EIP-AGRI Focus Group

Nature-based Solutions for water management under climate change

Minipaper: Assessing the socio-economic and environmental benefits of NbS: Challenges and future perspectives

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INTRODUCTION – MOTIVATION

The potential for introducing Nature-based Solution (NbS) approaches into farming operations, rural planning and policy-making is increasingly gaining attention from farmers, scientists, and decision/policy-makers as approaches that offer sustainable and cost-effective solutions for natural resources management and cross-cutting challenges including biodiversity conservation, climate change adaptation, public health and well-being. In this perspective, NbS are seen as open innovations that involve multiple groups, and provide co-benefits that are able to bridge economic and social interests, stimulating new green rural economies and green jobs. However, important questions remain about how to assess the environmental and socio-economic impacts of NbS within and across different societal challenges and the scales of intervention.
Aim of this work is to explore existing challenges in the assessment of NbS benefits and open-up the innovation process to all active actors, in order to provide new ideas that could be transformed into tools, services and practices that contribute to the evaluation of NbS impacts on the key environmental and societal challenges of rural European areas.

ASSESSING THE BENEFITS OF NbS

Scope

The challenges that the agri-food sector is facing today due to climate change, geopolitical developments, as well as the impacts of COVID-19 pandemic, requires transformative changes in technological, economical, and socio-ecological activities to address human needs while preserving Earth's systems. Nature-based Solutions (NbS) for water resources management are gaining importance as solutions that integrate societal challenges and nature conservation in rural landscapes. According to the Resolution adopted by the United Nations Environment Assembly (2022), Nature-based Solutions are defined as 'actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits.' In this perspective, they have the potential to offer long-term transformative pathways to agri-food sector towards sustainability (Takavakoglou et al. 2022). However, these efforts are often slow in catching on and the uptake of these solutions for water resources management at farm level or small agricultural catchments, is facing difficulties. This is because their benefits are not always straight forward, and the full-scale assessment of their socio-economic and environmental contribution/benefits lacks operational documentation on a solid basis. This is directly related not only to decision-making in terms of planning, but most important to their effectiveness and impact as part of farm management measures, rural development policies (including Eco-Schemes) and overall strategies related to environment, society and economy.

State-of-the-art

Overall, the benefits and co-benefits of implemented NbS can be observed in different domains and contexts. However, systematic evaluation frameworks that can assess their full potential (as well as their possible side effects) are still lacking (Ruangpan et al. 2020) especially regarding their applications in water resources management of agricultural areas. Such frameworks are needed in order to quantify the benefits so that farm operators and decision makers have a better understanding of their advantages and disadvantages. There are several existing frameworks that can be found in the literature, most of them aim to evaluate potential benefits of future NbS as in case of World Bank implementation guidance framework, others focus on hydro-meteorological benefits, others provide only qualitative assessments,

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while a vast majority is focused on NbS for urban areas (Veerkamp et al. 2021, Raymond et al. 2017a, Watkin et al. 2019).

A global systematic map of evidence on the effectiveness of nature-based interventions elaborated by Chausson et al. (2020) using data from literature review. Another effort to assess the effectiveness of NbS for climate change mitigation and adaptation was made by Kabisch et al. (2016). This work indicated four general types of indices used for integrated environmental performance, addressing human health and well-being as well as citizen involvement analysis and management. In 2017, the NbS effectiveness of urban green/blue infrastructure versus alternative approaches was explored by Sowińska-Świerkosz et al. (2017).

Recently, a new evaluation framework of NbS projects-at the stage of solution selection, was published by Sowińska-Świerkosz and Garcia (2021), based on the application of performance questions and indicators. One of the most extensive studies on the evaluation of NbS projects was made in the report of the ECLIPSE working group of experts (Raymond et al., 2017b), regarding the environmental/social/economic benefits of NbS and the need for an integrated system of indicators. The need for indicators that are based on best-practice principles, is also stressed in IUCN (2020) global standards for NbS. These indicators should be able to reflect *inter alia* the relevance with societal challenges, ecosystems and biodiversity, socio-economic aspects of livelihood as well as potential trade-offs between the benefits provided by an NbS. According to a latest European Commission publication on NbS (Science for Environment Policy, 2021), effective interventions should be evidence-based, integrate traditional knowledge and be supported by the best available data, research and practice. Furthermore, the publication emphasized that the elaboration of clear evaluation criteria and methods will encourage appropriate uptake and implementation of NbS. These criteria would provide the basis to build a framework constituting a multi-criteria decision-making approach to account for direct and indirect effects and benefits that different interventions may provide including the trade-offs between them.

In addition to the above, several EU funded projects are aiming to address the challenge of assessing NbS benefits, as for example the *Mara-Mediterra* project (2022-2025) recently funded by PRIMA Foundation under H2020. The project focuses on the use of NbS for water resources management in rural Mediterranean landscapes and aims, among others, to provide a ground-breaking approach for assessing environmental and socio-economic benefits of NbS in relation to the Land Degradation Neutrality concept and associated SDGs.

Nature Based Solutions can play a key role in enabling sustainable development thus sustainability assessment frameworks may provide a valid approach for assessing their benefits. Focused on agriculture, Alaoui et al. (2022) provides an overview of Sustainability Assessment Frameworks including the following:

- The Sustainability Assessment of Food and Agriculture systems (SAFA) is proposed by FAO to assess the environmental and social impacts of food and agricultural operations.
- The framework Response-Inducing Sustainability Evaluation (RISE) was developed to facilitate the evaluation of environmental, sociocultural and economic sustainability of farm operations.
- The Multiattribute Assessment of Sustainability of Cropping Systems (MASC) framework was developed by INRA (Institut National de la Recherche Agronomique) to assess how cropping systems contribute to sustainability at the farm level.
- The Land Degradation Assessment in Drylands tool (LADA) was developed by FAO for assessing and quantifying the nature, severity, impact and extent of land degradation on ecosystem services across different spatial and temporal scales.
- The Sustainability Monitoring and Assessment RouTine (SMART) was developed by FiBL (Research Institute of Organic Agriculture) to assist farms and enterprises in the food sector for assessing their sustainability level in a credible and transparent manner.

The above-mentioned frameworks have different characteristics regarding their assessment methodologies, time and data requirements to operate, and different outcomes with a different accuracy and level of complexity. However, they may provide a solid basis for the development of frameworks and tools targeted to NbS.

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Challenges and opportunities

The conceptual foundations of NbS have been formed by a diverse collection of cross-cutting ideas, resulting in a broad range of definitions, objectives, and applications. As to other paradigm shifts, NbS confront similar challenges, including: insufficient luck of costs and benefits understanding as well as complex externalities in their assessment; knowledge gaps of applications and their effectiveness; limited awareness and lack of long-term perspective; diverse stakeholder perceptions and values; lack of scientific and technical support; lack of operational examples and hands-on experience. In this perspective, the assessment of NbS' benefits represents a challenging task that should be further explored and documented, both from scientific and practical point of view, with tangible findings, results, and outcomes that will provide the required profs of concept. Main challenges in the assessment of effectiveness and benefits include:

Spatial aspects of interventions in relation to impacts/benefits
NBS confront challenges common to other complex systems for water resources management, which stem from heterogeneities (climatic-ecological, economic and social), connectivity and spatial flows, working across scales, and cross-domain feedbacks, as for example between social and environmental domains. Scalar challenges include working across spatial and ecological scales as well as administrative boundaries. Furthermore, the delayed accrual of some benefits generates temporal mismatches especially regarding the timing of interventions and their outcomes. The literature acknowledges the variation in scale, type and size of projects but there remains a gap of knowledge regarding both the scale of impact and the scale of activity necessary for maximizing sustainability (Gomez et al. 2020; Nelson at al. 2020)

Time horizon of assessment
The problem with current evidence for the benefits and cost-effectiveness of NbS for agricultural water resources management is that appraisals underestimate the economic benefits of working with nature, especially over the long term. Changes in the provision of ecosystem services over time, for example, under climate change and other stressors, are not efficiently considered, and there are major questions about how to balance future benefits with current costs. Engineered solutions can usually be implemented with relative certainty in terms of type and time-scale of benefits. On the other hand, NbS generally offer more flexible long-term alternatives with benefits that might not be reaped when the costs are felt.

Perspective
Appraisals rarely factor in trade-offs among different interventions and ecosystem services, or between stakeholder groups, which may experience the costs and benefits of NbS differently. For example, the importance (and value) of field margins for flood water management and non-point source pollution control is different between a farmer that needs pollinators, the tourist that crosses the area, or a fisherman in a neighbouring water body, reflecting differences in the extent of dependency on natural resources. In addition, NbS often involve multiple actions over fragmented fields within agricultural watersheds, crossing jurisdictional boundaries. For example, constructed wetlands as buffer zones for non-point source pollution control in rural landscapes require collective action across different levels of decision-making (e.g., local and regional) and among multiple authorities (e.g., ministries of agriculture, environment, finance). Therefore, such efforts require cooperation and coordination between stakeholders whose priorities, interests, and eventually values may not align. Thus, what counts as effective as well as the level of benefit, depends on the perspectives and needs of those involved.

Uncertainties
NbS are multi-functional systems delivering a wide range of benefits in terms of water resources management. Yet, non-monetary benefits (e.g., carbon sequestration, education, cultural value) are difficult to monetize, or there is high uncertainty about their non-market value and the means of verification. In addition, the cost-effectiveness of NbS relates to the variable levels of protection they offer, since the efficacy can vary with intensity and frequency of threats, the resilience of the ecosystem

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in which they are associated, and the vulnerability of the local economic and social system. Thus, the response of ecosystems is much harder to predict, as well as their costs and benefits compared to conventional engineered solutions. Furthermore, multiple interacting and context-specific factors that fluctuate over time, may control the effectiveness of NbS in delivering specific benefits. Such factors may be ecological (e.g. seasonal variation in the delivery of ecosystem services as related to the life cycle of vegetation), biophysical (e.g. natural hazards/risks intensity and frequency), and socio-economic (e.g. institutional capacity of response).

Considering the above, multiple opportunities arise for further research, development and evidence-based testing of assessment frameworks, tools, approaches, and operational applications.

RESEARCH NEEDS

- Assessing the short- and long-term impacts/effects/benefits of site-specific interventions (at farm level) on the small agricultural watersheds in which these are applied
- Assessment and evaluation of non-monetary benefits of water related NbS at farm level and rural landscapes
- Modelling the impacts and benefits of agricultural NbS across different temporal and spatial scales
- Exploring social perception and identify bottlenecks in the adoption of NbS for water management
- Governance schemes for the effective application of NbS at small agricultural watersheds
- Harmonization of methodological framework for assessing impacts and benefits
- Evidence base on social, economic and environmental benefits of NbS in rural landscapes and agriculture.
- Benchmarking and monitoring framework of NbS at farm level
- Developing harmonized methodologies for reporting and verifying outcomes
- Assessing the synergies of green and grey solutions in hybrid farming systems
- NbS relevant tools to perform water balance at nested scales
- Systems, modelling and multi-criteria analyses of NbS' co-benefits and trade-offs
- Design tools to disseminate outcomes and increase awareness among farmers, citizen's, policy-makers and developing effective participatory research approaches

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IDEAS FOR INNOVATIONS

Ideas for innovative projects /Potential EIP operational groups	Level of Interest/ Scale	Indicative activities / outputs	Potential partners/involved actors
• Developing tools for maximizing the socioeconomic impact and co-benefits of NbS for water resources management at farm level	Farm/Local (watershed)	– Developing tools and techniques of integrated analysis and assessment of benefits (environmental and socioeconomic at both spatial and temporal level). – Impact monitoring technologies across scales – Participatory evaluation and documentation of tools/techniques in pilot areas. – Development and evaluation of state-of-the-art decision support systems to maximize benefits (using artificial intelligence, machine learning, big data etc).	Cooperatives, farmers, research institutions, professional and socioeconomic chambers, farm advisors, water related agencies and IT companies
• Strengthening rural communities' involvement in the assessment of environmental and socioeconomic benefits of NbS	Local (watershed)/ Regional/ National	– Establishment of Living Labs. – Public perception-attitude study – Deployment of awareness raising and capacity building activities. – Development and implementation of participatory assessment tools and techniques. – Drawing roadmaps of actions and governance schemes of social innovation to support communities of action.	Cooperatives, farmers, research institutions, NGOs, governance schemes and social groups
• Socioeconomic aspects of conservation agriculture at farm level and rural landscapes	Farm/Local (watershed)/ Regional	– Establishment of Living Labs. – Development of techniques/tools for the spatial and temporal analysis of benefits. – Establishment and operation of local assessment ecosystems around pilot areas. – Quantification of benefits.	Cooperatives, farmers, research institutions, NGOs, farm advisors, companies related to agricultural sector
• Spatial planning of constructed wetlands as NbS interventions for water resources management at small agricultural watersheds and maximization of environmental and socioeconomic benefits	Local (watershed)	– Establishment of social science labs for the development of customized solutions. Development of spatial analysis and decision support tools for the establishment of constructed wetlands. Demonstration actions/thematic parks. – Guidelines of implementation. – Participatory plans of action at watershed level (short, mid, long term).	Cooperatives, farmers, research institutions, NGOs, decision/policy makers, engineers, governance schemes, local authorities

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• Rural development of Less Favoured Areas (LFAs) and climate affected areas through the introduction of NbS for water resources management: From interventions to benefits	Farm/Local (watershed)/ Regional	– Engagement of stakeholders and key local actors in the co-development and co-evaluation of pilot actions. – Technical guidelines of NbS implementation. – Participatory actions for the assessment of environmental and socioeconomic benefits. – Plans of action at watershed level (short, mid, long term).	Cooperatives, farmers, research institutions, decision/policy makers, governance schemes and authorities
• Towards Land Degradation Neutrality through NbS in rural landscapes	Local (watershed)/ Regional/ National	– Development of monitoring tools using LDN relevant indicators. – Documentation of effectiveness through pilot actions. – Thematic parks-Demonstration areas. – Land-use planning tools and guidelines for addressing LDN challenges through the establishment of NbS.	Cooperatives, farmers, research institutions, NGOs, decision/policy makers, governance schemes and authorities
• Assessing the effect and role of NbS towards the achievement of Sustainable Development Goals and rural development	Regional/ National	– Development of documentation tools and benefits assessment techniques using SDGs relevant indicators. – Documentation of effectiveness through pilot actions. – Thematic parks-Demonstration areas. – Participatory assessment of benefits and sustainability.	Cooperatives, farmers, research institutions farm advisors, NGOs, SMEs related to environmental management
• Establishing rural thematic networks of NbS for knowledge transfer and awareness	Regional/ National	– Establishment of targeted cooperation networks. – IT tools of knowledge transfer and networking beyond borders. – Digital registries of active actors. – Data base of NbS. – Activities for cross-fertilization of knowledge and innovation acceleration (e.g. innovation camps)	Cooperatives, farmers, research institutions, private IT and communication enterprises, farm advisors.

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