Morphological assessment of river restoration projects in South Tyrol (Italy)

Évaluation morphologique de projets de restauration de rivières dans le Tyrol du Sud (Italie)

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RÉSUMÉ

Pendant les derniers 15 ans, plus de 100 projets ont été réalisés à propos de la requalification fluviale à l'échelle du site. Ces projets ont eu l'objectif d'augmenter la dynamique fluviale et rétablir le continuum des fleuves à travers l'élargissement du canal actif, la création d'un plus grande variabilité morphologique et la diversification des habitats qui en résulte. Ce travail évalue les effets des actions de requalification faite sur trois tronçons fleuve dans le Tyrol du Sud. L'évolution de la morphologie fluviale a été évaluée durant les 70 dernières année sur les fleuves Mareta, Aurino e Isarco, en utilisant l'interprétation de photos aériennes et de données de relief de champ. Ces tronçons ont subi la trajectoire typique de dégradation du XXe siècle, caractérisée par un rétrécissement des plaines alluviales et du lit actif et de l'abaissement de l'altitude de fond, principalement causés par la réduction drastique de l'apport de sédiments suivie de l'extraction de gravier des ruches et de la construction d'interventions massives d'ingénierie fluviale, en particulier dans la période 1960-1980. Les résultats montrent que, malgré une augmentation globale de la qualité morphologique après la requalification, quelques années après l'intervention on enregistre une légère diminution du GUSI-R e du GUSI-D. Ces résultats peuvent être interprétés comme une réadaptation naturelle du fleuve à une nouvelle condition d'équilibre, caractérisée par un faible transport solide et un régime de flux altéré. Les mêmes résultats suggèrent que il faut considérer une stratégie de requalification à l'échelle du bassin.

ABSTRACT

In the last 20 years, more than 100 river restoration projects at the reach scale have been carried out in South Tyrol rivers. The aims of these projects were to increase river dynamics and reestablishing the river continuum by total or partial removing of check dams, widening the active channel and diversifying habitats and biodiversity through the creation of morphological variability. This work evaluates the effects of restoration actions in three reaches of paradigmatic rivers in South Tyrol. The River morphology evolution over 70 years was assessed for the Mareit, Ahr and the Eisack rivers, utilizing aerial photographic image interpretation and survey data. These reaches underwent the typical degradation trajectory of the 20th century characterized by general floodplain and riverbed narrowing and bed level lowering, mainly caused by dramatic reduction of sediment supply followed by gravel mining and massive river engineering interventions during the 1960 - 1980 period. Results shows that despite an overall increase in morphological quality after restoration, a slight decrease of the Geomorphic Units Richness Index (GUSI-R) and the Geomorphic Units Density Index (GUSI-D) is registered some years after restoration intervention. These outcomes may be explained by a natural river readjustment to a new equilibrium condition characterized by weakness of sediment transport (especially coarse) and altered flow regime. Such results lead to foreseen that a more extensive basin-scale based restoration strategy should be considered.

KEYWORDS

Geomorphic Units Survey and Classification System (GUS), restoration actions effects, river degradation trajectory, River Morphological Quality, River Restoration.

INTRODUCTION:

From the late 19th century, Alpine channels have been equipped with structures as check-dams, bed sills, retention basin, groynes, ripraps and levees, to prevent bed and bank erosion, to trap sediments and to reduce flooding risk.

In 2000, The European Water Framework Directive 2000/60 was established with the aim of improving and preserving the quality of all European water bodies defining river degradation as a “deviation from the pristine state of the ecosystem”. The aim of the Directive was to reduce the existing pressures and restore degraded river fragments, achieving a “good” ecological status. This result should have been achieved by 2015 but the target was not reached. Now, the deadline has been prolonged to 2021.

Moreover, as a component of the European Green Deal, the EU Biodiversity strategy for 2030 aims to restore at least 25,000 km of EU rivers and to plant more than 3 billion trees.

In Italy, morphological degradation is an important topic within inland waterbodies as catchments and rivers suffered land use changes and gravel mining during the 19th and 20th century. Those impacts lead to erosion and incision in numerous catchments and rivers.

In South Tyrol (eastern Italian Alps) there are about 381 open check dams, more than 28,000 consolidation check dams, and more than 13,000 longitudinal bank stabilisation works for a total of 1,650 km of river network subjected to correction works that modified the riverbed geometry. In the last 15 years, more than 100 river restoration projects have been carried out along many rivers and their floodplains, frequently including the removal of former regulation measures to aim the reestablishment of retention areas and habitats. Mostly, the measures comprised the creation of preconditions for natural succession (Alverá et al., 2012). Nevertheless, restoration success has been monitored in only few projects.

This study aims to assess the contribution of restoration projects in three rivers of South Tyrol (Mareit, Ahr and Eisack) in improving their morphological quality and to evaluate how relevant was the induced changes by restoration.

1 METHODS

The river morphology evolution over 70 years was assessed for three reaches (channel length ranging between 1 km and 10 km) of Mareit, Ahr and the Eisack rivers by comparing multitemporal historical maps. The effects of restoration actions in the same three reaches were evaluated by the mean of Aerial photographic images interpretation and survey data checks. Following the Geomorphic Units survey and classification System (GUS), published by Rinaldi et al. in 2015, the geomorphic units of the examined reaches were delineated for all the examined years, considering the channels before (2000) and after the restoration projects (2011, 2014). Then, a comparison between the considered years were made (2000, 2010 and 2014). The GUS strongly relies on remote sensing based data assessment, and field evaluation was needed only in case of uncertainty. In order to ascribe the changes to restoration actions, it was verified that other factors influencing river dynamics, such as the hydropower operation upstream, have presently the same effect on the channels as they did in the recent past (before the restoration).

2 RESULTS AND DISCUSSION

All studied reaches suffered degradation and pattern simplification over the last decades. The restoration actions leads to clear differences between the restored and unrestored reaches. Apart from the better hydromorphological quality also diversity in hydromorphological patterns increases. Even though the streams show defined banks along the floodplain due to the incision and human infrastructures, the result of the morphological assessments shows an increase in functionality and naturality (Table 1). Channel width has increased in Mareit and Ahr (respectively by 30 and 25 meters respectively between 2000 and 2014), while Eisack did not show a significative channel enlargement,

probably due to the lack of lateral space available. Eisack, in fact, is a urban reach confined by the presence of Bolzano city. As results of restoration actions, bars and islands have been increased and the introduction of some anthropogenic elements such as boulders or groynes has increased the number of habitats. In general, the removal of the check dams allowed a better continuity and increases the morphological status.

	2000			2011			2014		
	Au	**Ma**	**Is**	**Au**	**Ma**	**Is**	**Au**	**Ma**	**Is**
Artificial elements	3%		1.7%	1%		2.1%	1%		2.1%
Emergent & vegetation Units	13%		25.5%	26%		26.9%	33%		18.4%
Submerged units	84%		72.7%	73%		71.1%	66%		79.5%
GUSI-R	0.15 (5/34)	0.31	0.32 (11/34)	0.26 (9/34)		0.35 (12/34)	0.26 (9/34)	0.46	0.38 (13/34)
GUSI-D	14.91 (12/0.805)	82.6	16.67 (170/10.2)	28.57 (22/0.805)		40.01 (408/10.2)	44.72 (36/0.805)	258.45	35.30 (360/10.2)

The application of the GUS showed some limitations in terms of the adaption to restoration projects. In fact, some restoration structures are difficult to classify with the given units. Some restoration actions include the construction of structures built to stabilize the riverbed. These structures may influence the sediment regime of the stream, typically the pattern of erosion and deposition. In the application of the GUS the consideration of restoration measures, as well as reversible or positive artificial structures, for example fish ladders, are missing. Morphological assessments may face difficulties when deal with restoration works. The main, is to be able to understand how natural should be considered some induced reworks conceived to improve the morphological quality of the channel.

3 CONCLUSION

The three analysed restored reaches did not maintained the new planned width, but they tend to shrink simplifying their morphological diversity likely due to the weakness of other driving factors such as a sufficient solid transport regime) that allow to maintain the river dynamic that can sustain the projected river morphology.

With these premises it seems mandatory to wonder before undertaking any river restoration action if the searched good morphological status will persist also in the future. To answer this question, long term monitoring programs are necessary and watershed scale focus is needed. Otherwise river restoration will act like treating chronic headaches with an aspirin without looking for the causes that cause the symptom.

LIST OF REFERENCES

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