Catchment and Eco-hydrology

Albeit river basins are complex environmental systems facing an uncertain future, their response to global change remains poorly understood - rendering future water resources management all the more challenging. Their intrinsic property of changing systems calls for a better understanding of eco-hydrological processes controlling global hydrological and biogeochemical cycles, vegetation dynamics, pollutant removal, or ecosystem resilience. Progress is largely thwarted by prevailing knowledge and technological gaps - calling for the exploration of new avenues to frame and test hypotheses, and develop innovative water resources monitoring, modelling and management tools.

Research challenges

The mission of the Catchment and Eco-hydrology group is to integrate research, technology and education for ensuring sustainable water availability and quality. The research team does this by fostering interdisciplinary research on water threats in a context of global change with national/international private, public and academic partners. Researchers focus on pressing questions in water resource research and management, related to:

- how eco-hydrosystems collect, store, mix and release water, solutes and matter - in the past, at present and in the future;
- new environmental monitoring tools - operating at unprecedented spatial and temporal scales;
- better monitoring, forecasting and predicting our water futures, as expressed through floods, drinking water availability and quality, water for agriculture, or ecosystem services.

Innovative activities

The research group combines theoretical analysis with targeted experiments and innovative monitoring protocols in the field to test and improve our understanding and prediction skills related to water resources. For example, by testing new tracers, they intend to overcome limitations in classical environmental tracking protocols and shed new light on pressing questions related to water, solutes and matter sources, flow paths and transit times. With global change increasingly triggering extreme events, there is a pressing need for the design, crafting and testing of new field deployable, air- or space-borne sensors - delivering data at unprecedented spatial and temporal resolution. As a corollary, new data storage, handling, analysis and assimilation techniques will have to be developed. With structures such as long-term environmental observatories (e.g. the Alzette River basin as a Critical Zone Observatory, operated by LIST’s Observatory for Climate and Environment) or living labs being key in global change impact research, they equally serve as ideal open air laboratories for testing and ruggedizing innovative environmental monitoring systems, gain new process understanding and develop novel environmental management strategies.

Application areas

The research group intends to gear their energies and skills towards the exploration of innovative environmental monitoring systems, ultimately leading to a holistic understanding of eco-hydrosystem functioning. The subsequent improvement of forecasting tools will support a new generation of quantitative and qualitative water management strategies. Applications areas are (examples):

- Mechanistic understanding of fundamental river basin functions of water, solutes and matter storage, mixing and release (e.g. use of stable isotopes of O and H & tritium for water age dating, transit time modelling, soil-plant-atmosphere interactions);
- Field deployable devices for monitoring eco-hydrological processes at unprecedented temporal resolution (e.g. in situ water sampling, in-stream monitoring of physicochemical parameters);
- Documentation of river basin response to variability/change in boundary conditions (e.g. severe drought periods, flash-flood events);
- Training of experts with interdisciplinary skills for tackling increasingly complex questions in environmental systems and resources management (e.g. PhD candidates, Post-docs).

Main assets

- Doctoral Education unit in hydrological sciences (FNR PRIDE - HYDRO-CSI)
- Ecosystem interfaces as critical hotspots for transformation of ecosystem exchange fluxes (PPT ITN - Interfaces)
- Catchments As Organised Systems (PAPP and WIND-CATCH)
- Exploring catchment functions of drainage, mixing and release across space and time (PNR-CORE STORE-AGE)
- Water and Vegetation in a Changing Environment (PNR ATTRACT WAV)

Selected publications

- "Diat fluctuations of vicecity-driven opean enceives to streamline DOC concentrations", Schwab M.P., Klaus J., Pfister L., Weller M., Biogeoosciences 15: 2177-2188.

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