FACTSHEET

1. Fluvial remote sensing for monitoring physical effects of stream restoration projects

Monitoring and assessment of physical effects of stream restoration projects largely benefitted from important remote sensing technological advances of the last decades. The HyMoCARES project gave the opportunity to test several remote sensing innovative tools for the characterization of spatial patterns and temporal dynamics of river channels, in various fluvial environments of the Alpine Space.

Very high-resolution geodata are now available at the reach scale and can be acquired with a higher time frequency allowing monitoring physical changes occurring after hydrological events. These data can be obtained by drone, gyrocopter, helicopter or by boat for the monitoring under the water or can be directly acquired from static in situ timelapse cameras. The sensors usually used for the monitoring are multispectral (in the visible or infrared domains) or hyperspectral digital cameras, LiDAR, thermic sensors or bathymetric echosounders.

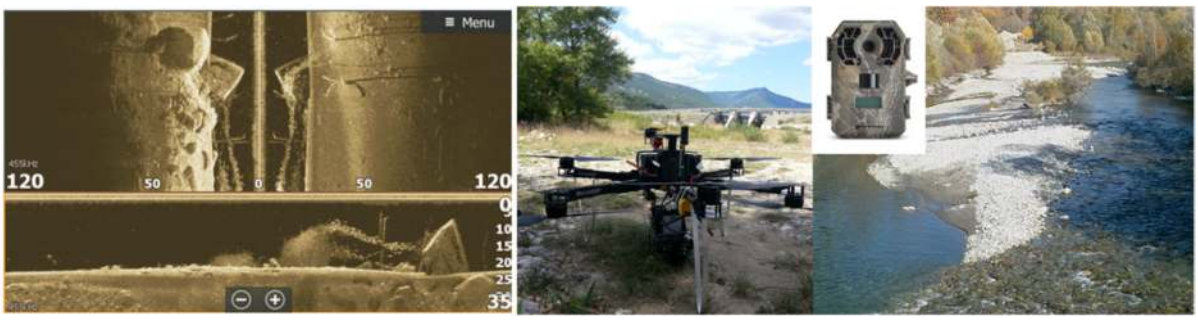

Figure 1. Vectors and sensors usually used for the physical monitoring, from left to right: image from the bathymetric echosounder used in the Lech river (Germany); drone equipped with a LiDAR sensor and a digital camera used on the Buëch and Drac rivers (France); in situ timelapse camera deployed in the Drac river (and resulting image)

Physical features can be monitored thanks to frequent acquisition of aerial and/or *in situ* photos. These photos can be orthorectified to assess planimetric changes of river channels. The mapping of hydromorphological units can be done from expert-based (e.g. Belletti et al., 2017) or automatic methods (e.g. Demarchi et al., 2016). If aerial photos overlap sufficiently (70-80%) and show various angles of view, SfM photogrammetric technics allow generating a 3D point cloud from which a Digital Elevation Model (DEM) can be produced. Such data has been used in several pilot sites of the HyMoCARES project to evaluate channel responses after restoration. It has been also possible to use sequential airborne LiDAR data to detect morphological change and to quantify reach-scale sediment budgets following restoration (e.g. Brousse et al., 2019).

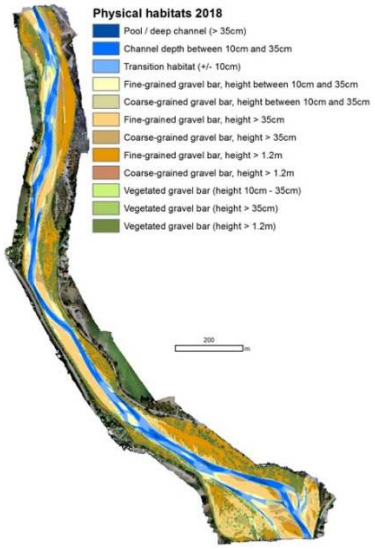

Figure 2. Physical habitats mapped in 2018 in the Buëch River using VHR orthophotos analysis (Liébault et al., 2019)

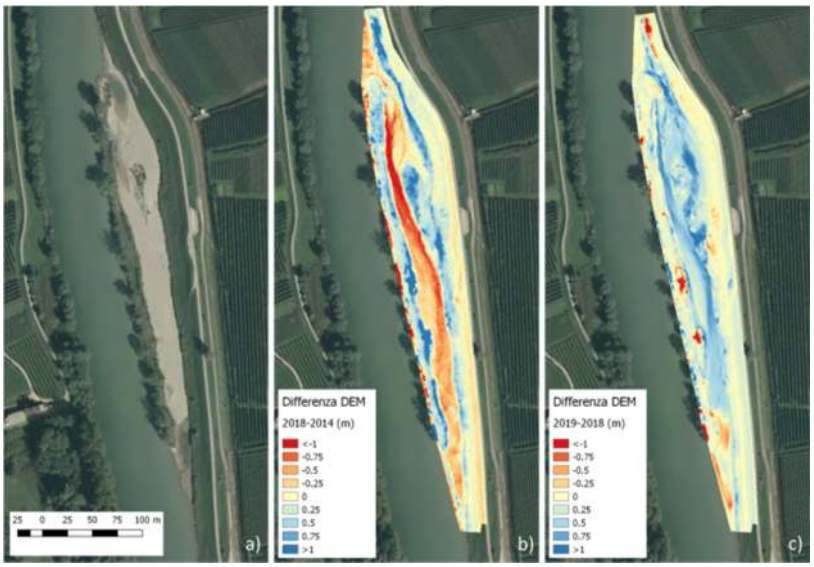

Figure 3. Adige River at Ischiello a) Orthophoto (2014), b) 2014-2018 difference of DEM (DoD), and c) 2018-2019 DoD (Fragola et al., 2019)

Thermal infrared imagery obtained from airborne surveys has been also successfully used to map the water surface temperature of river channels along reaches of several km lengths, allowing the detection of groundwater lateral inputs in the floodplain. It has been also possible to constrain the thermic longitudinal pattern of several HyMoCARES pilot sites with this kind of innovative imagery.

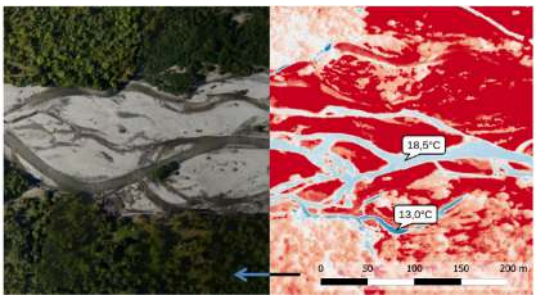

Figure 4. Patterns of surface water temperature obtained in the Drac River using thermal infrared imagery (Marteau and Piégay 2018)

Key message: Fluvial remote sensing data now offer powerful tool to monitor physical effects of stream restoration projects, providing high-resolution data covering large spatial scales

References :
Belletti et al. (2017) 10.1016/j.geomorph.2017.01.032.
Brousse et al. (2019) 10.1002/rra.3527.
Demarchi et al. (2016) 10.3390/rs8020097.
Fragola G. et al. (2019). Technical note on the evaluation of physical and ecological effects of river restoration works, Adige River Basin. DT331 HyMoCARES.
Liébault F. et al. (2019). Technical note on the evaluation of physical and ecological effects of river restoration works, Buëch and Upper Drac rivers. DT331 HyMoCARES.
Marteau B. and Piégay H. (2018), Relevés thermiques aéroportés sur les rivières Buëch et Drac, Unpublished technical report, Conseil Départemental des Hautes-Alpes.