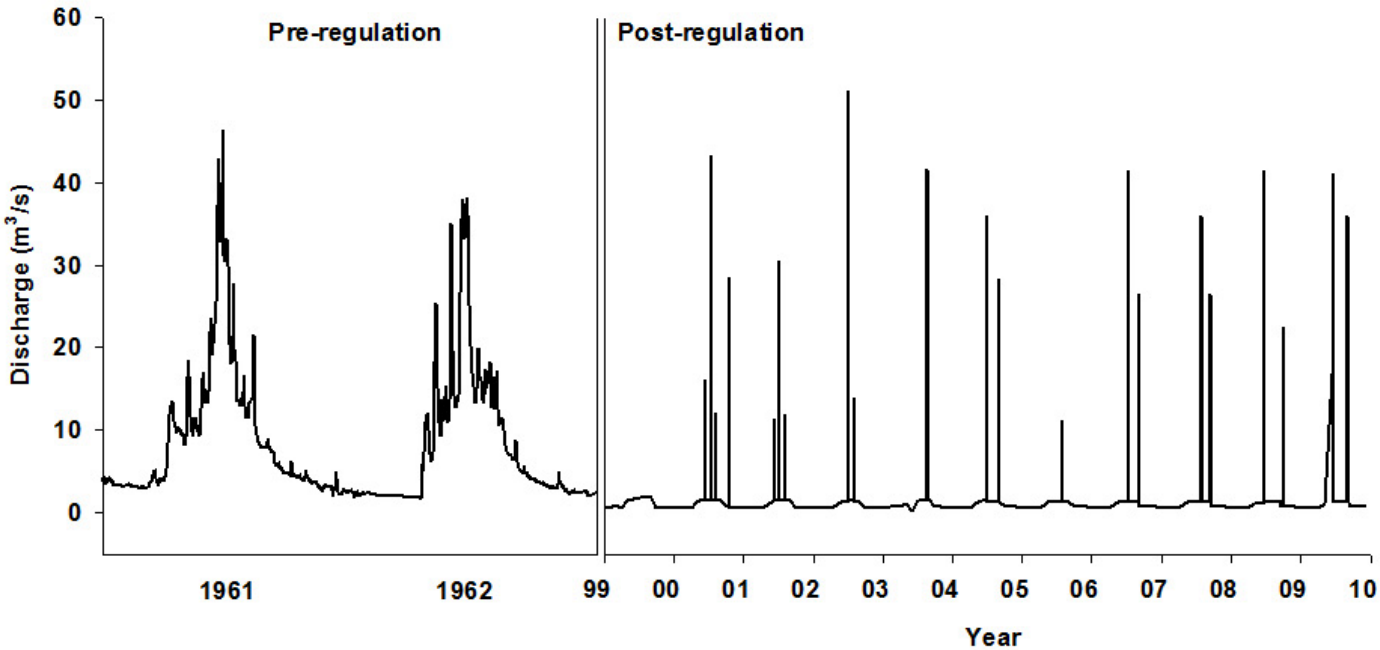
Adaptive management In river systems

by Christopher T. Robinson and Michael Doering

Water is life's currency. Urgent action is needed to guarantee that global water resources are managed for human needs while maximising the ecological services of riverine ecosystems. Restoring damaged rivers and optimising water resources through management is a theme in many developed countries. Adaptive management is one tool to address large-scale water resource issues. Addressing multiple issues by encouraging participation and feedback by those affected by river management is a positive result. River restoration through adaptive management must simultaneously enhance water use for humans while conserving the ecological role of rivers and their ecosystem services.

Simply put, "adaptive management" is learning from doing. The process (stakeholder involvement—management actions—scientific monitoring—learn/adapt) is used to revise/modify the original management action. Adaptive management invites stakeholders and multi-disciplinary viewpoints to the table. It works best with the involvement of interest groups such as resource managers, water users, stakeholders, and scientists. With adaptive management, learning follows policy/plan implementation. Stakeholders review outcomes and activities, and use the lessons learned to adapt plans as needed. It takes a broader, ecosystem approach to river management and considers multi-disciplinary viewpoints. It provides resource

Photograph of Punt dal Gal dam (Livigno Reservoir, hydropower facility, Italian-Swiss border) used to regulate flows in the Spöl River through the Swiss National Park. Based on results from a long-term experimental flood programme (beginning in 2000), high-flow events are now incorporated in the adaptive flow management programme for the river.



Photograph of a high-flow event in the Spöl River (left) and graph of the floods used in the experimental programme since 2000. Note the changes in magnitude and number each year as part of the adaptive flow management programme, reflecting ecological knowledge gained from previous floods and water availability in a particular year. Study provides one example of implementing flows in terms of an Optimal Ecological Discharge management strategy.

managers new ways to view an existing river and a systematic method to react to changes over time.

Flow regulation downstream of dams to mimic natural flows is an example of adaptive management for rivers. High-flow events are being integrated into adaptive management plans based on scientific theory and evidence. Examples include the recent high-flow releases in Australia's Snowy River and those on the USA's Colorado River below Glen Canyon dam.

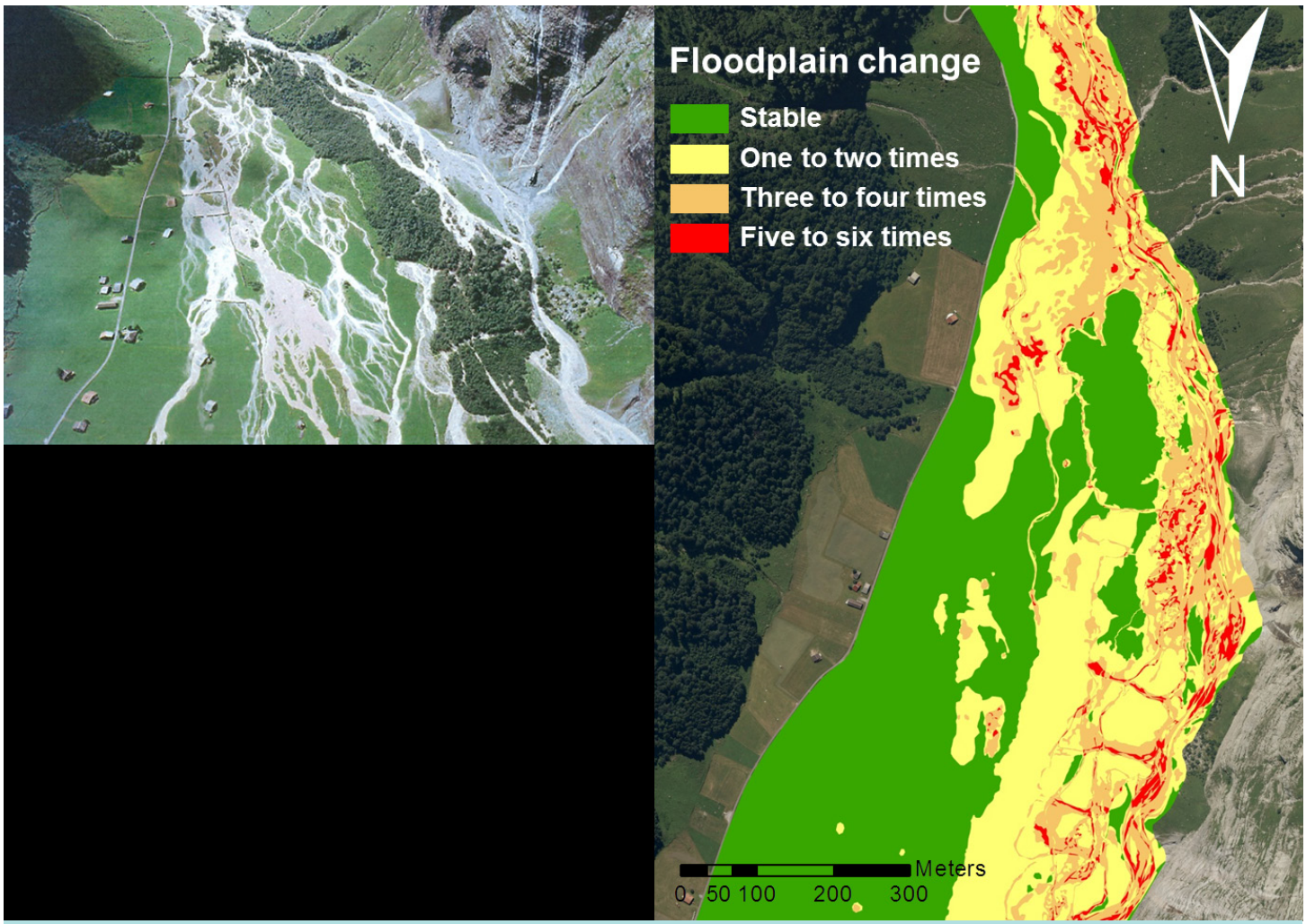
High-flow events can pose serious risks and hazards. With adaptive management, high-flow events can be used as opportunities to improve the ecology of regulated riverswhile minimising these risks and hazards. High flows can be a cost effective management action to improve floodplain ecosystems. High flows are implemented for a variety of management goals, e.g., (1) restoring fisheries, (2) manipulating floodplain habitats, and (3) improving the ecological services of river ecosystems. Indeed, high-flow events can be viewed as large-scale ecosystem experiments.

Adaptive management uses the principles of high-flow events to mitigate hydropower effects on rivers. For example, "hydropeaking" (i.e. the rapid increase in water released from a reservoir) can negatively impact river ecosystems, and adaptive management of hydropeaking can reduce these effects.

Intact floodplains comprise a complex mosaic of habitats. Many regulated rivers have lost important floodplain habitats such as islands and also connectivity with the floodplain; properties inherent to intact floodplains. Restored floodplain overflow areas can absorb the energy of high-flow events thus minimising flood risks and hazards. Using recent advances in landscape modeling, high flows can be used to restore habitat features. This rejuvenates the river connection with floodplains and adjacent lands. Modeling can show historical floodplain areas expected to best respond ecologically to high flows. High-flow events could be specifically timed in regulated rivers, whereas managers could anticipate and manage unplanned high flows in less flow-regulated systems.

Adaptive management in a global context

Global climate change is shifting precipitation timing and magnitude and increasing the frequency of high-flow events and periods of water scarcity. Computer forecasts and recent scientific evidence have predicted delayed alpine winter precipitation, which now occurs in late winter and early spring. Higher spring temperatures increase the probability for elevated spring flows followed by extreme low flows or drought in late summer. Essentially, water from ice and snowmelt is coming too early and too fast.



Oblique photograph of the Urbachtal (central Alps, Switzerland) during an extreme flood event in 1998 (left). Right figure shows the number of changes in six different floodplain habitats derived from referenced historical aerial images from 1940 to 2007 for the Urbachtal. Recent GIS analyses are revealing historical channels that could be reconnected to the main channel, enhancing the hydrological connectivity of this floodplain of national importance, while mitigating or reducing the risks and hazards of extreme flow events to local landowners.

Other factors affecting flows, such as escalating water withdrawals caused by an increasing global population, have resulted in many rivers failing to reach the ocean, especially in arid regions. Most large rivers are regulated through damming and reservoir networks. Globally, there are more than 50,000 large dams in place with additional dams planned in developing countries.

Long-term adaptive flow management for the Spöl River in the Swiss National Park uses high flows through dam releases to simulate the natural flow regime of the river. Beginning in 2000 and based on water availability, flood gates at Lago di Livigna reservoir are opened, creating two to three floods each year. The floods were initiated to improve trout habitat with tangential benefits to other river organisms. Using adaptive management, stakeholders, scientists and community interest groups have worked in monitoring the river and interpreting the results. This experiment has been so successful that high-flow events are now part of the regulatory framework. Flood timing and magnitude have changed over time as the system continues to respond to the new flow regime. Under adaptive management, these system changes encourage new goals and ongoing modification of the plan.

In the Urbachtal study, a landscape modeling approach is used to selectively re-open channels following an adaptive flow management programme. Flow in the Urbach is mostly natural, although regulated through irrigation diversions and levies. One goal is to restore floodplain connectivity while minimising adverse landowner effects. It is expected that opening more side-channels will reduce and mitigate high-flow risks and hazards. Anticipated benefits are enhancement of floodplain habitats and biodiversity.

Water needs of an increasing global population and increasing awareness of the value of river ecosystem services provide the stage for an adaptive management approach. This approach, taking into account multiple issues, viewpoints, and stakeholders, benefits river planning in many ways. It can be used to bring stakeholders to a common table to optimise river resources for humans and fulfill the river's role in floodplains. Damaged river ecosystems can be repaired, restored, and enhanced through adaptive management of high flows. Moreover, global water problems resulting from environmental changes can be mitigated by adaptive management. TWL

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