	EXTENDED ABSTRACT OF THE FINAL DELIVERABLE
TECMINE CEAM	***Report on ecosystem services, including a database on the vegetation cover, biodiversity and carbon sequestration, and the main ecohydrological variables, such as blue and green water.***
	Date: February 2022
	Authors: Diana Turrión, Luna Morcillo, David Salesa, Alberto Vilagrosa Fundación CEAM, C/Charles Darwin 14, 46980 Paterna (València, Spain)

Background & Objectives

One major goal of ecological restoration is to re-establish the main characteristics of an ecosystem such as plant biodiversity and ecological functions, which were prevalent before degradation and to, consequently, increase ecosystem services (ES) provision.

The benefits of restoration practices applied in TECMINE project were evaluated by running a monitoring programme on the ecosystem structure and function for the following 2 years after restoration. During monitoring, we assessed the dynamics of the ES provided by these restoration approaches, including carbon sequestration and hydrologic cycle.

The main objectives of this deliverable were to: 1) establish the levels of soil protection and fertility achieved after restoration actions; 2) assess plant colonisation patterns, including plant diversity, biomass and carbon sequestration for the years following restoration; 3) analyse hydrological dynamics; 4) compare the results obtained in the TECMINE Project with to two different reference areas: a native vegetation area (natural undisturbed area) and old reforestation (area restored more than 10 years ago using classical restoration practices). To accomplish these objectives, we analysed several indicators (Table 1).

Table 1. Functional indicators analysed to evaluate the state and functionality of the restored area.

Main assessment	Indicators	Description
Soil surface	Soil protection	Plant cover, biomass debris/litter and other fractions that protect the soil surface
	Soil fertility	Changes in chemical soil properties
	Soil compaction	Degree of soil compactness related to water infiltration and particle mobilisation by mechanical disturbance
	Landscape functional indicators: stability, infiltration and nutrient cycling	Soil surface assessment based on the Landscape Functional Analysis protocol
Vegetation	Plant development	Plant colonisation analysis and soil protection
	Plant diversity	Species diversity, including introduced and colonising species
	Plant biomass and carbon sequestration	Plant biomass determination and carbon sequestration estimations
Ecohydrology	Water balance	The main ecohydrological parameters characterising each area, partitioning green water/blue water; *Hydrobal* model.

Main results and remarks

- The early achievement of adequate plant cover after restoration tasks is crucial to prevent soil degradation processes and to promote the recovery of main ecological processes. Sowing of herbaceous species significantly increased the effective soil cover 1 year after restoration (Figure 1). Other elements covering the soil surface such as stones, litter, or organic matter debris (e.g., organic fences) were also important to increase the soil surface roughness favoring germination of seeds and the establishment of new native colonizing species.

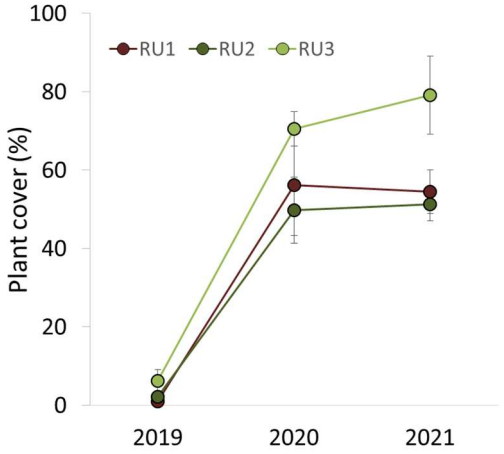

Figure 1. Total plant cover dynamics for the monitoring years (2019, 2020, 2021) in the different Restoration Units in the Geofluv West area. Values are mean±SE.

- Soil nutrient enrichment is a key step to consider in mining restoration. In proper doses and quality, the compost enhanced soil properties being essential to improve soil fertility and organic matter content. The combination of compost addition in surface and in the planting hole, allowed reaching fertility values close to those recommended for soil reference parameters in mining restoration.

- The spread of a colluvium layer on the surface improved soil properties in terms of stoniness, texture, and initial nutrient content. It is noteworthy that, over time, this substrate showed the lowest soil compaction values, enabling some main ecological processes like seed germination, water infiltration and nutrient recycling.

- The accurate species selection introduced in the TECMINE Project together with the implemented restoration techniques, generated the proper ecological conditions to favor the establishment of new colonizing species into the restored area, indicating the onset of the ecological recovery.

- The results obtained in terms of carbon sequestration and balance highlight the importance of implementing appropriate restoration actions aimed at enhancing carbon storage and progressively establish a carbon sink throughout the restored area (Figure 2).

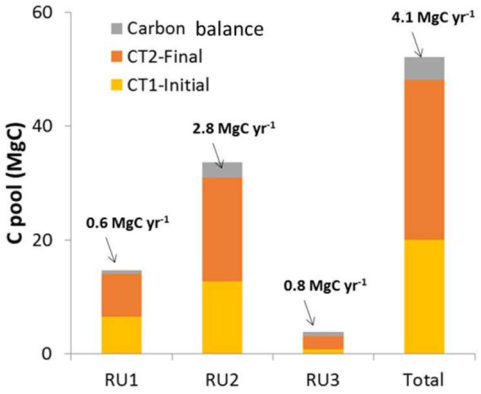

Figure 2. Carbon pools (soil and biomass) at the starting point (CT1), 2 years later (CT2), and the carbon balance rate (net gain in C by year). Values are shown per Restoration Units and the total carbon pool for the whole Geofluv West area.

- From the comparison made between the innovative restoration applied in TECMINE, old classically restored areas and reference ecosystems (Figure 3), we can conclude that only 2 years after restoration, most variables measured in the TECMINE restored areas (e.g., plant cover and species diversity) reached values closer to the reference ecosystem than those values obtained from old reforestation areas restored more than 10 years ago. The values furthest away from the reference ecosystem were found in soil fertility and plant biomass. In this regard, more time is required to allow plant development and subsequent associated processes such as nutrient cycling and soil enrichment.

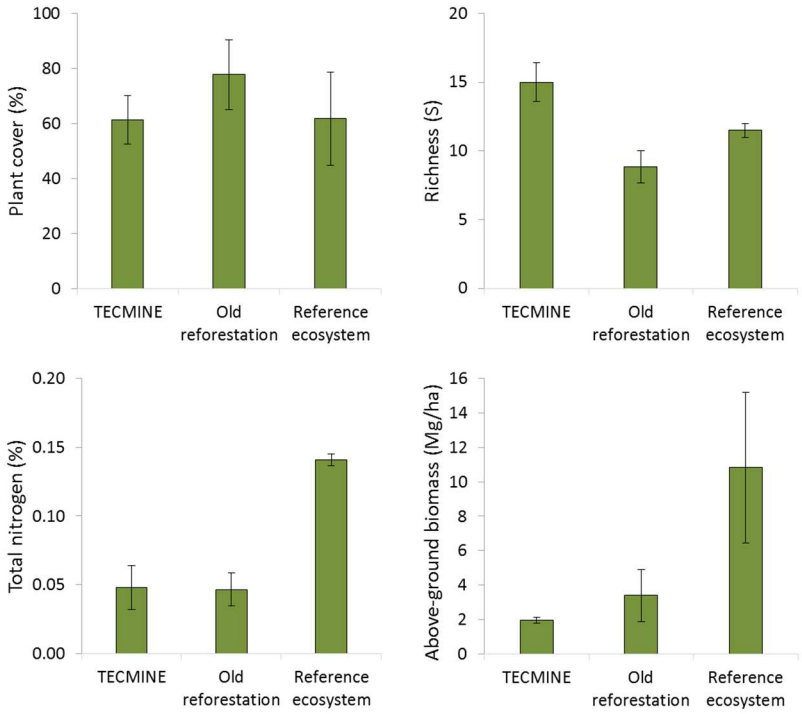

Figure 3. Average values (mean±SE) for plant cover (top, left), species richness (top, right), total nitrogen (bottom, left) and above-ground biomass (bottom, right) obtained in the restored TECMINE area, in old reforestation and the Reference ecosystem.