Using Sentinel-2 multispectral imagery to assess flow-intermittency in non perennial rivers

Carmela Cavallo[1], Maria Nicolina Papa[1], Giovanni Negro[2], Giuseppe Ruello[3], Massimiliano Gargiulo[3,4], and Paolo Vezza[2]

[1]University of Salerno, Civil Engineering Department, Fisciano, Italy (ccavallo@unisa.it mnpapa@unisa.it)
[2]Department of Environment Land and Infrastructure Engineering, Polytechnic University of Torino, Torino, Italy (giovanni.negro@polito.it paolo.vezza@polito.it)
[3]Department of Information Technology and Electrical Engineering, University of Napoli Federico II, Napoli, Italy (ruello@unina.it massimiliano.gargiulo@unina.it)
[4]CIRA, Italian Aerospace Research Centre, 81043 Capua, Caserta, Italy (m.gargiulo@cira.it)

Non-perennial rivers are characterized by periods with dry bed or chains of isolated ponds. Given the extremely high biodiversity and various ecosystem services, these environments require careful management. The main obstacle to the implementation of correct management practices is related to the lack of information about the duration and frequency of zero-flow periods, that are the primary determinants of ecosystem processes in this kind of streams.

In many cases, the presence of non-perennial reaches within the river network is unknown. Given the high extension of the network of non-perennial rivers and their strong spatial inhomogeneity, traditional gauging systems are not adequate to provide measures with adequate spatial coverage. Moreover, point measures cannot capture the space-pattern of presence/absence of water. On the other hand, field surveys of water patterns have a limited temporal resolution and therefore lack in capturing the regime's time-patterns. In this context, satellite data can make a key contribution thanks to the possibility of monitoring large areas with high temporal resolutions. Their use for monitoring the regime of non-perennial rivers has so far been limited by the availability of images with adequate resolution and accessible costs.

In this work, we explored the potential of medium-resolution multispectral Sentinel-2 data to identify non-perennial rivers and to assess their degree of intermittency. Examining the spectral signatures of water, sediment and vegetation covers, the bands in which these classes are most differentiated were identified. Exploiting these bands, we generated false-color image in which the pixels covered by water stand out from the background. From the false-color composite images, it was possible to identify the three distinct flowing status of non-perennial rivers: "flowing", "ponding" and "dry" . The classification of flowing status was checked against ground truth, showing very good agreement. To enable a wider audience to identify flowing status along non-perennial rivers, we have developed and made freely available a code on the Google Earth Engine platform. For all the archive images (since 2015) we identified one of the three possible flowing status: flowing, ponding and dry bed. The obtained dataset allowed to train a random forest (RF)

model able to predict the daily occurrence of a specific flowing status using as predictors spatially interpolated rainfall and air temperature data. The analysis was performed for 5 reaches of the streams Sciarapotamo, Mingardo and Lambro (Campania region, Italy), for which a RF model was calibrated. Classification RF models performed well in terms of accuracy (ranging from 82% to 97%) and true skill statistic (ranging from 0.65 to 0.95). All the studied reaches showed a no-flow condition during the observation period. Three of the five reaches resulted to have a dry bed condition each year while the other two reaches never dry up completely. With its ability to monitor the presence and absence of water in a cost-effective manner, this method has the potential to significantly improve the management and the conversation of non-perennial rivers, enabling a better understanding of their ecological status, as required by the European Water Framework Directive 2000/60/EC.