Monitoring of riparian vegetation growth on fluvial sandbars

Michael NONES[1], Massimo GUERRERO[2] and Renata ARCHETTI [3]

[1] Institute of Geophysics Polish Academy of Sciences
Ks. Janusza 64, 01-452 Warsaw, Poland
email: mnones@igf.edu.pl

[2] Department of Civil, Chemical, Environmental, and Materials Engineering, University of Bologna
viale Risorgimento 2, 40136 Bologna, Italy
email: massimo.guerrero@unibo.it

[3] Department of Civil, Chemical, Environmental, and Materials Engineering, University of Bologna
viale Risorgimento 2, 40136 Bologna, Italy
email: renata.archetti@unibo.it

ABSTRACT

The paper proposes a simplified methodology to track the evolution of vegetation patterns over a central sandbar of the Po River, Italy (Fig. 1a), by means of time-lapse photos retrieved from a fixed video camera installed on the top of a bridge pier. Looking downstream, the camera acquires images every twelve hours while hourly water levels are derived from a radar hydrometer located 300 m upstream of the study area. The vegetation growth rate is computed analysing ten images covering the period July-December 2017, characterized by a dry period during the summer/autumn and a flood at the end of the year. The bounds of the vegetation patterns were derived from the rectification of the acquired images by using an own-developed Matlab® script and a few ground control points acquired in July 2017 over the sandbar for rectifying the image and translate image coordinates into real-world coordinates.

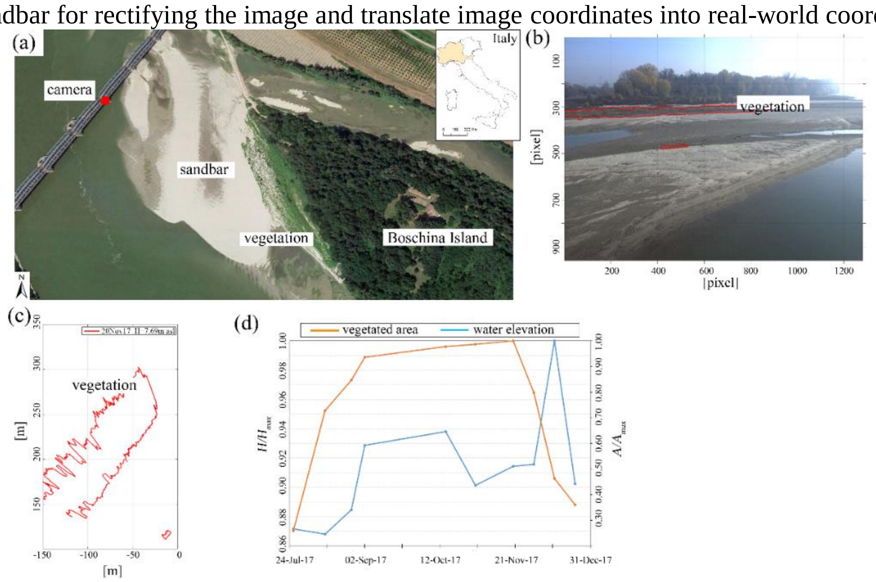

Fig. 1. (a) Google Earth image acquired on June 21, 2017; **(b)** reconstruction of the vegetation bounds on the raw image taken from the camera on November 20, 2017; **(c)** vegetation pattern after the homographic transformation for the same image; **(d)** computed vegetated areas and measured water elevations at the gauging station of Revere.

Aiming to obtain a dimensionless ratio representing the vegetation growth, the computed vegetated areas as derived from the rectified camera images were divided by the maximum one, measured on November 20 (Fig. 1d, orange line). As observable, till this maximum the vegetation cover slightly increases after a strong increment measured between July and August, reaching a quasi-stable state that lasts for around three months. Such state, in fact, is practically unaffected by hydrological variations (Fig. 1d, blue line), if they remain comparably low (i.e., low to mean discharge along the reach) without affecting the local morphology. A sudden change of the vegetation cover is observable in the last days of November, at the end of the growing season and when, generally, the floods become more frequent thus changing the sedimentary pattern with the erosion of the sandbar.

The correlation between an increment of the water levels (i.e., flow discharge) and a decrement of the herbaceous vegetation cover is not so clear from the present application, pointing out the necessity to perform additional studies spanning a longer temporal horizon and based on an improved calibration of the video camera. On the other part, notwithstanding the short time period studied, these preliminary outcomes seem to confirm the ones reported in similar studies. Indeed, in the case of sandbars and floodplains with low bank stability typical of sandy watercourses like the Po, erosive phenomena associated with floods disturb or interrupt the process of vegetation succession, reducing the growing period and the plant diversity of the vegetation covering these areas. However, an in-depth analysis of the adopted methodology is necessary to confirm the preliminary outcomes and to show the potential of time-lapse photography in describing the dynamics of the riparian vegetation forced by the local hydro-morphology. In addition, for the future a better rectification of the images is forecasted, having acquired additional control points both along the banks and within the main channel. Based on these first set of images, it is observable that a prolonged drought phase can enhance the encroachment of seasonal plants until the season is favourable, fixing the sandbar and changing the natural morphological pattern towards a single-thread one. Indeed, if the vegetation colonizes the sandbar in a stable manner, the active channel, where water and sediments are conveyed, becomes narrow and deeper, with possible consequences on infrastructures and local habitat.

Although correlated with several uncertainties, the method presented in the paper can represent a good way to estimate the vegetation growth rate on a fluvial sandbar in a relatively simple manner. On the one hand, there are many strengths in using time-lapse photography to monitor fluvial vegetation: i) it is a low-cost, low-maintenance, power-efficient method; ii) it can be used to detect trends at different temporal scales, from days to years; iii) it provides rough estimates of vegetation growth rates allowing for a comparison with the water levels. On the other hand, several limitations are embedded in the method: i) estimates are imprecise, depending both on the number and positioning of the ground control points and the camera calibration parameters; ii) being the results affected by the camera characteristics, the quality of the camera is paramount in obtaining images with an adequate resolution and covering the desired area; iii) the computed vegetated areas rely on many assumptions on the vegetation dynamics (density, type of vegetation, seasonality, etc.).

For the future, additional works should be focused on the improvement of the precision of the methodology, using ground control points better distributed over the whole area to reduce the positioning errors. Moreover, field samples of the local vegetation are necessary to corroborate the assumptions made in the analysis, as well as to recognize the growing stage. Given that the time range is paramount in the biological dynamics, a necessary and obvious next step is the evaluation of a longer period, covering alternating dry and wet conditions, and not just a single flood event, as well as several seasons, allowing for an analysis of the vegetation response to significant and frequent changes of the fluvial hydrology.