# The WEQUAL project: an innovative method for river ecological quality assessment

## Le projet WEQUAL : une méthode innovante d'évaluation de la qualité écologique des rivières

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## RÉSUMÉ

Ces dernières années, les infrastructures vertes et les environnements fluviaux ont fait l'objet d'un regain d'intérêt, comme le soulignent plusieurs documents et directives de l'UE (Infrastructures Vertes et Biodiversité, DCE et Directive Inondation). La qualité écologique, la biodiversité et la fonctionnalité des zones riveraines sont tout particulièrement devenues des questions clés pour les professionnels impliqués dans la gestion des zones fluviales. Le contrôle de l'avancement des travaux de restauration des cours d'eau, ainsi que les changements environnementaux liés à la construction d'ouvrages hydrauliques, est utile à l'évaluation de leur efficacité et de leur impact. L'évaluation de la qualité environnementale des zones riveraines et fluviales est l'objectif d'une nouvelle méthodologie d'enquête innovante, développée par le projet européen WEQUAL (Centre de services WEb pour la conception multidimensionnelle de QUALité et la télésurveillance des infrastructures vertes, Fedr province de Bolzano). Ce projet s'appuie sur des indicateurs écologiques dérivés en grande partie de données LiDAR et d'images RVB et multi-spectrales recueillies par les systèmes RPAS (Remotely Piloted Aircraft Systems). Biomasse, continuité, distribution, hauteur, couverture de la végétation et morphologie du lit sont analysées afin d'évaluer la durabilité environnementale, la biodiversité, la connectivité du paysage et la capacité de piégeage du carbone. Un système de prévision permettant d'évaluer les impacts des travaux d'aménagement du lit des cours d'eau sur l'environnement est aussi étudié. Ce système vise à aider les professionnels et les administrateurs dans l'évaluation des impacts « ex-ante » et « ex-post » par la mise en place d'un outil facile d'utilisation et efficace, à la fois en termes de coûts et de temps investis.

## ABSTRACT

In the recent years there has been an increasing interest on green infrastructures and river environments as stated in different EU policies (green infrastructure and biodiversity) and directives (WFD, Flood directive). In particular, attention to ecological quality, biodiversity and riparian functionality has become a key issue for all the technicians – engineers, ecologists, landscape architects and administrators - involved in river management. Monitoring the evolution of restoration works, as well as changes connected to river training works, is useful to evaluate their effectiveness and impacts. The environmental quality assessment of riparian and river zones is the aim of the innovative methodology now under development within the EU-project (FESR South Tyrol) WEQUAL - WEb service centre for a QUALity multidimensional design and tele-operated monitoring of Green Infrastructures. It is based on ecological indicators derived mainly from LiDAR data, RGB and multispectral images collected by several sensors mounted on Remotely Piloted Aircraft Systems (RPAS). Biomass, canopy cover, vegetation height/distribution/continuity, river morphology and riparian zone width are examined in order to evaluate the sustainability, biodiversity, landscape connectivity and carbon sequestration capacity of the monitored habitat. Forecast on the environmental development after river works construction is examined as well, aiming at supporting technicians and administrators in evaluating impacts ex-ante and ex-post, providing an easy and time-cost-effective tool.

## KEYWORDS

RPAS surveys, ecological indicators, green infrastructures, multidimensional analysis, riparian zones

# 1 INTRODUCTION

In the recent years there has been an increasing interest on green infrastructures and river environments, as stated in different EU policies (green infrastructure and biodiversity) and directives (WFS, Flood directive). Monitoring the environmental impacts of river training works or of restoration works is important to evaluate their effectiveness and to adopt, if necessary, proper counter-measures.

In the WEQUAL project, surveys are carried out with RPAS and an innovative method is now under development in order to extract indicators values through the elaboration of LiDAR data and high resolution aerial images. The extracted data are input for the tailored environmental quality assessment method which refers to the indication of the WFD and is simultaneously under development. A forecasting method completes the WEQUAL project aims. This method allows to compare different river training works design alternatives considering their environmental impacts and development.

# 2 METHODOLOGY

UAVs (Unmanned Air Vehicles) permit to survey extended and difficultly accessible areas in a short time, resulting in a very effective instrument. Within the project new platforms have internally been developed to carry on board the sensors. A fixed-wing UAV and a light-weight multicopter have been designed to host the multispectral and RGB camera and the first prototype have successfully been used to perform the surveys. The fixed-wing platform permits to investigate more extended surfaces than the multicopter, which is more indicated to obtain higher resolution datasets. A powered multicopter is being designed and developed to carry on board the LiDAR sensor.

RGB and multispectral images are elaborated and analysed in order to automatically recognize the soil use, riparian zone width and riparian vegetation continuity. LiDAR data collected on the same area permit to easily construct the DTM and DSM, for the description of the river and riparian zone morphology, and extract remarkable features as slope, transversal and longitudinal river continuity (Michez et al., 2013; Tompalski et al, 2017). Riparian zone vegetation can be characterized through the canopy height model (CHM), derived from the elaboration of LiDAR data. An estimation of the biomass volume is available too. During the validation processes, the automatically extracted features are compared with the traditional field survey results, in order to investigate the precision, accuracy and eliminate possible sources of error of the innovative system of assessment.

The collected data, through their proper elaboration, are inputs for the environmental quality indicators on which the environmental assessment method will be based. The indicators aim to give the technician involved in the river management an easy tool to understand the ecological functionality and identify environmental aspect that can be improved. The indicators refer to: presence and characterization of the vegetation (arboreal/shrubs), ecological functionality, river morphology, longitudinal and transversal continuity, fish life suitability.

Simultaneously the project aims at creating a forecasting method to compare different hydraulic works design alternatives considering their possible environmental development. The forecast is based on indicators which evaluate expected morphology and vegetation growth and refer to the ones presented for the monitoring phase (biomass volume, riparian vegetation, longitudinal and transversal continuity, etc). The forecasting method relies partly on data collected on the field and relating to previously built river training works.

Multidimensional analysis criteria will be used for combining the indicators in order to obtain environmental quality states and a comprehensive evaluation which takes into account the different design alternatives.

The area of monitoring/intervention will be identified through a web platform, directly accessible by technicians or administrators. The web platform will be used to identify the area to be monitored, for the data exchange and to visualize the results of the drone surveys, of the elaborations and of the evaluation methods.

# 3 PRELIMINARY RESULTS

Up to now some preliminary tests have been conducted on two different sites along the Passirio river and Adige river, in two different vegetative periods (May and November) using the LiDAR and the image sensors (RGB and multispectral camera). RGB and multispectral orthophotos have been used to automatically detect land use, recognizing vegetation, soil and water and to calculate vegetative

state indexes as NDVI.

The point clouds collected by the UAVs survey have been classified, and DTM, DSM and CHM have been extracted. The data clouds have been analysed in order to identify single tree's trunk diameter and canopy extension. Trees' vertical profile have been analysed through point density maps aiming at recognizing riparian structure, arboreal and shrubby presence. A comparison between dendrometric field measurements is now under development.

On the same time, a draft of the ecological quality assessment method tailored for the project's aims has been developed. The indicators have been derived from the results described above and with reference with some others similar previous works (Michez et al., 2013, Tompalski et al., 2017, APAT, 2007).

## 4 CONCLUSIONS AND FUTURE WORK

Major aims of the WEQUAL project, now under development, have been illustrated. The ecological quality assessment methods developed within the project will permit ante and post operam evaluation. The monitoring phase will be carried out with RPAS, resulting in faster and cost-effective surveys. Future work will regard the validation of estimates done on LiDAR data analysis and a comparison between the assessment methodology developed in the WEQUAL project and the ones already adopted and based on field traditional surveys. Multidimensional criteria will support technicians and administrators to easily compare different design alternatives from the ecological point of view and comprehend environmental impacts of restoration activities and of previously constructed river trainings works. The methods will be accessible through a dedicated web-based platform.

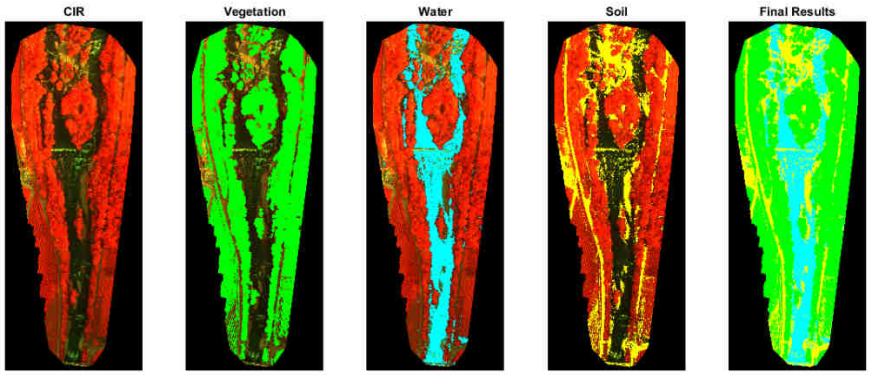


Figure 1 - Multispectral images analysis to detect soil use (vegetation, bare ground, water).

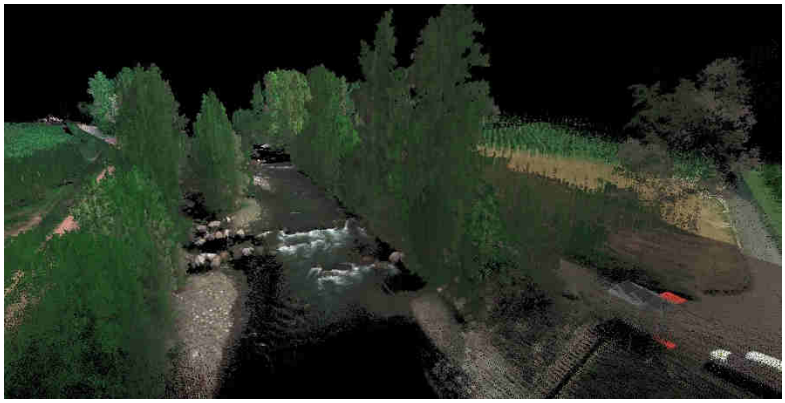

Figure 2 - LiDAR point cloud collected by RPAS survey

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