



IH cantabria
INSTITUTO DE HIDRÁULICA AMBIENTAL
UNIVERSIDAD DE CANTABRIA

IH cantabria

**Copernicus Tools for Monitoring Global Change
Effects in Rivers and Riparian Zones
(Cop.RIVER)**

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**Deliverable 15: Review of project indicators
Reporting period 2024 - 2025**

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1 BACKGROUND

Cop.RIVER aims to promote the use of Earth Observation (EO) in applications and services related to the ecological status of fluvial landscapes (*i.e.*, rivers and their associated alluvial plains, floodplains and riparian forests). The action will strengthen the Copernicus user uptake by supporting regional and national authorities in the implementation of the EU Biodiversity Strategy to 2020, the Habitats and Birds Directives and the Water Framework Directive by applying GAP analysis, to complement available Copernicus information on the state and characteristics of rivers and riparian zones.

2 PROJECT INDICATORS

Throughout the Cop.RIVER project, a series of national and EU-level activities were carried out engage relevant stakeholders, promote the use of Copernicus data, and develop tailored products for monitoring fluvial landscapes. Five national meetings involved participants from key environmental institutions, while workshops and uptake sessions facilitated knowledge exchange, with more than 60 participants involved. The project also produced a methodological toolkit and two pilot areas in the Cantabrian region served as testing grounds for five cartographic products. Cop.RIVER contributed to international conferences, and disseminated results through web stories and social media.

A detailed description of project indicator achievement is presented below.

2.1 National-level meetings with relevant end users and stakeholders related to Copernicus data and services

During the development of the project, we identified the following key agents for the co-design of relevant methodologies and products in the framework of Cop.RIVER:

- The General Directorate of Forestry and Biodiversity, a governing institution of the Spanish Ministry for the Ecological Transition and the Demographic Challenge (MITECO).
- The General Directorate for Water (aquatic domain), MITECO.
- The Cantabrian Hydrographic Confederation (terrestrial and aquatic domains), MITECO
- The National Parks Autonomous Agency
- The TRAGSA Group (terrestrial and aquatic domains), a company owned by the Spanish State General Administration, the Autonomous Communities and Municipalities.

These are relevant environmental institutions and practitioners involved in monitoring the ecological status of the terrestrial and aquatic domains.

The General Directorate of Forestry and Biodiversity is one of four directorates under the General Department of Rural Development, Livestock, Fisheries, and Food. This directorate is responsible for overseeing the management of public utility forests, biodiversity monitoring (with a particular focus on protected species), fire prevention, and the regulation of energy and fishing activities.

The Cantabrian Hydrographic Confederation is an autonomous body responsible for the management of the catchment areas of the rivers that flow into the Cantabrian Sea. Among the functions attributed to them are: the inspection and surveillance of the public water domain and its protection zones, the

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control of the state and quality of our rivers and groundwater, the hydrological planning (following the guidelines of the Water Framework Directive and the implementation of actions related to flood risk assessment and management.

The Directorate-General for Water is the governing body of the MITECO that assumes the competence of the General State Administration over water resources. Its functions include drafting regulatory proposals derived from the application of water regulations and participating in international organisations and monitoring international agreements, as well as coordinating participation in EU technical working groups for compliance with and monitoring of water directives.

The National Parks Autonomous Agency is an autonomous body aimed to for the conservation of the integrity of natural values and landscapes and to strengthen the link between nature and society, through actions that promote the generation of knowledge, the use and sustainable development of natural areas.

The TRAGSA Group is a company owned by the Spanish State General Administration with the aim of providing the services required in the environmental, rural development and resource and process management fields. TRAGSA develops and execute solutions that contribute to guaranteeing social development and economic and environmental sustainability.

Cop.RIVER organized multiple national-level meetings (bilateral and multi-agent), gathering more than 60 participants total.

2.2 Workshops opened at EU level on technical issues and results

We have held one EU-level workshop on needs and opportunities for monitoring riparian habitats ecology and conservation status, discussing and proposing methodologies and improvements based on Copernicus data and services and locally tailored products at IHCantabria. In addition, we held a workshop focused on needs and opportunities for monitoring the aquatic and sediment components of fluvial landscapes. More than 60 participants total have been gathered in these workshops, including participants from Spain and Portugal.

2.3 Number of national Copernicus user uptake session in Spain for presenting methods and results.

Cop.RIVER organized a Copernicus user uptake session fully focused on presenting an overview of CLMS products that contribute to the characterisation of elements and phenomena associated with riparian vegetation, river hydromorphology and the aquatic component of the fluvial landscape.

The Cop.RIVER User Uptake Session was held in mid-September 2025. The aims and scope of the Framework Partnership Agreement on Copernicus User Uptake ([FPCUP](#)) were presented. The Copernicus Land Monitoring Service (CLMS) Portfolio was presented and we depicted the role of these data and products in the development of the selected monitoring indicators and the Cop.RIVER toolkit (available [here](#)). The most relevant CLMS products to assess the ecological status of fluvial landscapes were evaluated. The key aspects of each CLMS product were summarised, including their spatio-

temporal resolution and extent. The strengths, weaknesses, and possible improvements were indicated (Fig. 3). Finally, a practical demonstration was given on how to obtain and process these products (e.g., via <https://wekeo.copernicus.eu/>, Fig. 4).

The audience participating in this session included national government technicians of environmental institutions (Spain), but also doctoral students and researchers from Portugal, Germany and Italy.

2.4 Locally tailored products based on Copernicus data and services for the monitoring of Global Change Effects in Rivers and Riparian Zones

A set of selected remote sensing indicators was applied to two case studies located in Northern Spain: The Saja-Besaya and Pas River basins. Both basins share the climatic setting and comprise similar vegetation formations in well-preserved areas, while land-use patterns and ecosystem conservation status differ notably, allowing us to explore the suitability of the Cop.RIVER toolkit (available [here](#)) in a range of environmental scenarios.

For the terrestrial domain, we used three indicators related to land use and land cover (i.e., CLMS product Riparian Zones), habitat connectivity (i.e., longitudinal connectivity of the 91E0 habitat), and vegetation structure (i.e., vegetation high obtained from the PNOA Normalized Digital Surface Model). For the aquatic domain, two indicators were calculated to evaluate the variable eutrophication: chlorophyll-a concentration and the Trophic State Index (TSI), which classifies water bodies into different trophic status classes. The maps and GIS layers can be downloaded from the Cop.RIVER toolkit (available [here](#)).

To validate the results obtained for remote sensing indicators, it is essential to incorporate ground truth data from diverse sources. Ground truth data allows for the assessment of the accuracy and reliability of estimates derived from the CLMS products, the calculations based on Sentinel-2, and LiDAR metrics, by comparing them against *in situ* parameter values. In cases where discrepancies are identified, ground truth data can be used to refine and enhance methodological approaches for improved precision.

2.5 Cop.RIVER – The toolkit

One of the main outputs from the project is the Cop.RIVER toolkit (available [here](#)). The toolkit provides a methodological framework for monitoring elements, processes and services associated to fluvial landscapes (e.g., riparian forest composition, riparian habitat connectivity, water quality) using CLMS products and complementary approaches to support decision-making in biodiversity and water resource management, restoration, and conservation actions.

First, the main guidelines, strategies, directives and monitoring approaches were reviewed to identify the reporting needs of national and regional authorities in the EU and Spain. Second, key ecological indicators to address monitoring variables were selected and the applicability of CLMS products was evaluated, combined with the identification of alternative remote-sensing products and approaches. Finally, the main features of key CLMS products are summarised, their strengths and weaknesses are

evaluated and potential improvements are suggested. The toolkit also includes two case studies where CLMS and alternative remote sensing products have been applied.

2.6 Contributions to international conferences

Two oral contributions have been presented in international conferences: the first, at the IV Iberian Conference on River Restoration (RESTAURARIOS 2023) and, the second, at the XXII Iberian Association of Limnology (AIL) Meeting (AIL 2024).

2.6.1 Contribution to the IV Iberian Conference on River Restoration (RESTAURARIOS 2023)

The RestauraRíos Conference is an international forum that bring together diverse groups of interest (including local, regional and national authorities) related to river management, research and planning, river restoration experts, environmentalists, river conservation volunteers, communicators and general public interested in the monitoring and recovery of rivers from Spain, Portugal and other EU countries.

The contribution entitled “The need for dynamic and continuous information for riparian zone characterization: Current and future challenges in a global change context”, co-authored by Álvaro Fernández-Menéndez, Laura Concostrina-Zubiri, Jose Manuel Álvarez-Martínez and José Barquín (all Cop.RIVER team members) was accepted as an oral communication in the RestauraRíos Conference after peer-review by the Scientific Committee. This work was presented in the session “SESSION 2. RECOVERY OF RIVER LIFE: RIPARIAN VEGETATION AND FAUNA” on June 21, 2023.

The goal of this study is to assess the potential of the Copernicus product Riparian Zones and a riparian vegetation cartographic base to fulfill the riparian zone characterization requirements within four European policy initiatives (Water Framework Directive; Habitats Directive; Floods Directive; EU’s Biodiversity strategy for 2030). We reviewed riparian status assessment methods, identifying 14 key variables that should be approached by the two products considered. The results show that both products can extract vegetation cover and connectivity at large scales, although some variables require additional data related to anthropic elements and channel and floodplain delineation. We conclude that the use of data like Sentinel-2 images or LiDAR and the development of products to characterize riparian zones over entire hydrographic networks is essential to continuously assess the status of riparian zones at large scales. This study highlights the necessity to develop effective tools to cover the continuous riparian characterization needs (structure, composition, and function) to face the incoming environmental challenges in a global change context.

2.6.2 Contribution to the XXII Iberian Association of Limnology (AIL) Meeting (AIL 2024)

The XXII Congress of the AIL, titled "Aquatic Ecosystems Under Threat: Advancing Our Knowledge to Mitigate the Effects of Global Change, Promote Adaptive Management, and Engage Citizens," aimed to bring together limnologists from Portugal, Spain, and other regions/nationalities to share and exchange knowledge and experience. It also aimed to gather political and environmental stakeholders, industry representatives, and all those interested in aquatic ecological research and building an environmentally sustainable future.

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One of the primary goals of the congress was to provide a platform for presenting and debating new scientific advancements necessary for improving the management and conservation of continental water ecosystems (from lakes to deltas and estuaries, including rivers and wetlands). This is set in a context of global change that requires new models of cooperation between human society and nature. The congress also served as a space for exchanging new technological tools that will greatly assist us in the future and are currently reshaping our surroundings.

Here, the work “Riparian forests are key regulators of thermal conditions across European rivers” was presented. This work aimed to advance our knowledge about the drivers of riverine thermal conditions. This is critical to preserving river biodiversity and functioning in the face of global change. In particular, riparian forests are a key ecosystem component providing shade and modulating air movement above the river and in exchange with the adjacent environment. To better understand the role of riparian forests as regulators of riverine thermal conditions, we investigated 20 sites in each of six basins from Southern Spain to Finland. Combining remote sensing data and in situ measurements, we studied how forest shade and land cover composition in the riparian zone influence river water and air temperature. Shade over the river was estimated with hemispheric photos taken in the field while land cover was defined using CORINE-Land Cover (Copernicus Land Monitoring Service). Daily water and air temperature were measured in the field from spring to late winter over a year. Forest shade had a significant effect on water and air temperature, yet, the direction and magnitude of this effect was season-dependent. Also, the land cover composition was related to the seasonal regime of air temperature (i.e., the combination of seasonal mean, minimum, maximum, SD, and range), while the dominance of forest/non-forest cover was related to the seasonal regime of water temperature.

The findings of this work will help to predict the implications of warming and land use change for ecosystem functioning and suggest riparian forests as an important tool for climate change adaptation in rivers.

2.7 Articles in peer-reviewed journals

A scientific paper, led by the Cop.RIVER team, using Copernicus data (spectral data) to evaluate riparian forest biodiversity will be submitted soon to *Ecological Applications - Method*. Assessing riparian forest diversity and dynamics at the basin level is key to understanding their ecological roles and conservation status. Unlike other forest types, the use of satellite-based multispectral indices for riparian zones remains underutilized. This study explored the seasonal link between Sentinel-2 greenness indices (NDVI and EVI) and six ecological indicators, including species richness, plant height, leaf traits, and the presence of evergreen and non-native species. Using linear mixed models, we found all indicators positively influenced spectral greenness, with diversity (Gini-Simpson), height, and leaf area showing the strongest effects. These relationships varied seasonally—NDVI was more responsive during dormancy, while EVI was stronger in growth periods. This highlights the value of full-year phenological monitoring. Although evergreen and exotic species had weaker effects, they were still significant, emphasizing the role of invasive species. Overall, spectral indices proved effective for tracking riparian forest health and productivity patterns.

2.8 Web stories and publication sin social networks

Two web stories have been published to summarize the aim, the progress and the results of the project, including the development of the toolkit with the methodological guideline to select remote sensing derived ecological indicators based on Copernicus data and alternative remote sensing-derived data and products, the evaluation of CLMS products and the two case studies.

During the development of the project, almost 10 press releases and notes have been published in social media depicting the aim and approach of the project, the celebration of the two expert workshops and the divulgation activities (e.g., European Researchers' Night) related to results involving the use of Copernicus data and products.

<https://ihcantabria.com/en/ihcantabria-promotes-projects-that-promote-the-conservation-of-riparian-forests-and-their-contribution-to-biodiversity-and-river-ecosystems/>

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