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

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ABSTRACT

Ecological quality, biodiversity and riparian functionality have become key-issues in river management activities. The WEQUAL project aims to support technicians with an easy and cost-effective ecological-quality evaluation tool.

1 INTRODUCTION

In the last years, interest in green infrastructures and river environments has been increasing and supported by EU policies (green infrastructure and biodiversity) and directives (Water Framework Directive, Flood Directive, etc.). In this context, monitoring environmental impacts of river restoration-works has become a more and more important task. Evaluating restoration-works impacts on the quality of ecosystem services allows to understand the effects of different design solution and to identify proper countermeasures, when necessary, able to preserve ecological quality, riparian functionality and increase biodiversity.

The WEQUAL project (WEb service centre for a QUALity, multi-dimensional design and unmanned-vehicles monitoring of Green Infrastructures) aims to create an innovative method to assess river ecological quality starting from unmanned-vehicles field surveys. The method is intended to support concretely practitioners and scientists in quality evaluations taking advantage of technology. The method considers field surveys carried out with RPAS (Remotely Piloted Aircraft Systems). Then, LiDAR data and high-resolution aerial images are elaborated and assessment-indicators values are extracted. Furthermore, a tailored, forecasting technique allows to compare different alternatives of river-restoration works design considering their environmental impacts and development and completes the WEQUAL project aims. The method aims to satisfy the recommendations of the Water Framework Directive and is currently under development.

2 METHODOLOGY

The method proposed by the WEQUAL project is based on the use of innovative technology and the development of automatic or semi-automatic procedures to evaluate environmental quality and works impacts.

Field surveys are planned to be carried out by means of UAVs (Unmanned Air Vehicles), which permit to cover extended and difficultly accessible areas in a short time, resulting in a very effective instrument. Within the project, suitable platforms are going to be developed to carry the sensors on board. A fixed-wing UAV and a light-weight multicopter have been designed to host the multispectral and RGB camera and the first prototypes have been used successfully for surveying. It is worth saying that the fixed-wing platform permits to investigate more extended surfaces than the multicopter, which is more indicated to obtain higher resolution datasets. Then, a powered multicopter is going to be designed and developed to carry the LiDAR sensor on board.

RGB and multispectral images obtained through field surveys are then elaborated and analysed applying automatic or semi-automatic procedures able to recognize the soil use, the riparian-zone width and the riparian vegetation continuity. LiDAR data collected on the same area are used to construct DTM and DSM describing river and riparian-zone morphology. Remarkable features as slope and river transversal and longitudinal continuity [1], [2] are assessed too. The characterisation of riparian-zone vegetation is performed through the canopy height model (CHM), obtained from of DTM and DSM data. An attempt of estimating the biomass volume is available too.

Information extracted automatically is validated by comparison with traditional field-surveyed results, in order to investigate the methodological accuracy and remove possible sources of error in the assessment system.

Collected data are used, through proper elaborations, as input data for the indicators of the environmental-assessment method. Examples of indicators that can be estimated starting from collected data are: the class of soil use, the spatial continuity of riverbed, the number and the type of transverse and longitudinal river works, the hydrological regime, the presence of riparian vegetation, its species characterisation, its areal dimension, the biomass vol-

ume, the spatial continuity of river banks, the relationship between works and vegetation. Such indicators are intended to give technicians involved in the river management an easy tool to understand the present ecological functionality of a river segment and identify environmental aspects that could be improved. Some of these indicators have been derived with reference to some previous works (e.g. [1], [2]) and assessment methods (e.g. [3], [4]).

At the same time, the project aims at creating a forecasting method to compare alternative hydraulic-works design options, considering their possible, long-term environmental impacts. Forecasts are based on projections about long-term morphology and vegetation growth, expressed on the basis of field data, which collection is in progress and refer to existing, deliberately heterogeneous river works.

Multidimensional analysis criteria will be used to combine indicators and to obtain an expeditious, possibly impartial, assessment of environmental-quality states and a comprehensive evaluation of the long-term impact of different design alternatives.

A dedicated web-based platform will support practitioners, technicians and stakeholders in applying the method. Within the platform, it will be possible to specify the study area where the method must be applied, to visualize results of UAVs surveys, to upload data about location and characterization of design works, to download results of automatic processing with reference to environmental impact assessment.

3 PRELIMINARY RESULTS

Up to now, some preliminary tests have been performed on two different sites along the Passirio river and the Adige river, in two different vegetative periods (May and November), using LiDAR and image sensors. RGB and multispectral orthophotos have been used to detect land use, to recognise river planimetric profile and vegetation extent automatically and to calculate vegetative state indexes, as for example the NDVI (Normalised Difference Vegetation Index).

Point clouds collected by UAVs surveys have been then suitably classified and DTM, DSM and CHM have been extracted. They have been processed also to identify single-tree trunk diameter and canopy extension automatically. Trees vertical profiles have been analysed through point density maps, aiming at recognizing riparian-vegetation structure and arboreal and shrubby presence. A comparison to dendrometric field measurements is now under development, as well as procedures for an automatic identification of riverbed and river banks on a DTM.

At the same time, a draft of the method for environmental-quality assessment has been developed.

4 CONCLUSIONS AND FUTURE WORK

Major purposes of the WEQUAL project have been illustrated. The environmental quality assessment methods developed within the project will allow ante- and post-operam ecological-quality assessment within a unique environment and using advanced technological tools.

Surveys for the current-state quality assessment are carried out with RPAS, which result to be fast and cost-effective. Future work will regard the validation of estimates performed on LiDAR data analysis and a comparison between the assessment methodology developed in the WEQUAL project and other approaches already adopted and based on traditional field surveys.

Multidimensional criteria will support technicians and stakeholders to easily compare different design alternatives from the ecological point of view and consider environmental impacts of restoration activities and of existing river works.

The method will be accessible through a dedicated web-based platform, to be developed.

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