RIVEAL PROJECT

RIPARIAN FOREST VALUES AND ECOSYSTEM SERVICES – RIVER REGULATION EFFECTS ON VEGETATION

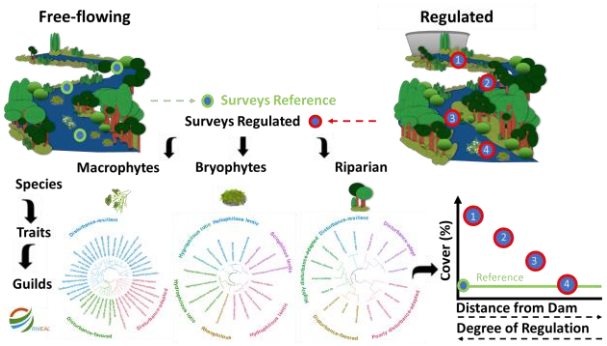
FLOW REGULATION

The artificial disruption of the natural river flow by dams has numerous consequences in the fluvial ecosystems. River flow regulation affects river hydraulics, hydrology and water quality, and modifies the natural dynamics of sediment, nutrients, and organic matter along the river continuum.

DEGREE OF REGULATION

The degree of regulation (DOR) is an index used in river regulation assessments quantifying the regulation level imposed by a dam on a river. It is defined as the ratio of the total volume of the dam's reservoir by the total annual flow of the river section's watershed. The DOR fades away downstream with the distance from the dam (DFD).

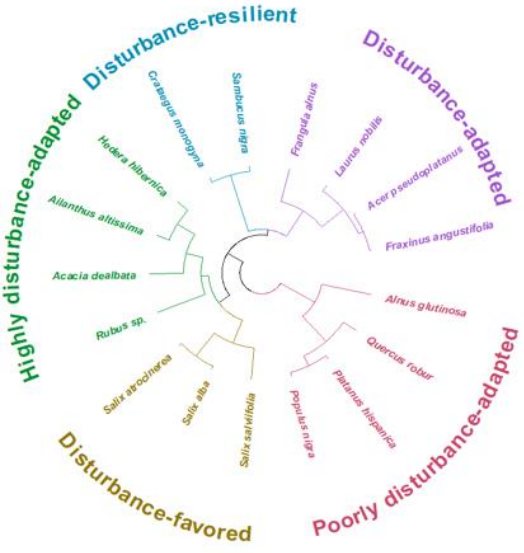
METHODOLOGY



Workflow of the study to determine the effects of river regulation on vegetation (from Lozanovska et al., 2020; doi:10.1016/j.scitotenv.2020.141616).

FUNCTIONAL APPROACH

- Functional trait: measurable attribute of an organism, associated with its fitness and performance;
- Functional diversity: ecologically relevant concept of great utility in community ecology research with greater explanatory power to solve pressing ecological problems;
- Flow-response guilds: groups of species sharing similar traits and having potential similar performance facing flow related metrics, such as river discharge, flow velocity, or river disturbance.

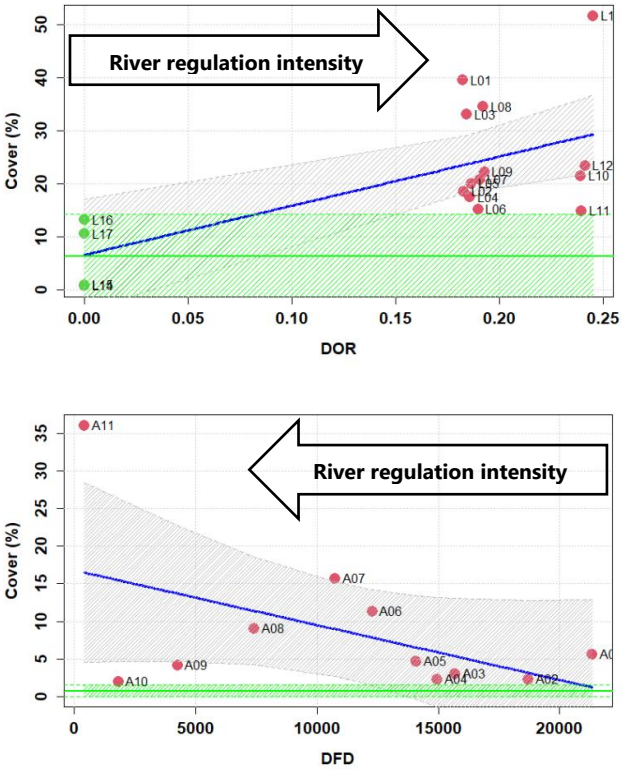


Guild clustering of riparian woody plant species based on traits (adapted from Lozanovska et al., 2020; doi:10.1016/j.scitotenv.2020.141616).

OBSERVED EFFECTS

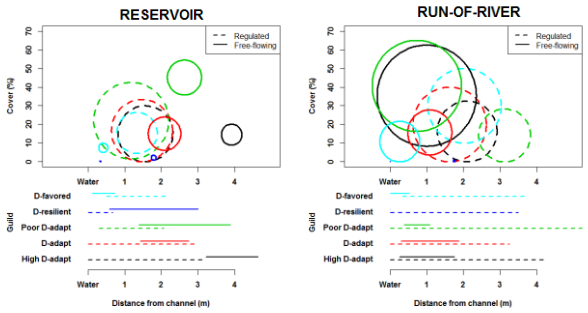
- Effects on communities:
  - Dominance of regulation effects over geomorphology and habitat influences;
  - Effects vary among and within plant groups;
  - Modifications on guilds cover and location;
  - Aquatic and riparian vegetation responses to regulation is plant group-reliant and guild-specific.

- Effects on recovery patterns downstream of dams:
  - Different recovery patterns according to plant group and flow response guild;
  - Fading effects along decreasing DOR and increasing DFD;
  - Higher number of significant alterations for dam sites downstream from reservoir dam, compared with downstream run-of-river dam sites;



Expected cover of the Disturbance-adapted macrophyte guild (blue) according to DOR and DFD (in meters) in unregulated (green dots) and regulated (red dots) sites of run-of-river (top) and reservoir (down) case studies. Grey areas stand for 95% confidence intervals of the blue regression line, green shaded areas the 95% confidence interval of the mean guild cover (green line) in unregulated circumstances. Disturbance-adapted macrophyte guild is composed by aquatic vascular macrophytes such as Myriophyllum spicatum, Potamogeton polygonifolius, or Ranunculus peltatus (adapted from Lozanovska et al., 2020; doi:10.1016/j.scitotenv.2020.141616).

- Effects on guild cover and location:
  - Specific cover changes of different flow-response guilds;
  - Increase in the cover of aquatic vascular macrophytes;
  - Bryophytes respond to river regulation with a decrease in cover;
  - Riparian guilds response depends on the guild and type of river regulation as a result of the specific adaptation traits to avoid or tolerate hydrological disturbances;
  - Shifts in the spatial location of riparian woody vegetation guilds in the riparian zone;
  - Encroachment of the riparian woody vegetation into the river channel in the reservoir rivers while it expands towards the floodplain in the run-of-river case study;
  - Water availability or magnitude of flows is not the only factor promoting plant cover changes in regulated rivers, functional adaptations also play an important role in it.



Riparian vegetation cover and location along the river's lateral gradient, in regulated and unregulated conditions. Circles diameter correspond to the average guild cover range. Observed vegetation shifts across the riparian zone are shown at the respective bottom panel. *D stands for disturbance, D-favored riparian guild (willows), D-resilient (e.g. Crataegus monogyna), Poorly D-adapted (e.g. alder), D-adapted (e.g. ash), Highly D-adapted (e.g. Rubus spp., Acacia dealbata) (adapted from Lozanovska et al., 2020; doi:10.1016/j.scitotenv.2020.141616).*

CONCLUSIONS

- Deviations from the natural flow regime originated by river damming lead to various plant group-specific feedbacks;

- Different regulation types induce diverse spatial settlements of riparian woody vegetation across the riparian zone;

- Run-of-river dams maintain high flow variability and flashiness whereas reservoir dams imprint water scarcity, which have greater consequences on fluvial vegetation;

- River regulation effects decrease to downstream along the river, down to a point from which plant communities' changes are no longer significantly different from the respective communities in unregulated sites.

https://www.riveal.pt

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