Alpine rivers hold important clues for preserving biodiversity and coping with climate change

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Marginal plants, particularly trees, play a crucial role in sustaining the biodiversity of Europe's big river systems, according to a recently held workshop organised by the European Science Foundation (ESF). This finding provides important clues for protecting Europe's rivers against a combined onslaught from human development and climate change, which are tampering with existing ecosystems and changing both the physical and biological forces acting upon them.

Both aquatic plants (living in rivers) and, more importantly, riparian ones (growing along the banks and on islands) play critical roles in building and sustaining habitats for colonisation by other species, and in the chemical and biochemical processes that keep rivers and their ecosystems healthy, according to Professor Angela Gurnell, convenor of the ESF workshop and director of the Centre for Environmental Assessment, Management and Policy at King's College, London.

Gurnell described some plant species as "ecosystem engineers" marshalling habitat development and maintenance. Furthermore, ecosystem engineering by plants operates at many different spatial scales, and in different ways along rivers from their source to mouth. But the vegetation itself is part of the habitat it supports and so vulnerable to the same forces, with the potential for tipping whole ecosystems into new states when certain thresholds are breached, for example as a result of a slight change in climate or river flows.

"Vegetation–physical process interactions are highly complex and are subject to distinct thresholds across which massive shifts in system condition can occur," said Gurnell. "Threshold crossing can be driven by both physical and biological processes and is particularly susceptible to changes in climate, river flow and channel management."

The ESF workshop focused on Alpine systems because most of Europe's largest rivers, including the Rhine, Rhone and Danube have their source in the Alps. Alpine rivers receive a significant part of their flow from snow and ice melt and so are particularly sensitive to climate change, but these rivers also embrace ecosystems and conditions that are found widely in other European rivers.

The ESF workshop heralded an important step forward for the field of modelling the complex physical and chemical processes of river ecosystems, by taking account of the vegetation's role not just as a guardian of habitats but also in modulating water flow and sediment movements. A full understanding of river habitats therefore requires these effects to be incorporated in the models used to analyse them and predict response to forcing factors such as climate change.

"Complex river channel patterns, including a wide variety of vegetated and unvegetated landforms, induce complex flow patterns at the surface and subsurface driving a range of hydraulic 'patches', which change their hydraulic properties and also connect and disconnect at different flow stages," said Gurnell.. "It is crucial to develop models that represent this hydraulic patchiness and its dynamics under changing river levels, whether through detailed numerical approaches or more aggregated statistical approaches, because these make it possible to define the range of hydraulic conditions available to aquatic organisms within different river settings."

Rivers and their ecosystems, apart from being crucial for human survival in many parts of the world, also make fascinating studies in their own right. Rivers are connected systems, not only because water, sediment and organisms move between upstream and downstream reaches, but also because the faster flowing and deeper middle of the river is linked to the edges where the water may move quite slowly, and also to flood plains during flood events. An important aspect of river modelling therefore lies in defining the major associations between physical patterns of flow, sediment and landforms, how organisms and ecosystems relate to them, and how both may change when threshold conditions are reached. Achieving this in turn relies on synergy between numerical models and experiments or observations both in the laboratory and in the field.

A major objective is then to apply this work firstly to develop tools that can help to identify the best ways of managing rivers. "Colleagues in mainland Europe have been developing ideas of 'channel-widening' with managers, whereby the river is given more space to adjust its morphology (structure) in a dynamic way within reaches where space can be made available for this," said Gurnell. The idea here is to reconnect river ecosystems with the banks and even floodplains in cases where space is available but past management has severed such links. However, it is also important that river flows can sustain the widening and that this process is applied at different sites along rivers to maintain upstream to downstream connections between affected sites if sustainable benefits to the river ecosystem are to be achieved.

Source: European Science Foundation