Geophysical Research Abstracts
Vol. 19, EGU2017-10377, 2017
EGU General Assembly 2017

Diachronic 3D modelling to monitor fluvial morphodynamics in a restored hydrosystem (Upper Rhine, Rohrschollen island)

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The Rohrschollen artificial island is a Natural Reserve located 8 km South-East the city of Strasbourg. The island results from several engineering works (correction and canalization) lead on the reach since the beginning of the 19th century to improve flood control, agriculture, navigation and to produce hydropower. Consequently, the main channel of the island (called old channel) was upstream disconnected, hydromorphological functioning was altered (narrowing and clogging, decreasing of morphodynamics and of surface water-groundwater exchanges...) and specific alluvial biodiversity declined drastically.

In the framework of a LIFE+ European program, an ambitious restoration project was carried out by the city of Strasbourg with the aims to restore hydromorphological dynamics and improve typical ecological characteristics of the hydrosystem: bedload dynamics, channel mobility, surface water-groundwater exchanges and renewal of pioneer ecosystems... To achieve these objectives, a new upstream channel was dug in the floodplain and a large floodgate was built in order to reconnect the old channel with the Rhine. Water input is about 2 m3.s-1 and could attain a maximum of 80 m3.s-1 during Rhine's floods. This new hydrological dynamics allowed to recover dynamic floods and high morphological activities, especially on the new channel which was intentionally undersized. As part of the partnership between the LIVE laboratory and the INSA of Strasbourg, a monitoring of fluvial morphodynamics was carried out, based on a diachronic 3D modelling survey.

Focused on three bending sectors of the channel, the initial state was realized in 2014, before the first flood, by a geo-referenced 3D model recorded by Terrestrial Laser Scanning (TLS) and panoramic images. This method was used as a 3D digital reference model and setup by differential GNSS techniques. The long-term diachronic monitoring was based on terrestrial photogrammetry surveys followed by dense matching techniques after each flood. This low cost method has the advantage to be very fast in the acquisition. Bathymetrical data were collected by tacheometry and total station on the whole channel. Based on a diachronic comparison of the obtained models, morphological changes were analyzed and volumes of eroded/deposed sediments were quantified in detailed morphological budgets (elementary 20 m long sections). The 3D models will be complementary with other field techniques like the tracking of passive integrated transponders, active layer evolution and floodplain deposition survey.

The results show the interest of the diachronic 3D modelling methods to estimate the intensity of the morphodynamic adjustments of the restored hydrosystem. These methods allows to (i) refine the understanding of the river dynamics on fine scale (sections), (ii) quantify sedimentary budgets on large scale (channel) and, (iii) predict evolutionary perspectives on the middle term.

The PICO reports the various stages of the implementation of a topographic survey of the channel as well as an overview of the obtained results, in particular a morphological diachronic comparison of the channel.