Accounting for biodiversity trade-offs from hydroelectricity production in Life Cycle Assessment

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ABSTRACT: The expected expansion of hydroelectricity production in future energy scenarios[1] shows that hydropower remains an important technology to achieve the United Nation's sustainable development goals (SDGs) on affordable and clean energy and climate action. However, the construction and operation of hydropower plants have significant environmental impacts, which interfere with the SDGs for life on land and clean water due to biodiversity trade-offs. The poster addresses the topic of balancing synergies and trade-offs arising from hydroelectricity production.

Life Cycle Assessment (LCA) is a tool that allows for a comprehensive evaluation of the environmental impacts associated with the entire life cycle of hydropower plants, from raw material extraction to decommissioning. LCA can contribute to the debate on how to design a renewable energy system, as for example onshore wind and hydroelectricity production can be compared in terms of environmental impacts. Furthermore, LCA can be used to minimize the environmental impacts through strategic site selection of future hydropower plants.

LCA case studies on hydropower have often neglected biodiversity impacts. Life Cycle Impact Assessment (LCIA) models are required to quantify biodiversity impacts and many still need to be developed. The biodiversity trade-offs associated with hydropower development concern freshwater, marine, and terrestrial species and arise in all life cycle stages. Dorber et al.[2] were the first to develop LCIA models for the impacts of land use change, water evaporation, and GHG emissions arising in the operation phase of hydropower plants.

The poster will discuss a framework to consider the remaining environmental impacts, such as river fragmentation, invasive species, discharge regulation, sediment trapping, and temperature changes. Many of these impacts are confounded, e.g., low discharge levels can result in fragmentation, as well as limited access to spawning habitats, increased temperatures, and stranding of species.[3]

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[1] Zhang, Y., Binsted, M., Iyer, G., Kim, S., Wild, T., & Zhao, M. (2022). Long-term basin-scale hydropower expansion under alternative scenarios in a global multisector model. *Environmental Research Letters, 17(11)*, 114029. https://doi.org/10.1088/1748-9326/ac9ac9

[2] Dorber, M., Arvesen, A., Gernaat, D., & Verones, F. (2020). Controlling biodiversity impacts of future global hydropower reservoirs by strategic site selection. *Scientific Reports, 10(1)*, 21777. https://doi.org/10.1038/s41598-020-78444-6

[3] Freeman, M. C., Bestgen, K. R., …, Wenger, S. J. (2022). Toward Improved Understanding of Streamflow Effects on Freshwater Fishes. *Fisheries, 47(7)*, 290–298. https://doi.org/10.1002/fsh.10731