Reach-scale hydromorphological characterization of European rivers using Hyperspectral and LiDAR data acquired from airborne and UAV platforms

Description for the general public

Freshwater ecosystems are considered among the most endangered ecosystems on earth. In the last century, they have been affected by a major decline in their biodiversity, mostly due to human development, pollution and climate change. In European river systems, this decline is mostly related to damming of rivers, water diversion, riverbed morphological modifications, pollution, agriculture and poor management practices; all factors that put river systems—and the water they produce for people—at risk. For this reason, the ecological quality and ecosystem health of river systems need to be improved.

The ecological status of a river system is not only driven by traditional chemical and biological quality elements but also by its Hydromorphological (HYMO) conditions. "Hydromorphology", as defined by the Water Framework Directive (WFD)—the most substantial piece of EU water legislation to date—describes the physical characteristic of the shape, boundaries and content of a water body. To achieve the good ecological status of river systems, the WFD requires Member States of the EU to assess, monitor and, where necessary, improve the ecological quality and ecosystem health of river systems. In particular, HYMO assessments of rivers and streams should form part of the operational monitoring programs of each Member State, at 6 year intervals.

A method called River Hierarchical Framework was therefore developed by an EU funded project (REFORM: http://www.reformrivers.eu/), to guide river managers in assessing the HYMO character of river systems. River ecosystems are divided into riparian and aquatic habitats, each of them described by a list of key HYMO indicators controlling processes and forms that needs to be monitored for characterizing the HYMO status of a river system. Conventionally, this is done through resource-demanding field-based surveys. This kind of approaches rely strongly on expert opinions, are discontinuous, hardly repeatable and represent only limited river sections. For this reason, their use for monitoring purposes, which require an objective and repeatable assessment method is very limited.

The innovative wave that characterized the digital revolution during (and after) the latter half of the 20th century, yielded a new generation of Remote Sensing (RS) technologies that has changed the way we look and analyze river systems. The improved accuracy recently reached by these technologies offers a wealth of opportunities to enhance our understanding of fluvial processes. Modern river monitoring and management can also be optimized, thanks to an unprecedented amount of continuous, spatially distributed information along river courses.

The aim of this project is to define a proper operational methodology for characterizing the HYMO status of a river system, using emerging RS technologies. Novel advanced sensors and platforms will be tested and compared: mainly Hyperspectral and LiDAR sensors mounted on Airborne and Unmanned Aerial Vehicles (UAV). Only recently, light LiDAR and Hyperspectral sensors have been started to be commercialized and therefore mounted on UAV as well. The potentials of such emerging UAV technologies in extracting detailed HYMO indicators is unknown and therefore it needs to be properly investigated. In particular, in this project we want to know which is the optimal RS technology, between airborne and UAV, for monitoring the main HYMO indicators in an automated, repeatable and cost-effective way. This knowledge is necessary for implementing an operational monitoring process of river systems.

HYMO indicators will be divided into riparian habitats and aquatic habitats. For each category, different data from Airborne and UAV platforms will be tested and compared for different representative river systems. The RS-based HYMO indicators extracted from RS acquisitions will form a geo-database describing the aquatic and riparian habitats composing the natural fluvial corridor of the river analyzed. These results will provide fluvial geomorphologist with an unprecedented source of data that did not exist before. Such type of information has the potential to advance the ability in understanding existing and novel fluvial processes theories and at the same time facilitating river management.

The project will provide a novel method for river managers on how to perform the periodic HYMO assessments required by the WFD in a cost-effective way, by using the optimal RS technology. Such kind of approach is also a very useful tool in the designing of cost-effective rehabilitation plans. Understanding fluvial processes and supporting river management practices by monitoring their riparian and aquatic habitats in a cost-effective way is a prerequisite for preserving ecosystems and their services in a good status, a value of which humankind and our societies have always benefited in a multitude of ways.