

Sustainability in the Water-Energy Nexus

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Ecosystem Services in the Water-Energy-Food Nexus

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Abstract: Given their substantial societal benefits, such as supporting economic activities and providing better livelihoods in rural areas, ecosystem services should gain higher importance in water-food-energy nexus debates. Yet, not all values from ecosystems are quantifiable, data is often not adequate and methods of measuring these values are not sound. This situation challenges researchers and water managers to improve research tools and give adequate attention to ecosystem services by implementing interdisciplinary approaches and integrated management of ecosystems and their services.

Keywords: ecosystem management; water use efficiency; fertilizer use efficiency; participatory research

1 Introduction

Services that humans obtain from ecosystems [1] have often been neglected or received little attention in policies of economic development and inter-sectoral resource (e.g. water) allocation. However, since these ecosystems provide fresh food, fiber, fuel, wood, and medical plants, they are essential for the livelihoods of many poor people in developing countries. Moreover, these services are important for regional public welfare by regulating microclimate, preventing floods, reserving water for drought periods, and cleaning return (drainage) flows. Because of the enormous marketable and non-marketable values of ecosystems current debates on

water-food-energy nexus should consider the importance of ecosystems in addition to integrated management of water to meet the demands of multiple sectors.

2 Issues of determining and evaluating ecosystem services

While most of us recognize direct values of ecosystems, such as water and air quality, more indirect values are not easily recognizable. This also applies to policy makers and water managers who are specialized in a specific field of knowledge and therefore focused on a limited set of ecosystem values. The complexity of ecosystems and the multiple beneficiaries of ecosystem services exacerbate the problem of determining all the types and the exact values of these services. The main issues of ecosystem services valuation and the ways of addressing them are therefore important topics in need of further discussion.

While scientists and policymakers unanimously agree on the importance of ecosystem services, measuring the value of these services remains a challenging task. Multiple methods for assessing the direct use values from ecosystem services such as contingent valuation, choice modeling, and travel cost methods [2] exist, but they are often subjective and may not reflect the real purchasing power of the users of the ecosystem services. Additionally, intrinsic and cultural values of ecosystem services are not measurable in monetary terms (Volk, GWSP conference presentation), which can lead to the underestimation of ecosystem values. Yet, what is measurable is manageable. This challenges researchers and development policy planners to develop improved methods of collecting data and assess ecosystem values.

3 Water availability to ecosystems

Given the importance of ecosystem services, adequate supply of water should be delivered to maintain ecosystems. Although a minimum supply of water

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needs to be conserved for ecosystems, there is no common agreement on how to determine the minimum environmental flows or the areas in need of conservation. The complexity of hydrological systems additionally necessitates the consideration of linkages between water availability for downstream ecosystems and related upstream land and water uses for assessing environmental flow requirements. However, in contrast to complicated models and calculations, in some cases, even a simple regression model may allow assessing these complexities with high reliability. For instance, water availability in different parts of the Mekong River Basin was modeled using a simple multi-variate regression model that indicated 20% reduction of downstream flow as a response to a doubling of paddy rice area upstream (Lacombe, GWSP conference presentation).

Expected global warming and intensifying inter-sectoral competition for fresh-water resources requires increasing productivity of production activities consequently enhancing ecosystems functioning or making more water available for ecosystems needs. Studies conducted in the Turkestan region in Southern Kazakhstan showed for instance that improved pasture management prevents soil erosion while construction of wells enhances the restoration of degraded rangelands (Nangia, GWSP presentation). Building greenhouses and adopting drip irrigation technologies can also increase water productivity and improve rural livelihoods. Introducing market mechanisms such as pricing water services would create incentives for more efficient use of water and thus wider adoption of water conservation technologies and measures.

Not only sufficient quantity but also adequate quality of water should be considered to meet ecosystem demands. Return flows from agriculture as well as toxic effluents from some industries are a serious threat for the surrounding and downstream livelihoods and can impair ecosystem functions. High water usage, low water use efficiency and large fertilizer and pesticide use in irrigated agriculture results in large wastewater (return) flows that degrade the quality of both surface and groundwater. To meet growing global food demand, increases of 30% and 60% of phosphate and nitrogen emissions, respectively, are expected by 2050 (Xie, GWSP conference presentation). This would further reduce water quality. Higher fertilizer use efficiency and land conservation are appropriate measures against water quality degradation.

4 Stakeholder participation to enhance ecosystem services evaluation

While hydrologists are generally successful in quantifying major physical features of landscapes (e.g., land cover, hydrology, and crop patterns) social aspects, especially inclusion of direct beneficiaries of ecosystem services, are often neglected. However, studies in a village of Ethiopia showed that integrating local knowledge into scientific models would allow to identify the most important ecosystem resources, better understand local conditions, determine hidden problems in the system and consequently formulate better recommendations for policy making (Tracy, GWSP conference presentation). According to the study, differences between the perceptions of male and female were also found, indicating improved quality of data on ecosystem services when female participants were involved in the survey.

5 Conclusion

Summing up, ecosystem services should gain increased importance in the water-food-energy nexus debate. Particularly:

- Improving the quality of data and methods of assessing the value of ecosystems are essential for efficient policy making;
- Involving direct beneficiaries of ecosystem services in research planning and design processes enhances the data quality and subsequent policy recommendations;
- Implementing interdisciplinary approaches of integrated land, water, and fertilizer use are important for better functioning ecosystem services.

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Session chair: Dr. Claudia Ringler (IFPRI)

Speakers:

- “Incorporating gendered landscapes into physically-based models via Participatory 3-D Mapping” presented

by: Tracy Baker, International Water Management Institute (Addis Ababa, Ethiopia)

- “Simple power-law models to predict flow metrics for water resource and risk management along the Mekong tributaries” presented by: Guillaume Lacombe, International Water Management Institute (Vientiane, Lao PDR)
- “Ecosystem services and river basin models” presented by: Martin Volk, Helmholtz Centre for Environmental Research (UFZ, Department of Computational Landscape Ecology, Leipzig, Germany)
- “Implications of socio-economic development and climate change on water quality – a global assessment” presented by Hua Xie, International Food Policy Research Institute (IFPRI, Washington D.C., US)
- “Valuation of Ecosystem Services for Improving Agricultural Water Management in Kazakhstan” presented by: Vinay Nangia, International Center for Agricultural Research in Dry Areas (ICARDA, Amman, Jordan)

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