

## **Assessment of morphological and ecological conditions of Italian alpine rivers using the Morphological Quality Index (IQM) and Odonata**

### **Évaluation des conditions morphologiques et écologiques des rivières alpines italiennes utilisant l'Indice de Qualité Morphologique (IQM) et Odonata**

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## **RÉSUMÉ**

Depuis quelques années des nombreuses méthodes d'évaluation ont été élaborées pour évaluer les conditions écologiques et morphologiques des rivières considérant les exigences de la directive cadre européenne sur l'eau. Les bioindicateurs sont généralement les organismes aquatiques, mais leur utilisation peut conduire à une évaluation incomplète de la situation de l'ensemble du corridor fluvial, en particulier pour les grandes rivières. Les libellules, tel que proposé dans les travaux précédents, devraient offrir une évaluation plus complète des conditions écologiques du système fleuve-plaine inondable, en raison des caractéristiques environnementales qu'elles indiquent. Dans cette étude, l'Indice di Qualità Morfologica - Indice de la Qualité Morphologique (IQM), couplé avec un système d'évaluation basée sur les odonates, est utilisé pour analyser les relations entre les éléments écologiques et morphologiques de l'environnement fluvial. Un autre aspect de la recherche est de tester les libellules comme indicateurs écologiques sur un ensemble de tronçons de rivières avec des morphologies et des impacts humains différentes. Les résultats préliminaires d'étude sur cinq tronçons de rivières montrent une bonne correspondance entre les résultats des deux systèmes d'évaluation, ce qui confirme la corrélation positive entre les conditions écologiques et morphologiques des tronçons et le bon potentiel d'odonates comme bioindicateurs dans les écosystèmes fluviaux.

## **ABSTRACT**

In the recent years many assessment methods have been developed to evaluate ecological and morphological conditions of rivers considering the requirements of the EU Water Framework Directive. Bioindicators are commonly aquatic organisms, but their use could lead to an incomplete evaluation of the status for the whole river corridor, for instance in large gravel-bed rivers. Dragonflies instead, as proposed in previous works, should offer a more complete evaluation of the ecological conditions of the river-floodplain system, due to the environmental characteristics that they indicate. In this study, the Italian Morphological Quality Index (IQM), joined with an Odonata based assessment system, are used to analyze the relationships between the ecological and morphological status of the fluvial environment. Another aim of the research is to test dragonflies as an ecological indicator over a set of reaches with different channel morphologies and human impacts.

Preliminary results from five reaches show a good correspondence between the two assessment systems, confirming the positive correlation between ecological and morphological conditions of river reaches and the good potential of Odonata as bioindicators in riverine ecosystems.

## **KEYWORDS**

Dragonflies, ecological indicators, hydromorphology, Indice di Qualità Morfologica - Morphological Quality Index (IQM), Water Framework Directive.

## 1 INTRODUCTION

The assessment of ecological and hydromorphological conditions of rivers is a key issue in river management and restoration, according also to EU Water Framework Directive (WFD). Different types of bioindicators have been used to assess ecological conditions of rivers, and they generally are aquatic organisms (e.g. diatoms, aquatic macrophytes, benthic macroinvertebrates and fishes). The use of these bioindicators could lead to an incomplete evaluation of the whole river corridor, especially in those rivers where large areas of the corridor are occupied by bars, islands, floodplain, and recent terraces. As proposed by Chovanec and Waringer (2001) and Smith *et al.* (2007), dragonflies could allow a more global ecological assessment at the reach scale, in respect to what is possible with the categories of bioindicators mentioned above. In fact, dragonflies are good indicators of ecological quality of land-water ecotones, habitat heterogeneity and hydrological dynamics of water bodies (Chovanec and Waringer, 2001). As regards evaluation of morphological conditions of river reaches, a new method, Indice di Qualità Morfologica – Morphological Quality Index (IQM), has been recently proposed and adopted in Italy for application of WFD procedures (Rinaldi *et al.*, 2011). This index is based on the comprehension of the geomorphological processes that drive the physical functioning of rivers. In this study the morphological and ecological conditions of some Italian alpine rivers are analyzed using those methodologies (i.e. dragonflies and IQM). The aims are (i) to analyze the relationships between the ecological and morphological quality of the fluvial environment and (ii) to test dragonflies as ecological indicators over a set of reaches with different channel morphologies (from braided to single-thread) and different human impacts.

## 2 METHODS

The study cases are 6 alpine alluvial rivers, 3 draining from the central-western Alps (Varaita, Sesia and Chiese) and 3 from the eastern portion of the Alps (Adige, Brenta and Tagliamento). The latter 3 rivers were surveyed in 2011, while the other 3 will be surveyed in 2012. Three reaches have been selected for each river and they are located in different physiographic contexts: one reach in the alpine–prealpine region, while the other two respectively in the High and Low alluvial Plain (Table 1). Each reach should be representative of a river segment (defined by the intersection of the borders of the physiographic units with the river itself), in terms of morphological and ecological characteristics and human impacts.

REACH	RIVER	PHYSIOGRAPHIC CONTEXT	MORPHOLOGY
Verona	Adige	High alluvial Plain	Meandering
Legnago	Adige	Low alluvial Plain	Sinuous
Tezze s.B.	Brenta	High alluvial Plain	Braided
Curtarolo	Brenta	Low alluvial Plain	Meandering
Latisana	Tagliamento	Low alluvial Plain	Meandering

Table 1. Physiographic context and morphology of the study reaches.

The recently developed IQM (Indice di Qualità Morfologica – Morphological Quality Index) (Rinaldi *et al.*, 2011) has been used to evaluate the morphological conditions of the study reaches. The index, which is obtained through remote sensing analysis and field-collected data, is composed by 28 indicators divided in 3 categories: 1) functionality of geomorphological processes; 2) presence of artificial elements; 3) recent channel changes. IQM allows an assessment of the fluvial reach in a five-tiered classification scheme, as required by WFD.

Dragonflies are used as ecological indicators to evaluate the ecological integrity of river-floodplain ecosystems in the study reaches using the assessment system proposed by Chovanec and Waringer (2001) and tested for the first time in Italian rivers. Within each study reach 4 sites have been selected for dragonfly surveys, that are based on adult observations, larvae and exuviae sampling. Each site has been visited four times a year, to determine the autochthonous dragonfly community. The sites should be representative of the diversity of habitats that are present in the reach, following, if possible, an ideal transect from the main channel to secondary channels or non-flowing channels, up to isolated ponds – backwaters located in islands or in the floodplain. The assessment system is based on three elements: abundance of autochthonous species, number of sensitive species (numerated in a specific

list) and the Odonate Habitat Index (OHI). The latter is calculated for every site and the calculation of the mean OHI value describes the degree of connectivity, flow dynamics and terrestrialization of the water bodies of the reach, while OHI range describes the variety of habitat types occurring in the reach.

### 3 RESULTS AND DISCUSSION

Preliminary results of five study reaches surveyed in 2011 are presented and discussed. Dragonfly data refer only to adults, because larvae and exuviae are still under identification. Results are summarized in Table 2.

REACH	IQM VALUE	IQM CLASS	N°SPECIES (total)	N°SENSITIVE SPECIES	OHI (Mean)	OHI (Range)	ODONATA CLASS
Verona	0,47	Poor	0	0	0	0	Very poor
Legnago	0,61	Moderate	6	2	1,33	0,26	Poor
Tezze s.B.	0,63	Moderate	12	2	2,49	1,47	Moderate
Curtarolo	0,74	Good	8	3	1,93	1,15	Moderate
Latisana	0,76	Good	13	6	2,21	1,71	Good

Table 2. Results of IQM and Odonata-based assessment system.

The higher values of IQM index (i.e. class “good” of morphological status) were reached in the Low alluvial Plain reaches of Brenta and Tagliamento River, while the worst value was obtained in the High alluvial Plain of Adige River (“poor” quality). The two remaining reaches scored class “moderate” of morphological status. Results from Odonata-based assessment system are slightly different: only one reach was classified in “good” ecological status, two reaches in “moderate” status, one in “poor” status and one in “very poor” status. There is a correspondence between the results of the two assessment systems in two reaches, while in the other three reaches the value obtained through Odonata is one class lower than the value indicated by IQM. However, these preliminary analyses did not consider data from exuviae and larvae, and therefore the final values for the Odonata assessment system might differ from those reported here. As expected, the reaches with the lowest IQM and Odonata values are along Adige River due to the fact that this river is heavily impacted by channelization and dams for hydro-electric power production.

### 4 CONCLUSIONS

Preliminary results of this on-going research show a good correspondence between the two indices used in this study (i.e. IQM and dragonflies), therefore a positive correlation between morphological and ecological conditions. It is confirmed that Odonata are useful bioindicators in riverine ecosystems, able to describe the alteration of many characteristic features of this environment. On the other hand, it seems that the method that has been used for Odonata assessment (Chovanec and Waringer, 2001), could require some modifications to be applied to a range of morphological channel patterns in the alpine context.

### LIST OF REFERENCES

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