



SECTOR Extractive.

COMPANY LafargeHolcim.

COLLABORATORS

Plegadis_Cinclus, Universidad de Castilla-La Mancha (UCLM), Universidad de Alcalá de Henares, FIRE, Brinzal, Ecoacsa.

LOCATION

Municipality of Yepes and Ciruelos (Toledo, Castilla-La Mancha, Spain).

SITE FACTS

The extraction began in 1927 and, after a long period of regeneration of the vegetation through natural succession, in 2004 actions to accelerate and monitor this process commenced. These actions are currently ongoing, together with other actions, such as experimentally introducing endangered endemic species of high ecological value (*Vella pseudocytisus* L. subsp. *pseudocytisus*).)



Ecological restoration based on natural succession and conservation education in a quarry on the Mesa de Ocaña

Environmental characteristics

The quarry is located at 700 m of altitude, on the geological formation known as the Mesa de Ocaña. Limestone predominates in this area and, to a lesser extent, gypsum. The surroundings of the quarry are mainly agricultural lands, where cereal, olives and vineyards are grown in a **semi-arid bioclimate**. The predominant natural vegetation is formed by holm oaks and kermes oak, and their different successional stages.

Causes of degradation

The main causes of degradation in this area are agriculture and open cast mining. The extraction of limestone takes place from a single extraction face, which is one thousand meters long, but does not exceed 10 meters in height. The process is carried out through a transfer system, which allows the extracted areas to be restored as the extraction front advances.

Objectives of the restoration

The objective is to create a 250 ha nature reserve through the **ecological restoration** of the quarry. This restoration process favors the edaphological, floristic, structural and functional diversity of the regional ecosystems, and creates and improves ecological niches for the regional invertebrates, amphibians, reptiles, birds and mammals. The aim of the project is the conservation of regional diversity, and once restored, to return the area to public use by promoting environmental awareness and biodiversity knowledge. The objective of the generated ecosystem services is



to improve the initial natural capital of the area, which was severely degraded due to agriculture.

Progress of the restoration

Diagnosis: a floristic catalog of the vegetation was developed by sampling, classifying and mapping the vegetation types in the quarry and nearby areas. An **edaphological** characterization of vegetation types was carried out. Models of vegetation succession of the natural recolonization process of the quarry over time were developed. Then, an assessment of each species of the floristic catalog was done, according to its geographical distribution, its role in the ecosystem from a structural and functional point of view, and its conservation status. **Bird and insects were censused.** The biodiversity value of the site was assessed. Finally, strategies to ensure that biodiversity indicators increase over time were developed.

Execution: the following actions were carried out:

Preliminary actions

- **Prioritization** of plant species, seed collection, germination and plant production.

Main actions

- Mining and restoration actions were carried out simultaneously. As the extraction front advanced, the fertile soil which had been initially removed and stored, was extended, and singular plants such as olive trees were transplanted.
- Revegetation of the vegetation series of holm and kermes oak formations was carried out with natural species and vegetation types such as thyme, esparto grass, retama broom bushes, kermes oaks and holm oaks.
- **Promotion of pollinators: beehives** were placed to favor the pollination of flora and support local European bee-eater populations.
- Actions to promote **cliff-nesting** bird species were carried out in collaboration with the NGOs Brinzal, FIRE Foundation and the University of Alcalá. Also, barn owls were released using the **hacking method**.
- **Public use and environmental education:** a bird observatory was installed; botanical itineraries were designed; bicycle routes and recreation areas were created, and the Environmental



Interpretation Center “La Mesa de Ocaña” was built. This center is registered in the Environmental Education of Castilla-La Mancha Equipment Network. Here, the process of restoration and the different research activities that take place are explained, as well as the environmental value of the surroundings of the quarry.

- The ecosystem services provided through the restoration actions have been analyzed with a tool created specifically to **measure ecosystem services** generated through mining restoration. This tool was developed by ECOACSA to analyze the cost-benefit to identify the added value of the different restoration actions.

Adaptative management

- The efficiency of the restoration actions is being carried out.

i Other restoration aspects

- In addition to the plants produced in the quarry, **specialized nursery** plants which guarantee the regional origin and genetic quality of the individuals are also being used.
- A series of experimental plots were established. Some are dedicated to the reintroduction of the endangered species *Vella pseudocytisus subsp. pseudocytisus*, and others are used to analyze the influence of factors such as herbivory, draught in summer, orientation, winter frost, germination, growth, development and survival of species such as *Ephedra fragilis*, *Ephedra nebrodensis*, *Quercus rotundifolia*, *Stipa tenacissima* and *Thymus vulgaris*.
- The honey produced at the quarry is collected and distributed as “Natural Honey from the Yepes-Ciruelos Quarry of LafargeHolcim Cement”

Monitoring system for the restoration project

- To evaluate the correct evolution of the restoration processes, and **biodiversity index - developed in collaboration with WWF** - of butterflies, birds, insects, lichens and plants was applied
- Most recently, the Biodiversity Indicator and Reporting System **(BIRS)** developed by the IUCN has also been applied

Main results of the restoration

- 250 ha have been restored following ecological restoration criteria, obtaining a notorious increase in the biodiversity of the area (i.e. plant communities restored, increase in bird and insect populations, increase of populations of plant species of conservation concern, improvement of the edaphological diversity)..
- An area for public use for ecological awareness and leisure purposes has been developed.
- **Ecosystem services** have been created, with a potential use of 15000 people.
- It is an area where the **University can experimentally** test ecological restoration of the natural succession.

Problems and solutions

Using the fertile layer of soil that had been removed initially, allowed the use of the autochthonous seed bank, which has a very high plant diversity.

In this semi-arid climate, water availability is the most limiting factor for plant survival. The mortality was near 100% when carrying out revegetation in spring. By advancing the restoration actions to

autumn/winter, the maximum number of days with dew is guaranteed and now, survival rates are almost 100% percent.

We observed that late successional species, such as the Retama broom (*Retama sphaerocarpa*), jasmine (*Jasminum fruticans*), *Rhamnus lycioides*, *Rhamnus alaternus subsp. muniozgarmendiae*, *Colutea hispanica*, the kermes oak (*Quercus coccifera*) or the holm oak (*Quercus rotundifolia*), had difficulties colonizing the quarry. Therefore, the specific restoration actions consist on facilitating the colonization of these species by collecting and planting their seeds, as well as planting individuals. The proximity of the quarry fronts to the natural areas of the edges of the Mesa de Ocaña also facilitate and accelerate the entry of late successional species to the restoration areas.




Good practices and lessons learned

- Previous studies allowed to identify facilitating species and species that restored ecological processes, as well as species of interest including **endangered plants** which could have an ecological niche in the restored area.
- We guaranteed the genetic quality of the individuals used in the restoration by planting seeds collected from the area, and through collaborations with specialized nurseries.
- The research carried out has allowed to identify which species should be used in the ecological restoration, when, and how to do it in a strategic way. The restoration actions aim to accelerate the process of natural succession and promote the biodiversity at the quarry.

- Environmental education and specific seminars on ecological restoration in the Environmental Interpretation Center “La Mesa de Ocaña” is increasing the knowledge and appreciation of the general public towards biodiversity and natural processes. The public use of this restored area constitutes a legacy of immense social, cultural and natural interest.
- To carry out quarry restoration by applying ecological restoration techniques through partnerships with conservation experts.
- This restoration is an example of “Nature-based Solutions”.



MORE INFORMATION

-  **Vídeo** regarding a new conception of quarry restoration
-  **TV report**
-  **Restoration of the Yepes-Ciruelos quarry**

CONTACT

-  **María del Pilar Gegúndez**
-  pilar.gegundez@lafargeholcim.com