negotiations with private landowners for compensation agreements or purchase of farmland. Private landowners have the power to block the implementation process. However, their interest strongly depends on whether they are directly affected by flood protection measures (Thaler et al., 2017). The study site in the Aist River basin demonstrates an approach to flood risk management based on upstream-downstream relationships. Downstream communities, which are at higher risk of flooding, contribute significantly more than upstream communities, as compensation for taking land and sharing risks in a regional setting. Even when solidarity-based risk-sharing is agreed upon, there is evidence in practice that both sides benefit due to commuting relationships and economic linkages (Seher and Löschner, 2018).

Collentine and Futter (2018) highlight that many scholars suggest short-term flooding of farmland as a tool for downstream flood management because it is less costly to pay farmers for temporarily flooding of upstream land than for urban flood damage. However, it is important to determine whether changes in the management of rural land, such as blocking drains or agricultural practices such as retaining stubble that increases surface roughness and thereby slows water flow, or compacting the soil due to water pressure to increase runoff, siltation, and the like, should qualify for additional compensation or be considered part of the basic requirement to maintain the land in "good agricultural or environmental condition" required to receive the single farm payment. In addition, the authors note that the implementation of NWRM in Sweden (measures based on drainage management and short rotation coppice) may contribute to water retention but may also lead to loss of agricultural income and therefore trade-offs in the inclusion of agricultural land are necessary.

In the countries of Central-Eastern Europe such as Slovenia, social acceptance of purely green measures is limited and often meets resistance in the planning stage due to institutional path dependency related to the implementation of grey measures in the past, as well as related land use restrictions on land under nature-based solutions (Glavan et al., 2020). Due to the specific topographical and geographical characteristics in Slovenia and the high degree of urbanisation of floodplains, site-specific conditions and the impact of different measures on hydrological conditions in the catchment and consequently on flood risk need to be assessed before measures are implemented (Johnen et al., 2020).

In the Republic of Croatia, green measures have been included in recent legislation, e.g. River Basin Management Plans or National Climate Adaptation Strategy, where they are recognised as flood risk management and climate adaptation measures. Although current flood risk management measures still rely heavily on traditional 'grey' elements, there are also large-scale flood protection programmes that have integrated semi-natural retention systems and natural floodplains in the lowland areas of the country, in the Sava and Drava River basins (Potočki et al., 2021, Schwartz, 2018). NBS are also supported by payment mechanisms, e.g. in the Forest Act and Rural Development Programme, where funds are allocated for some forest management measures and for "restoration of habitats important for biodiversity conservation (e.g. meadows, pastures and ponds for livestock watering)". But this approach is not yet widely used or recognised as a useful mechanism (The Biodiversity information system for Europe, 2021, Vuletić et al., 2020).

When the Republic of Serbia became an official candidate for membership in the European Union, it had to transpose EU legislation into national law, including the principles of the EU- Water Framework Directive (WFD) and the EU Floods Directive. The EU legislation forced Serbia to prepare flood risk maps and expand its flood risk management measures by now considering, among others, nature-based solutions (NBS) (Kaufman et al., 2021). Such a method of flood management has not yet been formally adopted. Ongoing activities in the context of the implementation of the EU Flood Directive are i) the evaluation of the existing River Basin Management Plan (RBMP) development process, ii) the improvement of the knowledge and practices of Rural Water Directorate and technical bodies in relation to stress and impact analyzes, cost recovery and cost-effectiveness analyzes, and iii) the

increased involvement of the public and stakeholders in the development of elements of RBMPs.
In this context, the Water Protection Improvement Study (Study, 2020) was prepared for the case study of the Kolubara River. This river was selected due to the 2014 flood, as the existing infrastructure was not able to protect the area from the negative impacts of the flood. The aim of this study was to develop a concept for integrated flood protection, including both structural and non-structural measures: Erosion control in the catchment area, retention of water in the upper parts of the catchment area, creation of water retention areas, modernization and reconstruction of flood protection facilities and nature-based solutions. Many other activities related to the implementation of the Water Framework Directive are underway (www.srbijavode.rs; www.vodevojvodine.com).

DISCUSSION

Like the global policy framework, EU policy also supports to varying degrees the adoption and implementation of NBS (EEA Report, 2021) by enabling permanent innovation based on research and experimentation through the EU funding programme Horizon 2020 and continuing in the upcoming Biodiversity Partnership at Horizon Europe, the next EU Framework Programme (2021-2027) (European Commission, 2021). Therefore, each country applies NBS measures according to its needs and natural conditions. The work of Thaler et al. (2020) discussed the different legal frameworks for compensation in Austria and the Netherlands, and thus the different nature of compensation for land use. In many countries, compensation is paid for actual damages (yield losses) in case of floods, neglecting the fact that actual negative impacts can occur in different ways (e.g. restrictions on agricultural land in flood polders, obligation to tolerate measures related to the construction or maintenance of water protection structures). No special consideration is given to restricted agricultural development on land designated for temporary flooding. Farmers are discouraged from investing in highly profitable enterprises (greenhouses, orchards). Needless to say, land in the plains designated for flood retention of major rivers such as the Danube, Rihne, and Maine is prone to compaction and pollution from various pollutants that could prove harmful to humans in the food of animals (grazing livestock) and consequently in meat or milk. This concern about pollution was triggered by the negative impact of the 2014 floods in Serbia, which certainly degraded the quality of surface waters and all water-related ecosystems (Ristić et al., 2021; Solomun et al., 2021). Pollution risk assessments have been carried out in all affected agricultural areas and the resources required for remediation and restoration of soils have been identified for government needs (SEPA; 2014). However, the possibility that affected people could achieve environmental justice and claim a compensation fee for land rehabilitation, e.g. in small farms, is difficult to demonstrate, as scientists are cautious and dispute in certain segments that the changed condition is solely due to the floods or that different guidelines and quantitative indices have different degrees of risk (Čakmak et al., 2018; Antić Mladenović et al., 2019).
As the application of the NBS approach is long process, the use of land and compensation for loss should be based on a broader consideration, through public participation, because

we need to leave the land in the same or better condition for the new generation and currently live and work from agriculture, which means that compensation should be based on economic, environmental and social justice when land is used to mitigate the negative impacts of flooding downstream.

CONCLUSION

NBS as a complementary measure to flood defence infrastructure, with the approach *keep water where drops*, to mitigate the rapid concentration of flood waves and thus the downstream adverse effects. Each country, whether in the EU or surrounding countries such as Serbia, has specific topographical and hydrological conditions, so the implementation measure should be site-specific, as per EU policy. Serbia, as a candidate country for EU accession, is expanding its flood risk management measures taking into account the implementation of the NBS. The implementation has not been done yet, only a case study has been prepared for the Kolubara River. The main challenge in implementing the NBS is compensation for land use to achieve social, procedural and environmental justice in the interest of farmers and people and structures protected upstream. As in EU countries, the development of NBS measures in Serbia should be constantly improved, tested and researched. Land use and compensation for loss should be based on a broader consideration, through the public participation, in order to leave the land in the same or better condition for the new generation that currently lives and works from agriculture.

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