Environments continuities and flood risk mitigation at catchment scale: which management scales and which level of achievement are suitable according to the purpose of the project?

Continuités des milieux, intégration des risques et gestion des bassins versants : quelles échelles pour quelles mises en pratique ?

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RÉSUMÉ

Gestion des risques vs. gestion de milieux, trames verte et bleue vs. trame grise, continuités vs. fractionnements du réseau hydrographique: une conciliation des thématiques est-elle vraiment possible en pratique? A partir de retours d'expérience de gestionnaires travaillant sur des bassins versants de tailles différentes au sein des Alpes françaises, nous mettons en évidence l'intérêt, mais aussi la difficulté de décliner cette approche multi-thématique à l'échelle globale du bassin versant.

ABSTRACT

Environmental management guidelines are difficult to integrate or even antagonistic when they aim to link topics that are usually considered separately. However, it is of strong interest to link risk mitigation planning and environmental continuity improvement; to link greenway, blueway and 'greyway' networks; or to work towards the integration of discontinuities of the hydrological network. Starting from feedbacks of managers working on various alpine river environments in the French Alps, we illustrate the interest and the difficulty to integrate such conceptual approaches at catchment basin scale when dealing with practical needs.

KEYWORDS

Management, environment continuity, flood risk, combined approches, alpine catchment basin

1 INTRODUCTION: TOWARDS AN INTEGRATIVE APPROACH OF ENVIRONMENTAL MANAGEMENT GUIDELINES AND FLOOD RISK MITIGATION AT CATCHMENT SCALE

Environmental management guidelines encourage to develop the continuity of natural environments, thanks to conceptual tools such as 'greenways' or 'blueways' that works towards the preservation/restoration of wildlife resources and migration. At the same time, flood risk mitigation planning increasingly integrates the importance of preserving the 'freedom space' of rivers to minimize flood vulnerability of riverine infrastructures throughout the world (Malavoi et al., 1998; Biron et al., 2014). Preserving these 'greyways', where the river can self-adjust its sediment fluxes, allows to enhance river resilience from a flooding perspective. But at the same time, the preservation of a wider water corridor ensures the ecological services associated to the greenways and blueways.

Thus, environmental management guidelines and flood risk mitigation planning could theoretically be coupled to both enhance ecological services and reduce flooding risk. To anticipate future river management guidelines and legislation, rivers managers are trying to combine such approaches. In particular, the new coming law about environment management and flooding risk mitigation (GEMAPI law) will actually require river stakeholders to gather these two competences, within a single structure, over a single territory, to work at catchment scale. However, the parallel implementation of the related tools are sometimes problematic when facing practical cases.

2 GREENWAY, BLUEWAY AND 'GREYWAY' VS. FLOOD RISK MANAGEMENT: PRACTICAL CASE STUDIES IN ALPINE RIVER CATCHMENTS

The two alpine river catchments we study here are located in the French Alps: the Arc River in the Maurienne valley and the upstream Isère River in the Tarentaise valley (Table 1). The two river catchments are adjacent: the Isère River is localized right North from the Arc River, which is a tributary of the Isère River. Both systems are characterized by narrow valleys, a strong hydrological forcing (mountain climate), supercritical flows and locally high sediment inputs that lead to high transport rates of bedload and suspended sediment load.

Table 1. Physical characteristics of the study reaches.

River	Arc (Maurienne)	Isère (Tarentaise)
Catchment area (km²)	1957	1900
Length of the study reach [a] (km)	118	90
Mean slope (%)	1.5	2.2
Mean width (m)	~40	/
Mean discharge [b] (m^3/s)	31	27
Maximum daily discharge [b] (m^3/s)	500	246

[a] The downstream limit for the Isère River study reach corresponds to its confluence with the Arly River in Albertville. For the Arc River, the downstream limit corresponds to its confluence with the Isère River in Aiton.

[b] Discharge values are from the 'Banque Hydro' (www.hydro.eaufrance.fr). Mean values are calculated over 64 years for the La Saussaz station (Arc River) and over 112 years for the Moûtiers station (Isère River). Both stations are approximately located in the middle of each study reach.

In both cases, urbanization laterally constrains the channel dynamics while a large part of the water resource is diverted for hydropower purposes, agriculture, drinking water supply and snow culture. As a consequence of this hydrological modification, natural sediment fluxes are heavily modified, which in turn influence the river morphodynamics and ecosystems.

Because both catchments are partly located at different elevations (ranging from high mountain areas above 2000 m to piedmont areas at ~300 m a.s.l.), these river systems present a large variety of

ecosystems, with specific flora and fauna adapted to harsh climatic conditions. Thus, the preservation of such ecosystems should be a priority for development policies at local and catchment scales.

According to the technical and political trend to combine environmental and flood management tools, the Isère stakeholders are working at catchment scale by implementing two programs: one devoted to flood risk management ('Programme d'Actions de Prévention des Inondations') and the other to preserve and to improve water and riverine environments qualities ('Contrat de Bassin Versant'). On the Arc River, a program of water quality improvement ('Contrat de Rivière Arc' 1996–2002) was successfully performed at catchment scale and two programs of flood risk management were successively implemented since 2010. For instance, actions of flood risk mitigation and environment quality improvement were successfully combined on alluvial fans in the Isère valley, in order to protect people as well as to integrate ecological continuities (fish and sediment fluxes). At larger scale, some 'spaces of freedom' (Malavoi et al., 1998; Biron et al., 2014) were identified along the Isère watercourse: such reaches allow self-regulation of sediment fluxes by self-adjustment of planimetric design and longitudinal profile. Improvement of morphodynamics is associated with an improvement of the ecological services delivered by the river. But such reaches are few on the Isère River, and none on the Arc River:

- Valley space is highly competitive and despite communication about flooding risk mitigation measures, river mobility is still seen as highly conflictual with the human land use of the valleys. Thus, reduction of the vulnerability is still not a priority for the territories compared to their economical development. For instance in the Arc River, large volumes of sediments from highway and railway galleries digging are being stocked in the valley. These volumes might conflict with tributary inputs in the main channel on a long term perspective;
- Even if these two river systems are naturally dynamic, numerous flow diversions reduce their ability to self-adjust at different spatial scales. Since water intakes are also seen as essential for valley development, it is unlikely that such diversions will be reduced in the future. For instance, sediment deposits due to flow reduction occurs at local scale in the Viclaire floodplain (Isère River) as well as, at larger scale, in the Combe de Savoie downstream the Isère study reach.

3 CONCLUSION: HOW TO FIND THE PROPER MANAGEMENT SCALE AND HOW TO ASSESS THE RELEVANT LEVEL OF ACHIEVEMENT NEEDED?

In practice, to ensure that a restoration/rehabilitation project can effectively be implemented with maximum support from the political side, stakeholders must determine and anticipate:

- The proper management scales (spatial and temporal scales) that are defined as 'relevant technical perimeters' (a.k.a. 'périmètres techniques pertinents'; Bourdin et al., 2011);
- The 'real(istic)' level of achievement to aim to.

Based on an increasing number of experiences and feedbacks, some project management guidelines are being developed by French river agencies (e.g. Bourdin et al., 2011) to help assess and anticipate the difficulty to achieve such projects that combine various environmental and flood management tools. In addition, even if it is sometimes possible to combine such purposes at local scale, river stakeholders still face the challenge of performing such combined actions at larger scale, because of the need to involve larger territories that are not used to work together.

LIST OF REFERENCES

Biron, P.M., Buffin-Bélanger, T., Larocque M., Choné, G., Cloutier, C.-A., Ouellet, M.-A., Demers, S., Olsen, T., Desjarlais, C. and Eyquem, J. (2014). Freedom space for rivers: a sustainable management approach to enhance river resilience. *Environmental Management*, 54(5), 1056-1073.

Bourdin, L., Stroffek, S., Bouni, C., Narcy, J.-B. and Dufour, M. (2011). *Guide technique SDAGE - Restauration hydromorphologique et territoires: concevoir pour négocier*. Agence de l'Eau Rhône-Méditerranée et Corse, 105p.

Malavoi, J.-R., Bravard, J.-P., Piégay, H., Heroin, E., Ramez, P., Gasnier, L., Boucheseiche, C., Rivas, J., Cambon, A., Trocherie, F., Coulet, M., Caltran, H. and Ravasseau, J.-P. (1998). *Guide Technique n°2 : Détermination de l'espace de liberté des cours d'eau*. Agence de l'Eau Rhône-Méditerranée et Corse, 42p.