LIFE Project Number

LIFE16 ENV/ES/000159

Final Report

Covering the project activities from 01/11/2017 to 01/05/2022

Reporting Date[1]

01/08/2022

LIFE PROJECT NAME or Acronym

LIFE TECMINE

Data Project

Project location:	Ademuz, Valencia, Spain
Project start date:	01/11/2017
Project end date:	01/11/2017 **Extension date:** 01/05/2022
Total budget:	1,589,256 €
EU contribution:	942,456 €
(%) of eligible costs:	59,76%

Data Beneficiary

Name Beneficiary:	Generalitat Valenciana. Conselleria de Agricultura, Medio Ambiente, Cambio Climático y Desarrollo Rural
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[1] Include the reporting date as foreseen in part C2 of Annex II of the Grant Agreement

This table comprises an essential part of the report and should be filled in before submission
Please note that the evaluation of your report may only commence if the package complies with all the elements in this receivability check. The evaluation will be stopped if any obligatory elements are missing.

Package completeness and correctness check	
Obligatory elements	**✓ or N/A**
Technical report	
The correct latest template for the type of project (e.g. traditional) has been followed and all sections have been filled in, in English *In electronic version only*	✓
Index of deliverables with short description annexed, in English *In electronic version only*	✓
Mid-term report: Deliverables due in the reporting period (from project start) annexed Final report: Deliverables not already submitted with the MTR annexed including the Layman's report and after-LIFE plan Deliverables in language(s) other than English include a summary in English *In electronic version only*	✓
Financial report	
The reporting period in the financial report (consolidated financial statement **and** financial statement of each Individual Beneficiary) is the same as in the technical report with the exception of any terminated beneficiary for which the end period should be the date of the termination.	✓
Consolidated Financial Statement with all 5 forms duly filled in and signed and dated *Electronically Q-signed or if paper submission signed and dated originals* and in electronic version (pdfs of signed sheets + full Excel file)*	✓
Financial Statement(s) of the Coordinating Beneficiary, of each Associated Beneficiary and of each affiliate (if involved), with all forms duly filled in (signed and dated). The Financial Statement(s) of Beneficiaries with affiliate(s) include the total cost of each affiliate in 1 line per cost category. *In electronic version (pdfs of signed sheets + full Excel files) + in the case of the Final report the overall summary forms of each beneficiary electronically Q-signed or if paper submission, signed and dated originals**	✓
Amounts, names and other data (e.g. bank account) are correct and consistent with the Grant Agreement / across the different forms (e.g. figures from the individual statements are the same as those reported in the consolidated statement)	✓
Mid-term report (for all projects except IPs): the threshold for the second pre-financing payment has been reached	**N/A**
Beneficiary's certificate for Durable Goods included (if required, i.e. beneficiaries claiming 100% cost for durable goods) *Electronically Q-signed or if paper submission signed and dated originals* and in electronic version (pdfs of signed sheets)*	**N/A**
Certificate on financial statements (if required, i.e. for beneficiaries with EU contribution ≥750,000 € in the budget) *Electronically Q-signed or if paper submission signed original and in electronic version (pdf)*	**N/A**
Other checks	
Additional information / clarifications and supporting documents requested in previous letters from the Agency (unless already submitted or not yet due) *In electronic version only*	✓
This table, page 2 of the Mid-term / Final report, is completed - each tick box is filled in *In electronic version only*	✓

**signature by a legal or statutory representative of the beneficiary / affiliate concerned*

1. Table of content

2. List of key-words and abbreviations

TECMINE: Innovative techniques for Facies Weald and Utrillas mine restoration
UCM: Universidad Complutense de Madrid (Beneficiary)
CEAM: Centro de Estudios Ambientales del Mediterráneo (Beneficiary)
SIBELCO: SIBELCO MINERALES S.A. Mining Company (Beneficiary)
GVA: Generalitat Valenciana (Coordinating beneficiary)
VAERSA: Valenciana d'Aprofitament Energètic de Residus S.A. (Beneficiary)
UPM: Universidad Politécnica de Madrid
CT: Coordinator Team
ASANA: On-line Management Tool
PA: Partnership Agreement
GA: Grant Agreement
GeoFluv™: The landform design method implemented
SERE: Society for Ecological Restoration-Europe
SIBERIA, CAESAR, LISEM: Landscape Evolution Models
AEMET: Agencia Estatal de Meteorología
UNIZAR: Universidad de Zaragoza
PM: Project Manager
OC. Other Cost
EA: External Assistance
TC: Travel cost
PR: Progress Report
MT: Midterm Report

3. Executive Summary

LIFE TECMINE project arises from the need to improve the results of mining restoration affecting forest land in Mediterranean environments.

Given the climatic conditions, characterised by low annual rainfall, but of a torrential nature, together with sandy and clay substrates (mine waste), resulting from the extractive activity in the Weald and Utrillas facies (which implies a high vulnerability to water erosion), conventional restoration practices are not effective in recovering the functions of a forest ecosystem. Consequently, severe hydrological problems (high erosion and low infiltration), lack of suitable soil substrates, and a low success in reforesting these areas by traditional methods result in gully landscapes, unstable and with low biological diversity and visual integration.

Dealing with this, the Valencian Administration (GVA) decided to focus on a demonstration project whose **main objective** was to test other restoration techniques and the combination of them, in such a way that these deficiencies are properly addressed, while increasing the quality of the restorations as a whole. To this end, a team of restoration experts (UCM; CEAM) has been involved, whose designs have enabled an expert water management, both by controlling runoff and by using it for the development of more diverse vegetation that is better adapted to the conditions of the area to be restored. Besides, the VAERSA's participation, both in the project management and the organisation of multiple transfer and training actions, has made available to the mining sector a suitable reference and the necessary training to adopt a new and more efficient restoration model. Finally, the involvement of the mining company SIBELCO has also been key, providing a site representative of these scenarios and validating both, technically and economically, the provided solutions as sustainable alternatives for the mining sector.

The project has been carried out over 4.5 years (with a 6-month extension requested in September 2021) and has been structured into preparatory (A), implementation (B), monitoring (C) and dissemination (D) actions. In general, all of them have gone as planned with some non-relevant modifications that have been reported to the agency and some unforeseen events (such as the COVID-19 pandemic) that we have been able to overcome, reaching the objectives on time and even surpassing these goals.

The initial development of A Actions, has allowed gathering information on the main barriers to achieving higher standards of mine restoration. Similar problems to those addressed in this project have been found both in Mediterranean environments in Spain and beyond (Australia, US, Chile) as well as in other environments (e.g. Sweden). The compilation of real cases, techniques and solutions applied (see deliverables "State of the Art" (A1) and "Expert Panel" (A2)), have allowed us to broaden the target stakeholders, to consider some recommendations in the project implementation and to reaffirm the importance of projects like this under the current global concern about resource supply and climate change. Actions A3 and A4 have incorporated into the preliminary designs the changes resulting from a detailed analysis of the morphological reference, the substrates available in the mine and the recommendations of the previous actions. All of this led to a delay of a few months, but this did not delay implementation, thanks to the involvement of all the partners and especially the company SIBELCO, which adapted the necessary deadlines and budgets.

Some contributions, not previously considered, have been seeding and the installation of organic blanket. Both have been very successful as soil conservation actions, providing rapid and early soil cover from native species (>60% in the first year).

In September 2018 (less than a year after the start), B Actions started with earthworks (B2, B3) and the specific training in the GeoFluv method (B1). It was decided to invite professionals from other public administrations in Spain and an expert from the University of Newcastle (Australia) that is well known as a reference in mine closure issues. From this point on, and in a fully coordinated manner between the partners, the work of soil improvement and preparation (B4) and revegetation (B5) was carried out. The latter, already started from the beginning of the project with the collection of seeds and plant parts for the cultivation of plants in the GVA nurseries.

One of the partial delays corresponds to B2 Action, which was completed in February 2020 instead of the end of 2018, due to the wait for the blasting permission for the upper slope zone. Despite this, actions on the lower slope were carried out normally and seeding and planting of the upper area could be done in time before the summer.

In April 2019 B actions were completed and C actions started. Emphasise the importance of implementing monitoring programmes, not only in demonstration and innovative projects, but also in all restoration projects. In this way, progress can be evaluated, deviations can be detected and, if necessary, corrective measures can be implemented. In our case, different programmes have been carried out relating to (1) morphological evolution and erosion; (2) survival and growth; (3) ecosystem services and (4) fauna. We can say that designs and methods applied have been appropriated, although in some cases it has been needed to adapt them to the situation (e.g. the method to measure erosion). The campaigns carried out, mostly with a monthly frequency, have provided a sufficient series of data to obtain statistically significant results. It has been possible to draw conclusions that are technically sustained and valid for future projects. The lessons learned have allowed improvements to be implemented in other LIFE projects such as RIBERMINE and the replications, and have been transferred to the training actions aimed at professionals at national and international level (D and B7). In addition, they have been incorporated in the deliverables corresponding to actions C1 and C2 as well as in the Technical Guides to support planning and evaluation processes of mining restoration (Action B6).

The results show that, geomorphic restoration models with GeoFluv, in which it has been possible to construct a smooth topography with a colluvium substrate and seeding, have allowed better management of runoff and greater infiltration. Runoff densities are between 0 and 0.15 m/m2 below the value above which the development of the plant community is at risk (0.60 and 0.70 m/m2; Moreno de las Heras et al. 2009; 2011). This, together with site preparation aimed at maximising water availability for plants, improved substrate fertility and appropriate species selection, have led to a survival rate of over 75%, above expected growth and early seed and fruit production, ensuring the sustainability of the restored ecosystem. In addition, concrete-based drainage works, which had proved to be ineffective, have been avoided, resulting in savings in both execution and subsequent maintenance. This fact has contributed to consider that the system is not only not more expensive but that it can also represent a significant saving in projects where mining and restoration work are properly integrated from the beginning of the activity.

Therefore, we can conclude that the TECMINE model is efficient and sustainable in its three aspects (environmental, economic and social).

Regarding the social aspect (C3 Action), at the beginning and at the end of the project, surveys were carried out with professionals and experts on the one hand and the local population on the other, in order to evaluate the perception and impact of the project, as well as the effectiveness

of the communication strategy. As a result, we can say that TECMINE has had an impact on these sectors. In the first case, experts and professionals value positively the result of the restoration, as well as the participation and collaboration between administration, industry and science. In the second case, the population appreciates the landscape improvement in comparison with other restorations in this region that did not reflect an adequately rehabilitated space. In addition, the majority of those surveyed consider that the TECMINE project can contribute to the knowledge of the territory and its revitalisation.

In relation to Action D, from the beginning of the project and throughout its implementation, a Communication Strategy has been carried out aimed at all stakeholders, identifying the objectives to be achieved, as well as the most appropriate messages, communication channels and activities to be developed in each case.

In total, more than 20 national and international technical conferences have been held, more than 17 activities with students from the different educational levels. TECMINE team has participated in more than 20 events (many of them at local level) aimed at the general public, where the importance of mining, the impacts derived from this activity and the restoration measures that we apply in the TECMINE project were conveyed. The total number of people reached is estimated at more than 5,000. These activities have been complemented with international scientific publications.

As a result of the consortium commitment and the training activities, 3 replications have been carried out during the project and the 1st professional Network on Mine and Quarry Restoration has been set up at national level with more than 130 experts and professionals from the public and private sector. This network has been presented at the National Aggregates Congress and is collaborating in the organisation of COST training actions and the SERE Congress under the After-life plan already running.

4. Introduction

Mining activities have a high economic importance as raw materials suppliers in Europe. However, the mineral extraction leads to serious **environmental impacts** that should be managed in the restoration projects under the legislative framework. Despite this, it is observed that after implementing restoration practices, some impacts such as erosion, landscape intrusion and lack of biodiversity persist.

This work aims to demonstrate that other restoration techniques than those usually applied could lead to better results.

In the TECMINE project, restoration actions have been carried out on 13 hectares of a kaolin mine (Mina Fortuna), located in Ademuz (Valencia). When mining operations (pre-restoration state) was finished, a degraded space was left. We distinguish 4 areas (see figure nº1):

1) **Mine face**, characterised by a single, almost vertical slope with stability problems in the head zone.
2) **West zone**. Former mine pit filled with tailings (clays, sands). Prior to restoration, the material had reached and even exceeded the original elevation.
3) **East zone**. Small area of hillside affected. Type of substrate: clays and colluvium.
4) **Permanent pond**. Rainwater collection hole with clay base.

The **baseline scenario** was characterised by a degraded area with no vegetation or edaphic substrate to support it, as well as an unstable morphology, characterised by a mine face of high height and inclination and waste dumps of sterile material. After the exploitation of the mineral resources, the availability of material to carry out the restoration was limited to stockpiles of tailings (in this case, sands and clays). These materials lacked the physical and chemical properties necessary for the recovery of a functional and sustainable ecosystem. A small volume of colluvium was also available, but this was insufficient given the area affected. In addition, and due to the aforementioned situation, the landscape impact perceived by the population was negative, which contributed to a negative image of the sector.

The specific **objectives** are:

- To propose technical solutions for mine restoration in Mediterranean forest areas.
- To guarantee transferability and replicability by providing technical training and supporting tools.
- To provide public administration with tools to assess mine restoration projects.
- To increase awareness and support mining sector by providing cost-effective solutions.
- To identify and involve all relevant stakeholders.

The **expected results** at the star of the project were:
-13.6 hectares of forest ecosystem restored to enhance biodiversity (vegetation and wildlife) by encompassing 8 habitats types (3 priority habitats:9S30, 9560 and 6220), that in turn foster colonization of wildlife, and 10.000 plants of 34 different species (100% of change).
-Alien species eliminated along the river.
-2 ponds where wildlife is expected to colonize.
-A new soil created by mixing the 3 types of material available in the area and adding organic matter.
- It is expected reduction of erosion rates up to 50% compared with traditional restoration techniques and consequently the reduction of sedimentation in the river (RioDeva).

- Increase water infiltration and aquifer recharge.
-An increase of Carbon sequestration from plants and soil.
-Reducing water consumption for irrigation.
- 2 guidelines
-12 participatory activities, at least 4 local associations involved and 2,600 individuals made aware.
-Up to 60 jobs considering direct and indirect jobs from project implementation.
-Up to 2,600 individuals made aware.
-Up to 1,150 individuals changing behaviour.

Fig. 1 Project area before the project (2017). Photo: Google earth


Fig. 2 Project area after 2 years of restoration (2020). Photo: Google earth


Fig. 3 Project area after 3 years of restoration (2021). Photo: TECMINE

5. Administrative part

The Project management process has consisted of the next steps:

i. The Coordinator Team (CT) prepares, every 6 months, the **Coordination Meetings** (CM) in which reviews the overall project in terms of actions, deadlines, deliverables, timeline and budget. At least a representative of each beneficiary attends the CM and prepares a presentation with the actions' progress. Usually the meetings take place at the project area to join visit the restoration after that. During the pandemic, CM were on-line sessions. CT prepares the minutes that are share with the attendees for their approval.
ii. The CT provides **templates** about all kind of project documents (technical and dissemination character). This was sent after the 1st CM.
iii. The CT follows the actions' progress and provides support beneficiaries when needed.
iv. Beneficiaries inform the CT about any issue during the project implementation. **Internal meetings** are foreseen when any issue or proposal may affect other beneficiaries.
v. As a general rule, any change is decided by consensus, considering all beneficiaries' opinions. Yet, final **decision is made by the coordinator**.
vi. **Deliverables** are reviewed by the CT and shared with the rest of the consortium when the review phase finishes, in Google Drive or Dropbox.
vii. Every 6 months the CT asks for the **financial documents** to the beneficiaries who must send them within a month.

The project management has proceeded well; coordinating team makes a great effort to keep a good communication within the consortium. Priority is given to support partners when they need to modify something, asking Neemo when the CT does not know the proper answer or to the Agency for the issues that may be more relevant in terms of justifying expenses. On the other hand, transparency is crucial to be able to help each other. Partners, by their side, accept the implemented management system, complying with the requirements and sharing the information with full confidence.

To date, there has been no conflict or issue within the consortium that could not be resolved with the agreement of all. The main faced issue has been the fact that SIBELCO put on sale the mine site and it could affect the implementation. This was solved by including in the PA the obligation to subrogate the commitment to the new owner in case of sale. So far, the mine has not been sold. On the other hand, some administrative issues with the beneficiary UCM has been addressed as informed by e-mail dated on December 11, 2018). Finally, this was solved with an amendment to the PA. Currently, the communication is appropriated.

About Neemo, the communication with our monitor Sara Mora is very fluent, useful and efficient. She provides us support, guidance and help any time we needed. Besides, she encourages us to follow the approach of the management and give us a useful feedback when she visit us.

Regarding the communication with EASME/the Agency, we are grateful for the letters and emails that our project advisers have sent us supporting the proposed changes and solutions at the time we needed.

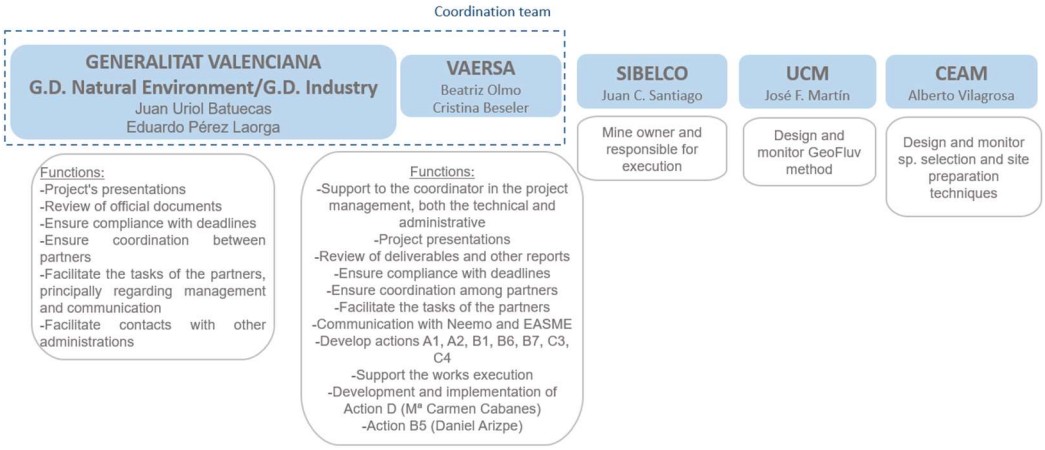
Project Team

Project team has not changed with respect to the proposal:

Coordinator: GENERALITAT VALENCIANA Conselleria d'Agricultura, Medi Ambient, Canvi Climàtic i Desenvolupament Rural

Associated beneficiaries:

The mail role of the beneficiaries and functions of the CT are shown in the following figure:



People involved in this project are:

Beneficiary	Person	Function	Actions involved
GVA	Juan Urion	Coordinator	E, D
	Eduardo Perez-Laorga	Support to coordination	E, D
VAERSA	Beatriz Olmo	Project manager	All
	Cristina Beseler	Technical support	All
	Mª Carmen Cabanes	Community manager	D
	Ana Lliso	Administrative	E
	Daniel Arizpe	Technician for plant production	B5
	Dolores Bofías	Support during maternity leave	A2, E
	Ruben Albarracín	Labourer	B5
	José Miguel Martí	Labourer	B5
	Salvador Boix	Labourer	B5
	Nuria Notatio	Labourer	B5
	Antonio Ibañez	Communication support	D
	Guillem Pascual Peiró	Technical support	All
UCM	José Francisco Martín	Geomorphological restoration Expert	A3, A4, B1, B3, C1, B7
	Miguel Ángel Sanz	Geomorphological restoration Expert	A3, A4, B1, B3, C1
	Cristina Martín	Technical support	A3, A4, B3, B1, E
	María Tejedor	Technical support	B3, C1, E, B7
CEAM	Alberto Vilagrosa	Ecological restoration Expert	A4, B4, B5, C2
	José Antonio Alloza	Ecological restoration Expert	A4, B4, B5, C2
	Luna Morcillo	Technical support	A4, B4, B5, C2
	Emilio Valls	Administrative	E
	Diana Turrión	Technical support	C2, E, D
SIBELCO (does not declare personnel cost)	Juan Carlos Santiago	Responsible for sustainable department	B1, B2, B3, B4, B5, B7, D, E
	Susana Tejada	Director of the mining center "Fortuna"	B1, B2, B3, B4, B5, B7
	Alfredo Soriano	Mining foreman	B1, B2, B3, B4, B5

Two Amendments to the Grant Agreement have been placed:

1) **Letter Amendment N°1 to Grant Agreement** sent by the Agency. Brussels, 16/08/2018. easme.b.3(2018)3793051. Reference: Modification of the definition of conditions for natural persons, submission of VAT certificate and threshold for submission of the certificate on the financial statements.
2) **Letter Amendment N°2 to Grant Agreement**. Requested by the Coordinating beneficiary on his letter of 21/09/2021. NATURE OF THE MODIFICATION: Extension of the project duration until May 1st (2022) and changes in the EU co-financing share of beneficiaries.

6. Technical part

6.1. Technical progress, per Action

ACTION	TYPE	STATUS	
A1. State of the Art	**Preparatory**	**Completed**	
		Foreseen start date: Nov.2017	Foreseen end date: Jan2018
		Actual start date: Nov.2017	Actual end date: May2018

This action has been conducted as follow:

1) Analyze the current framework of mining sector at national and European level with emphases in its economic, environmental and social impact.
2) Describe the legal framework.
3) Review on restoration techniques from the most widely implemented to the most innovative worldwide. Among the latter, the techniques selected in TECMINE project.
4) Gather the existing guidelines that may be a good starting point for technicians to improve mine restoration projects. This has been also useful for Action B6 (Guidelines).
5) A compilation of mine sites that have been restored for different uses is also provided.

How:

- Gathering articles and reports related to ecological and geomorphological restoration.
- Surfing the web to find good examples and useful material such as videos and pictures that make easier for the user to understand the addressed issues in TECMINE.
- Asking experts and technicians working on mine restoration. Often, significant cases are not published and the technicians' experience is very valuable.

Who:

The team involved in this action includes:

(1) TECMINE's beneficiaries provided VAERSA team with the relevant literature about the most innovative techniques. Also, pictures and reports of actual cases where these have been implemented.

(2) Other technicians of VAERSA working on mine restoration projects assessment for more than 10 years have collaborate directly with the review of the documents and the deliverable. They have also provided many good examples and pictures of the traditional way to restore mine lands.

Main findings and results (outputs achieved in quantifiable terms**)**:

This action has provided the mining and environmental experts and professionals with a document that gathers the most critical issues in current restoration practices applied in mine sites with a complete literature review and graphic information to better identified the main weaknesses of traditional practices which motivated the need for the TECMINE Project.

As a good indicator of the people reached is the nº of downloads that is 2,491.

Implications for other actions and the project: This action has been used to identify some of the experts participating in action A2 and has been also used when carrying out action B6 (Guidelines).

Main issues and solutions

The time to gather, select and review relevant documents and information as well as to write a comprehensive document was underestimated in the proposal. Consequently, the deliverable was delayed. It was finished by May 2018 instead of January 2018. Despite this, the expected findings were reported on time to be useful for Action A2 in such a way that Project schedule has not been affected.

Deliverable

The Deliverable "State of the Art" was attached to the 1st Progress Report (November 2018).

ACTION	TYPE	STATUS	
A2. Expert Panel	**Preparatory**	**Completed**	
		Foreseen start date: Jan.2018	Foreseen end date: Feb.2018
		Actual start date: March 2018	Actual end date: July 2018

This action has been conducted as follow:

1) Define the expert's profile according to the project's interest
2) Identify potential experts from Action A1 finding and beneficiaries' recommendations
3) Select experts in geomorphology (Moreno de las Heras), hydrology (Guillermo Tardío), biodiversity and soil (Ramón Vallejo and Klara Rehounkova) and social science (Dan Ryan).
4) Organization of the Panel. Expert panel took place on 2018, March 21st and 22nd. First day, the beneficiaries explained the project techniques while visiting the project area. Second day was for experts' presentation and conclusions. It took place in GVA facilities in Valencia.

How:

We contacted to SERE (Society for Ecological Restoration-Europe) asking for experts ate EU level within the ecological restoration community. Once experts accepted the invitation, VAERSA team sent them an abstract about Project's objectives, actions and expected results. Besides, TECMINE beneficiaries prepared a specific report about the techniques and actions in which they are involved in order for the experts to assess the TECMINE solutions. Experts were encouraged to prepare a short presentation with:

- Feedback about the project approach and proposed solutions
- Recommendations about the implementation
- Recommendations about other practices suitable to be implemented in the project

Who:

The team involved in this action:

1) Personnel from GVA y VAERSA beneficiaries organized the Panel.

2) Personnel from UCM, SIBELCO and CEAM prepared documents and made the presentations.

Main issues and solutions

- This action has been carried out with no inconvenience.

- Regarding the budget, instead of considering all contacts and costs allocated to an external assistance (F3), part of the experts has charged their costs directly to the GVA beneficiary as other costs (F7).

-Regarding the deadline, action was 5 months delayed because of the time for identifying the experts. It was more time consuming than expected. This had no-relevant consequences for the project (preliminarily accepted by EASME in the letter of 14/02/2018.)

Main findings and results:

In general, experts agreed that the overall project approach is well defined. They consider it as an integrative project, i.e. legitimate through the Communication Plan, holistic and iterative.

The main conclusions and recommendations are:

1. The main objective should be to start the reference ecosystem, not delivering it.
2. The importance of best practice projects is that can improve restoration practices and can help to change legislation.
3. It is recommended to create micro-topographies by means of the "rough and loose" techniques that create a diversity of habitats.

4. It is important to test the long-term performance of the geomorphic design using landscape evolution models (e.g., SIBERIA, CAESAR, LISEM).
5. Species list should be reviewed to incorporate pioneer species.
6. We have to consider more irrigation for plants to survive, at least for the first summer period.
7. It is suggested to incorporate large woody debris from the nearby forestry residues and **c**reate sediment ponds.
8. Use soil bioengineering erosion control techniques like "mixed dikes".
9. Attention must be paid to the contact point of the artificial drainage area and the natural.
10. Be careful with the micro catchments when intense rainfalls because they could break and concentrate a water flow that would start rill erosion processes.
11. Have additional analysis of soil to calculate amendments.
12. High soil water infiltration is a critical part of the restoration. Mulching improves soil water infiltration.
13. TECMINE project has a very good Communication plan**.**
14. Try to get an emotional engagement with the community**.**
15. Set community engagement opportunities.
16. Collaborate with local community to develop the narrative of TECMINE.
17. Implement a sociological study.
18. Implement Guidelines for the management of the reclaimed area for the final local users.

Implications for other actions and the project: Most of these inputs were considered in A4, B and D Actions such as the rough and loose, the needed irrigation, guidelines, analysis of soil, mulching, opportunities to engage community, among others.

Deliverable

The Deliverable "Expert Panel" was attached to the 1st Progress Report (November 2018).

ACTION	TYPE	STATUS	
A3. Referent and limitations	**Preparatory**	**Completed**	
		Foreseen start date: Feb.2018	Foreseen end date: May2018
		Actual start date: Feb.2018	Actual end date: Jun2018

UCM team is in charge of designing GeoFluv™ method (A4 Action). To do so, it is needed to previously identify a referent area with similar conditions of climate, lithology and vegetation. In order to select the most suitable referent, it was decided to focus on fluvial terraces and undulating plains and hills of the Utrillas and Weald Facies that are the lithology of the mine.

This action has been conducted as follow:

1) Find out the reference area (Office work)
2) Validation of the pre-selected areas (Field work)
3) Rainfall data analysis (Office work)

How:

1) Find out the reference area (Office work)

The process consisted on analysing and overlapping different layers of information by using ArcGIS and Google Earth Pro software.

Layers: Geology, PNOA ortophotos, Digital Terrain Models, Drainage network and Slope analyses

2) Validation of the pre-selected areas (Field work)

Once few areas have been pre-selected, fieldwork is necessary to check whether those areas are appropriated or not. To do so, some parameters were measured in the field (e.g. maximum distance from ridgeline to channel's head).

3) Rainfall data analysis (Office work)

The Natural Regrade software requires rainfall data. Specifically: i) the volume of precipitation equivalent to one hour rainfall for a return period of two years (2-yr, 1-h rainfall); and ii) the volume of rainfall equivalent to six hours precipitation for a return period of 50 years (50-yr, 6-h rainfall). Data information was obtained from the National Agency of Meteorology (*Agencia Estatal de Meteorología*, AEMET, in Spanish). After that, Intensity-Duration-Frequency curves (IDF curves) were calculated and some conversion were needed to obtain rainfall values required by the software.

Who: The team involved in this action is the personnel from UCM beneficiary

Main issues and solutions

Action has been carried out as expected. Deliverable was finished only a few weeks after the foreseen end date. The only difficulty has been related to finding out a suitable reference area in the vicinity of the Fortuna mine by the time it was needed. It has been solved by using available suitable data for equivalent reference areas in the Alto Tajo region. This is about 100 kilometres from the Fortuna mine but on the Same Utrillas Facies. Therefore, it is considered to be a suitable reference area.

Main findings and results:

The main conclusions obtained is the difficulty of finding a suitable reference area in the vicinity of the Fortuna mine, in particular, and in Mediterranean landscapes (in general), which have been highly modified by human activities throughout history. This fact represents a limitation of the methodology but not invalidate it, as it is possible to obtain the input from other surrounding regions.

Implications for other actions and the project: information of this action are the inputs to include in the design of next A4 Action.

Deliverable

The Deliverable "Referent and limitations" was attached to the 1st Progress Report (November 2018).

ACTION	TYPE	STATUS	
A4. Demonstration project design	**Preparatory**	**Completed**	
		Foreseen start date: May.2018	Foreseen end date: Aug2018
		Actual start date: Jan 2018	Actual end date: October 2018

This action includes 3 sub-actions, one for each of the main techniques to implement.

Sub-action 1 addresses the design of the slope area considering techniques for both stabilizing the steep slope and integrating it in the surrounding landscape by mimicking a nearby natural area with similar landform and lithology.

Sub-action 2 corresponds to the GeoFluv™ designs based on the inputs from Action A3 and applied to the non-consolidated material of west and east areas.

Sub-action 3 focuses on the site preparation and plantation stage.

This action has been conducted as follow:

1. Review of the proposal
2. Consider recommendation from Expert Panel (Action A2)
3. Internal coordinating meetings to (1) exchange information, (2) identify potential incompatibilities between techniques and (3) exchange points of view about the overall result.
4. Designs
5. Elaboration of the Deliverables

How:

Each beneficiaries developed its own designs.

Who:

The whole consortium has been involved in this action. Especially, teams from UCM, CEAM and SIBELCO have worked together to find the best solution both for each sub-action and for the project design as a whole. Beneficiaries responsible for each sub-action are:

Sub-action 1: SIBELCO

Sub-action 2: UCM

Sub-action 3: CEAM

Main issues and solutions

Designs has been modify with respect to the proposal for different reasons:

Sub-action A4_1 consists of the design of the restoration method to stabilized and integrate the slope area. To do so, principles of the Royal Talus techniques are used. Yet, as informed to EASME on Monday, February 12, 2018 by e-mail, we do not have the participation of the owner of the patent (EASME approved the change temporarily in his email of February 20, 2018). Instead, we count with the inputs of other experts in this field (from SIBELCO and the Expert Panel). Hence, Guillermo Tardio is expert in slope stabilization and landscape integration and he was asked for participating in the Expert Panel. He has also visited the mine in April 2019 during a Network meeting and we count with him along the project as adviser.

Inputs considered in the design are:

- Limited affection to the unstable blocks of limestone in the crest of the slope.
- Use of the blocks of limestone that fall under the security berm to reproduce natural debris which become in a drainage channel. The final appearance would be a sequence of dikes and green islands throughout the gully and trying to reach the maximum colonization of vegetal species. As a second advantage, these concentrations of rocks would also become in a refuge for reptiles and other animal species.

- Create a sequence of holes and mounds in the berm at the slope bottom as a way to control the runoff water and to promote the infiltration and storage of water. Instead of a flat surface, this design reduces the energy of the runoff and, consequently, the erosion of the berm and slopes

According to the proposal, the work plan includes the next stages: (1) blasting the upper strata of limestone, (2) remodeling the lower levels of soft material and (3) use the surplus material to create the transition with the GeoFluv model and (4) create drainage channels using natural materials instead of concrete.

The only issue under this action was that the permission for blasting took longer than expected; therefore, the linked B2 action had to be delayed as informed by email to EASME in February 21.

Sub-action A4.2

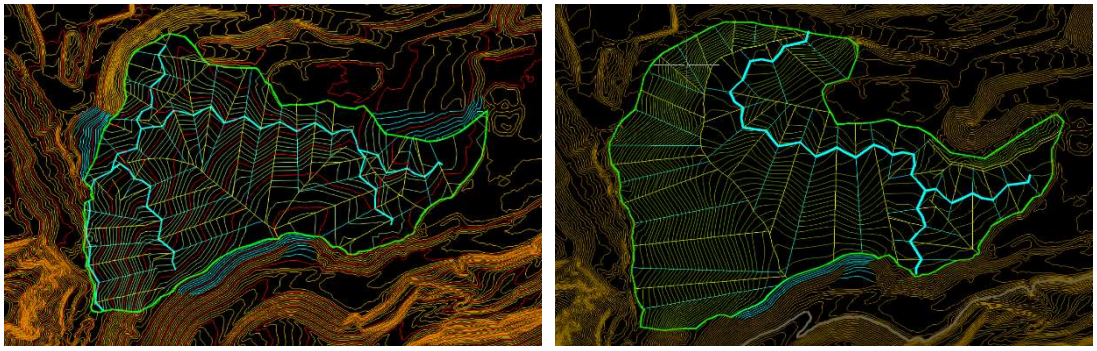
Two different designs were made. One for the Pond Area (east area) and one for the Platform (west area). In both cases, hundreds of iterations have been necessary to found a solution that manages the runoff properly, combined with balancing cut and fill, getting the lowest possible gradient slopes and minimizing tractive forces (potential of erosion) of the channels.

In the Platform area, there were assessed 2 options. Option A is the one initially proposed but some constrains for the design has suggested changing the design by Option B, which has been the one constructed.

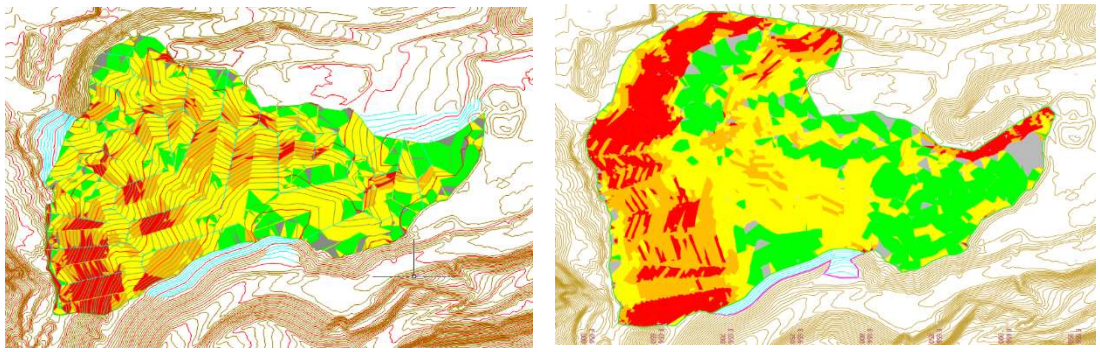
The main reason for evaluating this option is that the difference in elevation between the base of the highwall and the local base level (about 30 m) made difficult to reach functional and stable designs. Therefore, option B considers the location of the local base level at the north, connected to a ditch of one of the dirt road of the mine, which is at higher *elevation*. In addition, other constraints such as the fact that existing *areas already vegetated* and a *mineral pile* had to be respected, led to an alternative design with respect to the original one. ***Option B allowed lower earth movement, best geomorphic functionality and reshapes the current outslopes at the northwest, providing a better landscape integration.***

Platform area (Aerial photograph). June 2018

DESIGN GEOFLUV OPTION A **DESIGN GEOFLUV OPTION B**

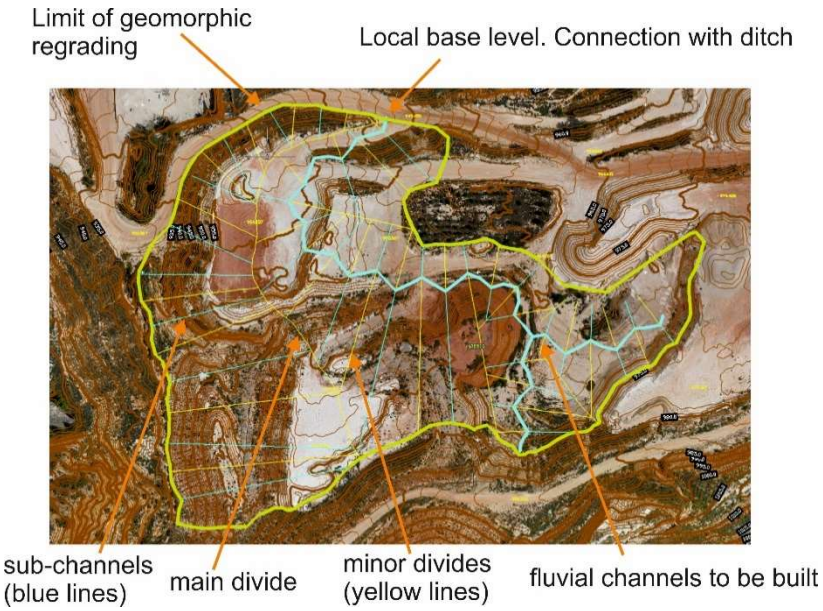


Main channels (thick blue), main ridges (curved yellow), contours (green and red), subridges (straight yellow) and subchannels or swales (straight blue).



The images below clarify the spatial position of the main elements of the geomorphic design of the platform. All of them show the main elements of the designs overlayed on an orthophoto with contours of the pre-restoration scenario

Option B, selected as constructible one, because of lower earth movement and higher stability



Sub-action A4.3

After the evaluation of the predominant substrates in the quarry for main substrates characteristics used in the discussion meetings, the internal meetings with the other groups discussing about this topic and

the inputs from Expert Panel the following modifications on site preparation techniques are included and described in Deliverable Action A4.3.

- Include surface treatments to improve soil properties (i.e. mulch, compost, direct seeding and fascines).
- Re-designed Micro-catchments according to substrates characteristics and limitations observed after water retention tests and soil analysis where the use of a plastic sheet in units 2 and 3 is not recommended. In addition, it allow to simplify the executions.
- Replace the Micro-catchemnts in the Unit 1 "Drier and top areas, steep slopes >30%" of the platform by standard holes to avoid uncontrolled runoff due to an excess of water accumulation in the hole platform which could compromise the effectiveness of the GeoFluv design.

Note: We asked EASME for a preliminary approval of these changes taking advantage of the first Progress report (PR). Our adviser, Michel Quicheron, in his letter about the PR considered them justified.

See next table for a complete description of treatments in each Restoration Unit according to Deliverable A.4.3.

Units	Slope treatments	Doses	Surf. (ha)	Observations		Reforestation treatments	Doses/Qty/Number	Surf. (ha)	Observations
Unit 1_Geofluv-top. Drier and top areas, steep slopes >30%	- Compost - Seeding - Strips (20% surf.)	20 Tn/ha 100-150 kg/ha 1.5 Tn/ha	3.01	Only applicable to Area 1: Platform mine area (see Fig. 8) *This unit include some adjacent areas (external to Geofluv) with slopes >30% (Talud Royal areas).*		- Standard holes(*1) (40x40x40) - Mesh/Treeshelter (50/50%) - Compost - Hydrogels	1000 holes/ha 1000 units/ha 2 kg/hole (125Tn/ha) 5 gr/hole	4.72	(*1) All holes include "castill Vegetation units: 6220, 934 5210 *This unit include some adjac areas (external to Geofluv) w slopes >30%*
Unit 2_Geofluv-medium Dry-mild areas, medium slope 15-30%	- Compost - Seeding	20 Tn/ha 100-150 kg/ha	2.66	Only applicable to Area 1: Platform mine area (see Fig. 8).		- Standard holes (*1) (40x40x40) plus microcacthments - Treeshelter - Compost - Hydrogels Other treatments (*2)	600 holes/ha 600 units/ha 2 kg/hole (125Tn/ha) 5 gr/hole	2.69	(*1) All holes include "castill (*2) Comparisons at small sca dry well, waterbox or cocoon system, pipe with holes+funn similar. *Minimum 300 holes/treatment in three differ areas and two exposures* Vegetation units: 9340, 5210, 9560
Unit 3_Geofluv-bottom Wetter areas, bottom and valley areas, flow accumulations Slopes <15%	- Compost	20 Tn/ha	1.79	Only applicable to Area 1: Platform mine area (see Fig. 8) *This unit include some adjacent areas (external to Geofluv) with slopes <15% (Talud Royal areas).*		- Standard holes (40x40x40) plus microcacthments - Treeshelter - Compost	600 holes/ha 600 units/ha 2 kg/hole (125Tn/ha)	2.14	(*1) All holes include "castill Vegetation units: 5210, 9530, 9240 *This unit include some adjace areas (external to Geofluv) wi slopes <15% (Talud Royal areas).*
Unit 4 River and riparian vegetation	- Biorolls o similar organic meshs		0.24	For protection of the river banks		Standard holes (40x40x40) Mesh for seedling protection	600 holes/ha 600 holes/ha	0.24	Vegetation units: 92A0 Trees

About timing, all the sub-action started at the foreseen date but due to the difficulties found in the different designs and the interdependences between them, some deliverables were delayed. Finally, all deliverables were completed in October 2018. This delay has not significant consequences. The design of Site preparation and plantation was finished in October 2018 and the implementation actions started in February 2019 with enough time to prepare it. The species were already produced in the nursery as planned.

Main findings and results:

This preparatory action has allowed a better adaptation of the designs to the actual scenario, thanks to the inputs from previous actions (A1 and A2), the internal meetings that assure the integrative and adaptative approach of the project and the results of some specific analysis. This kind of actions allow to gather details or new situations that are not considered during the proposal.

Deliverable

Deliverables A4_1_Remodeling design of slope area; A4_2_Design of geomorphological restoration and A4_3_Design of restoration units were attached to the the MidTerm Report (Nov 2019).

ACTION	TYPE	STATUS	
B1. Technical training	**Implementation**	**Completed**	
		Foreseen start date: Aug.2018	Foreseen end date: Aug2018
		Actual start date: Sept.2018	Actual end date: Jan2019

This action has been conducted as follow:

1. Contact the experts/trainers to organized the training and initiated the administrative procedures
2. Identify and invite personnel from the targeted administrations
3. Classroom course (level 1)
4. On-line course (level 2)
5. Field training on execution (level 3)

How:

We contacted several administrations in Spain and abroad. The target audience of this course was technical personnel from public administrations (regulators) involved in the mine restoration process, from the project assessment to the monitoring stage.

The criteria for the selected administrations were:

- Regions under similar mining, climate and lithology characteristics
- Regions with similar environmental and social problems related to mining where in addition regulators have shown interest in new techniques and approaches
- Regions where examples of innovative mine restoration projects have been implemented

Five public administrations from Spain and four from abroad (Lebanon, Greece, France and Israel) were encouraged to participate in the training. Finally, 12 technicians from Spanish administrations participated (Andalusia, Catalonia, Aragon, Valencia and personnel from the Environmental Ministry).

Besides 2 technicians from SIBELCO participated with the purpose of acquiring the knowledge to put in practice the method in other mines of the multinational.

Who:

Beneficiaries in charge of organizing the training are VAERSA and GVA. Personnel from UCM support the organization and act as trainers.

Regarding trainers, the inventor of the patent of the GeoFluv™ method, *Nicholas Bugosh* from US, together with the UCM team conducted the course. In addition, we counted with one of the most influential authors in the field of landform stability in mine rehabilitation, *Greg Hancock*, professor at the University of Newcastle (Australia). He introduced us to the use of Landscape Evolution Models in mining reclamation.

Main issues and solutions

Modifications with respect to the initial proposal are:

1. Levels of the training were organized in a different way as already informed in the previous reports.
2. In the initial proposal, the expert of the Royal Talus Technique was included but as explained in Action A4, finally he is not. Instead, we have included another innovative method in mine restoration projects. This is about LEM (Landscape Evolution Models). One of the main experts on these methods and particularly in SIBERIA model (Greg Hancock) participated in the training by introducing us the models with a focus on their functionality and applicability in mine restoration.
3. About timing, training started in September instead of August 2018 due to experts' recommendation: explanations about execution (level 3) are more useful if the earth moving works have already begun. This modification was accepted by EASME in the letter dated 14/02/2018.
4. Finally, some public administration rejected the invitation. From our point of view, this is because of the fact that some countries are still working on developing a proper legal framework to manage

the environmental problems of mining activities, focused on monitoring the impacts during the activity and are still implementing the traditional way to restore. Aiming at moving forward, we organized an addition course on-line and focused on administrations (Action D).

Main findings and results:

The idea of this action was to provide regulators with the knowledge that private sector is starting to acquire. This way, research, private sector and public bodies may grow at the same time and in the same direction being updated about the new methods to get successful mine restoration projects.

Regarding GeoFluv^{TM} method, once the training is completed, participants are able to assess projects from mining companies that include this method as well as to design geomorphological solutions for its own projects.

Regarding landscape evolution models and the SIBERIA software, this is a very interesting method to assess how mine restoration solutions evolve over time and if they are stable. So that, this is considered as a complementary technique to the GeoFluv design. From the established collaboration, UCM team is going to work with Greg in order to improve the results and impact of TECMINE project by implementing SIBERIA.

At the end of the training, 16 people received training at some level.

As a conclusion, we could say that:

- This training is time-consuming and very specific, so in order to implement this technique in future projects, entities have to consider this.
- This method is implemented with a specific software but public administrations usually work only with free software.
- This training provides a new approach about mine restoration, so even if the software is not used, the principles of the method are a good starting point to move forward.
- Training actions are key to guaranty the transfer and replication of LIFE projects.
- Participants are satisfied and encouraged to transmit the new approach and the TECMINE project to the corresponding administrations. Further collaboration between administrations is fostered.

Images during the training

Implications for other actions and the project: This training has impact in the B3 action and in the results of dissemination, training (D action) and replicability (B7 Action).

Deliverable

The Deliverable was attached to the MidTerm Report (Nov 2019).

ACTION	TYPE	STATUS	
B2. Stabilization and landscape integration of rock slope	**Implementation**	**Completed**	
		Foreseen start date: Aug.2018	Foreseen end date: Jan.2019
		Actual start date: October 2018	Actual end date: October 2019

This action consists of:

- Creation of a berm for both purpose, security and planting
- Blasting the upper strata of limestone
- Remove the unstable blocks in the ridges of limestone to avoid rock falls
- Remodeling of the lower levels of soft materials to adapt the geometry to the desired design of strata and berms
- Construction of the drainage network adapted to the new forms created, using natural materials instead of concrete
- Sowing and planting

According to the proposal, action B2 was the first action of techniques implementation but it has been more appropriated start by Action B3 since the design of the GeoFluv required to move material from the platform area to the slope and this material has been used to build a security berm to stabilize the slope.

How:

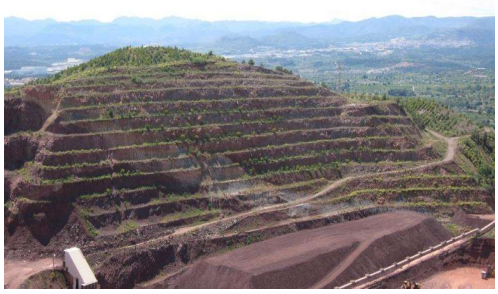
As the GeoFluv was implemented in the platform area, the berm was built with a perfect balance of material (around 60.000m3 were exported). This is, the amount of material to cut in the Platform Area should be the same to fill (to build) the security berm. This way there is no need for additional material and either leftover material that increase the cost.

The equipment used consist of backhoe, bulldozer, dumpers and caterpillar tractor. For blasting, explosives. It consisted of micro-blasting affecting a small part of the slope, only the minimum necessary. The cost to construct the security berm is allocated to the next action B3 since it is difficult and it may not make sense to distinguish between the Platform area and the Slope.

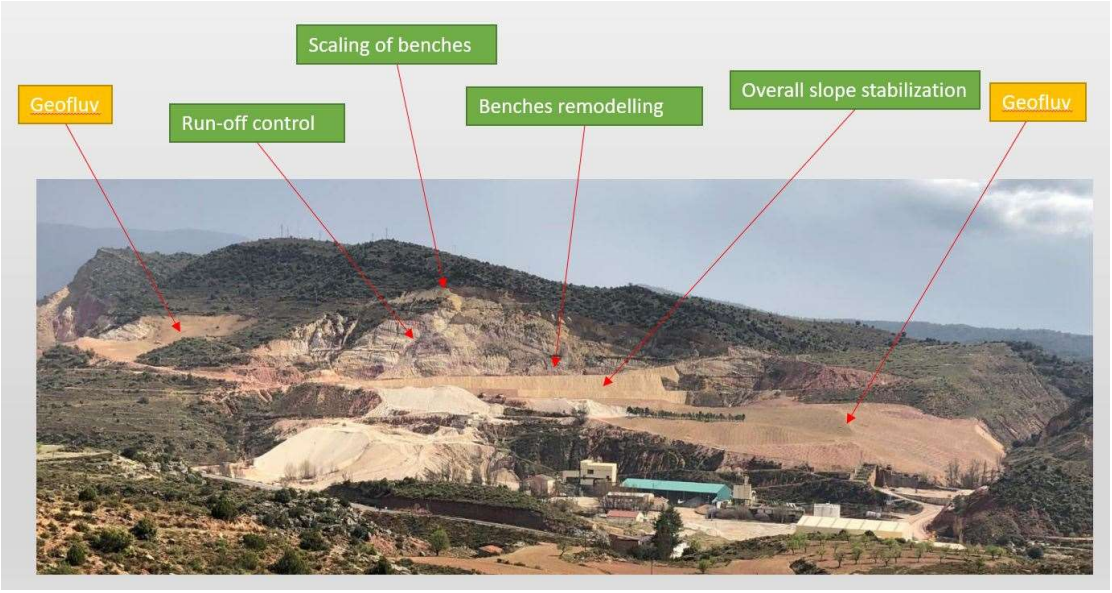
Who:

Beneficiary SIBELCO is responsible for the execution. The basting was subcontracted to an expert company and simulate the royal talus technique.

Starting oint of the slope area



Traditional mining reclamation method (berm/slope) VS TECMINE model (2020)



Actions for stabilization and remodelling of the mine face

Main issues and solutions

The main issue in this action is related to the upper part of the slope area. As explained in action A4, we tried to avoid blasting because it seemed that with machinery, it could be possible to remodel this area. After efforts to carry out this solution, it was not possible and we had to return to the blasting alternative. That is why this **action is delayed**. We asked for that permission by e-mail on date February 21, 2019. The main impact of the delay is about the 300 plants that have to be planted in October 2019.

After building the berm, the slope was steeper than expected in the proposal and the erosion risk made us include an **organic mesh to protect the soil** during the first stage until the vegetation grows and acts by itself. Besides, once the decomposition process occurs, this material is incorporated into the soil what improve the soil properties. This material has been also placed in other slope areas under erosion risk. These are transition areas between the TECMINE area and the surroundings. This modification was also informed by e-mail on date February 21, 2019

Costs related to the organic mesh are assumed by the beneficiary GVA since this is not planned and SIBELCO budget is already compromised. GVA can afford this cost with the savings from other actions. It costs around 15.000€.

Main findings and results:

Success indicators remarked by the company SIBELCO are:

- Landscape integration
- Overall slope stability
- Effects of runoff water on berms and slopes
- Water infiltration in the berms
- Efficiency of the drainage network and individual elements
- Habitat viability

Implications for other actions and the project: This action is connected to previous B3 action and next B4 and B5 actions.

Deliverable

There is no specific deliverable in this action.

ACTION	TYPE	STATUS
B3. Geomorphological restoration based on GeoFluv Technique	**Implementation**	**Completed** Foreseen start date: Aug.2018 Foreseen end date: Jan.2019 Actual start date: Sept.2018 Actual end date: Feb. 2019

Actions B3 corresponds to the execution of the GeoFluv designs according to action A4_2.

This action has been conducted as follow:

- Staking out the topography of the GeoFluv designs carried out with Natural Regrade

- Planning and implementation of earth moving works

- Peer guidance in the field of the construction process, according to the training already taught to the machinery operators and mining staff in previous action B1

- Checking that the built landforms honoured the designs

- Gathering a broad set of photos and videos of the process

How:

The equipment needed for the implementation have been: excavator, bulldozer, dumpers and caterpillar tractor. This work has been subcontracted by SIBELCO.

Who:

Beneficiary SIBELCO has been responsible for the execution. Beneficiary UCM participated by supporting and monitoring the execution and VAERSA participated with the supervision and coordination.

Besides, UCM has trained machinery operators and mine staff with the instruction to construct the designs (Action B1).

Main issues and solutions

There have not been main problems during the construction process. The main issues that arose, and there solutions, are as follows:

ISSUE	SOLUTION
Minor and specific parts of the design did not fit well with the functionality of the landscape	Re-design of those specific reaches
Swales' concavities were not fully reshaped	Some swales were regraded until they got their final landform
Limestone bedrock was found underneath one site of the colluvium area (480 m2)	Colluvium was not available, as it was expected, at the referred area where limestone bedrock was found. Despite that, the projected 10 000 m3 could be obtained at the planned area, because it was possible to dig deeper in other areas, to compensate the fact that it was not available where the limestone bedrock was found
The careful finishing of some landforms was not fully acquired	Final regrading's were made

In general, the GeoFluv desing and construction process can be considered a clear success. However, after 1-2 years of the remodelling made, minor deviations occurred. The consortium has recorded them carefully, and actually, their careful analysis at TECMINE has made possible correcting them at: (a) LIFE RIBERMINE (LIFE18 ENV/ES/000181), a subsequent LIFE project based on geomorphic restoration; (b) at the San Luis (Arguisuelas, Cuenca, by SAMCA) replica. It is important to state clearly that none of these deviations implied any risk for the general project. They were just minor deviations, which actually had a very beneficial effect in terms of learning. They have been:

1. Small maladjustments between the elevation of the main channel of the GeoFluv designs and its local base level (around 0.5 m in the GeoFluv East) caused small incision of the main channel until it reached the equilibrium with the bottom of the small pond (Figure 1). Therefore, we learned in TECMINE that the adjustments between slope and elevation of the main channel and the local base level need to be VERY PRECISE.

Figure 1

2. Instabilities at the local base level (incision of the ditch, at the local base level of the GeoFluv West, Figure 2), caused localized upstream incision of the main channel, by upstream migration of the knickpoint. Therefore, we learned in TECMINE that the local base level of any design needs to be TOTALLY STABLE. This was difficult in this location, since the other possibility of local base level for the designs, which is the creek located to the west, experienced also natural incision.

Figure 2

3. At the GeoFluv West, the outslope below the Mas del Olmo road connects directly with the restored (Figure 3) GeoFluv-based area. This connection should have considered a proper run-off management, such as building a trench or a dich, which, in turn, should have connected with a GeoFluv channel. Once we realized of this minor deviation, we introduced it at the GeoFluv East.

Figure 3

4. At the design of the so called 'herringbone' landform, at the outslope connecting the GeoFluv West design with the creek to the west, some swales had not a proper design of their runoff tracking (Figure 4). Therefore, such wrong runoff tracks caused localized erosion.

Figure 4

5. Some localized areas where the carbonatic colluvium was not properly spread: (a) did not have a correct vegetation cover; (b) experienced localized erosion, rilling type (Figure 5). This has been one of the most clear conclusions of the TECMINE project, which is that geomorphic regrading should be always followed by a careful and total cover of any type of topsoil, subsoil or growth media (as the carbonatic colluvium, which proved to be a key restoration success element).

Figure 5

Main findings and results:

The main conclusions of the implementation, building, of the GeoFluv technique at the TECMINE project, including general conclusions transferable to Weald and Utrillas mines of the Iberian Range, are the following:

1. Despite minor deviations, it was possible to build the projected geomorphic design fitted to the planned designs.
2. A good definition of convexities and concavities implies a high density of staking out, increasing costs of topography.
3. The so-called "finishing" details should be considered at any action of the project, promoting a philosophy of "best possible work" and "high sensibility towards the environment that is being transformed" for any person involved in restoration works.
4. Some sort of entropy is generated when the decision-making processes are not clearly hierarchized.
5. Driving tyre vehicles on rehabilitated areas should be avoided always. And all type of dirt roads should be removed and decompacted.
6. The use of carbonatic colluvium to be used as subsoil, common in this physiographic setting, is highly recommendable. Although data from monitoring is not available yet, so far, areas with good cover of carbonatic colluvium have not undergone, almost, to any degree of erosion. The texture, pH and stoniness of this surficial deposit has all type of advantages for purposes of ecological restoration. In future and active mines, the proper removal, storage and reuse should

be promoted. In active mines where there is not such provision, or in abandoned mines, existing colluvium deposits in the surroundings of the mines should be located, and actions aimed to their use should be also promoted.
Deliverable
The deliverable “Topography map and Digital Elevation Model” was attached to the the MidTerm Report (Nov 2019).

Next pictures show the evolution of the GeoFluv West modelling in **Platform area:**

Next pictures show the evolution of the of GeoFluv East modelling in **Ponds area**:

ACTION	TYPE	STATUS
B4. Site preparation based on new microcatchments design	**Implementation**	**Completed** Foreseen start date: Nov.2018 Foreseen end date: Mar.2019 Actual start date: Feb.2019 Actual end date: April. 2019

Action B4 corresponds to the execution according to the previous preparatory action A4.

This action planned the application of the following main treatments:

1.- Improved Microcatchments to maximize runoff water capture (runoff harvesting) and promote infiltration to the root zone of the seedling.

2.- Application of organic matter (OM) to the planting holes which may act as a slow-release fertilizer. Additionally, biosolids promote microbial activity, improve the soil texture and increase water holding capacity.

3.- Addition of hydrogels to increase the water-holding capacity of the sandy soils (in Unit 1).

4.- Treeshelters or meshes installation to ameliorate hard environmental conditions, protect from browsing and improve seedlings survival.

5.- Banded application of mulch to the soil surface (fascines) to produce micro-relief to enhance and facilitate water retention and infiltration, and improve the organic matter (carbon content) into the soil

How:

The task to implement this action have been described in the deliverable A.4.3.

Who:

Beneficiary SIBELCO is responsible for the execution who subcontracted the work. Beneficiary CEAM participated by supporting and monitoring the execution and VAERSA with the supervision and coordination.

Main issues and solutions

According to the final design of the mine, some of the treatments initially planned in the project memory changed as consequence of modifications in the surface area of the different units, the characteristics of the soils after a detailed analysis, and the expert panel recommendations after the discussion of some proposed methodologies.

The projected changes that are being implemented are:

1) Application of compost on the top soil layer. The compost came from composted sewage sludge mixture with pruning refuses. The objective was to improve the soil surface fertility that allow new seed germinations. This treatment was applied to some specific parts within the Restoration Unit 2 in the GeoFluv-West. This action was included in Deliverable A.4.3. to be applied to 7.8 ha. However, due to restrictions on the compost supply capacity it could not be applied to the whole restoring area. Consequently, the main part of the available compost was applied to the GeoFluv-West platform, along a total surface area of 2 Ha. Moreover, from the interaction among Life Projects (Life +Regrow: LIFE16-ENV / ES / 000331) we got composted waste from olive mills to test its effects in a small area (250 m^2) within the GeoFluv-East. The effect of compost application was monitored and compared among application and not application in a small area within the Unit 1 by applying of the RestoCat protocol and soil and vegetation inventories. The results were useful to provide recommendations for future restoration projects.

2) Sowing of a seed mixture in the whole restoration area (Geofluv East and West) and in other units as berm-talus areas. The objective is to promote a quick plant cover during the first months after the restoration works. This plant cover allows the protection of the soil from intense rainfalls and also favors water infiltration into the soil. Seed mixture consisted of a 47% of *Dactilys glomerata*, a 47%

of *Lotus corniculatus*, and a 3% of *Thymus vulgaris* and 3% of *Santholina chamaecyparisus.* This treatment was considered after the Expert Panel and the discussions among the partners.

3) Re-designed Micro-catchments according to substrates characteristics and limitations observed after water retention tests and soil analysis. Soils had a high content of clay and silt that promoted low infiltration and high water retention in the surface, especially important during torrential rainfall episodes. For this reason, the use of a plastic sheet was not recommended, it could create excessive water runoff to the seedling. In addition, it allowed to simplify the executions. Dry-wells were in a similar situation with projected low effect in areas with fine soil textures because they would be clogged. This modification was already introduced in the Deliverable A.4.3.

4) Replace the Micro-catchments in the Restoration Unit 1 "Drier and top areas, steep slopes >30%" of the platform by standard holes. Previous studies in drylands showed that Micro-catchments in steep slopes can produce uncontrolled runoff due to an excess of water accumulation in the hole platform which could compromise the effectiveness of the GeoFluv design. This modification was already introduced in the Deliverable A.4.3.

5) Geofluv East. It was only applied a sowing treatment in the surface and the application of compost in specific areas with a very shallow soil top layer. As a consequence of the shallow soil layer in the surface (less than 20 cm), there exist a high risk of degradation and erosion processes associated to deep materials which have fine textures, rich in clay and silt. These fine textures in the surface of the restoration treatments could be negative for the stability of the GeoFluv design and functionality. Constructing the needed holes for planting (40x40x40 cm) may lead to changes in the material composition on the top, it means, that the inert material (mainly clay) that is now under the organic soil, may end up on the top, which was also not advisable for the proper functioning of the GeoFluv model. For these reason, only a sowing treatment was applied. This modification was was reported (e-mail dated on March 6, 2019) and accepted by EASME (e-mail dated on March 11, 2019).

6) Talus-Berm areas. In this area, we have designed a combination of treatments with organic mesh covering the talus and plantation in strips (20cm wide x 60cm long) with *B. retusum* and *D. pentaphyllum*.

7) Missing species in the plantation: Due to lack of propagules or the inadequate success in production of planned species, some of the projected species could not be planted in the restoration. These species are: *Stipa offnerii, Santholina chamaecyparissus, Thymus vulgaris, Populus nigra, Fraxinus angustifolia, Salix alba, Agrostis stolonifera*). These missing species were substituted by other co-existing species that already were cultivated from the beginning of the project as *Psoralea bituminosa*. In other cases, changes in the proportion of species within the restoration unit allowed these modifications without substantial changes. These changes in species is expected to do not have negative consequences in the final diversity and therefore, it does not affect the initial objectives of the project.

After the review of the initial project and adjusting the final surface areas within each unit (after the design of the Deliverable A.4.3), the final Restoration Units, treatments and species planned for each unit were as follows:

Geofluv West: the total area was divided into different units as initially planned (according to definitive slopes and water availability, Fig. 1).

- **Soil surface implementation treatments:**

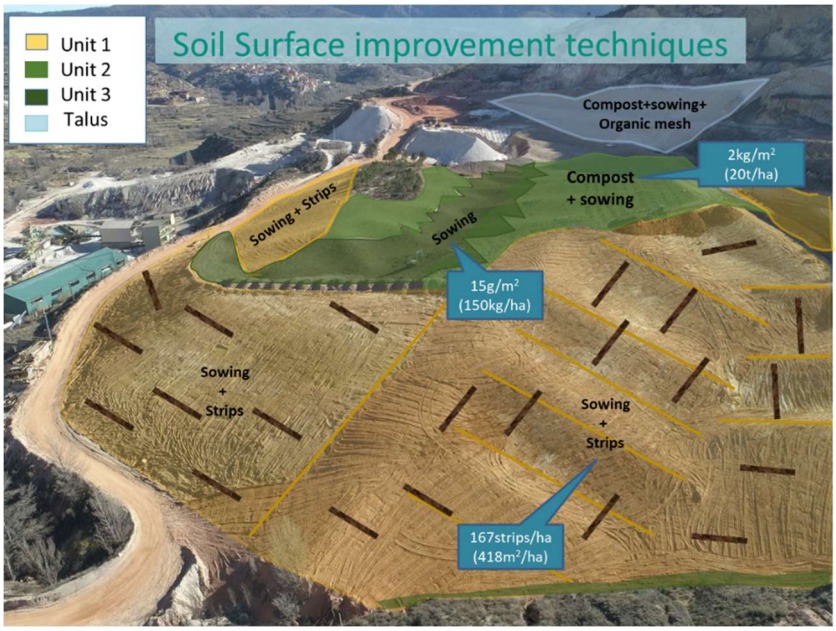


Figure 1. Treatments designed in each Restoration Unit.

- **Restoration Unit 1:** Drier and top areas, steep slopes >30%

Projected Area: 1.8 has. **Projected density:** 1000/ha **Total Projected plants**: 1800		**Final Area**: 2.9 has. **Final density**: 1000/ha **Final plants:** 2890	
Habitat	**Species**	**Presence (%)**	**Number of plants**
Habitat 6220	***Brahypodium retusum***	**15**	**435**
	Psoralea bituminosa	**10**	**290**
	Lavandula latifolia	**10**	**290**
	Rosmarinus officinalis	**10**	**290**
Habitat 9340	***Rhamnus lycioides***	**20**	**580**
	Rhamnus alaternus	**8**	**230**
	Colutea arborescens (= C. brevialata	**8**	**230**
	Dorycnium pentaphyllum	**10**	**289**
Habitat 5210	***Juniperus oxycedrus***	**2**	**58**
	Juniperus phoenicea	**7**	**200**

- **Restoration Unit 2:** Dry-mild areas, medium slope 15-30%

Projected Area: 1.4 has. **Projected density:** 600/ha **Total Projected plants**: 864		**Final Area**: 2.0 has. **Final density**: 600/ha **Final plants:** 1200	
Habitat	**Species**	**Presence (%)**	**Number of plants**
Habitat 9340	***Quercus ilex***	**30**	**360**
	R. lycioides	**20**	**240**
	R. alaternus	**14**	**170**
	C. arborescens	**9**	**105**
	D. pentaphyllum	**9**	**105**
Habitat 5210	***J. oxycedrus***	**4**	**45**
	J. phoenicea	**9**	**105**
Habitat 9560	***Juniperusthurifera***	**6**	**70**

- **Restoration Unit 3:** Wetter areas, bottom and valley areas, flow accumulations

- Slopes <15%

Projected Area: 1.8 has. **Projected density:** 600/ha **Total Projected plants**: 1080		**Final Area**: 0.4 has. **Final density**: 600/ha **Final plants:** 240	
Habitat	**Species**	**Presence (%)**	**Number of plants**
Habitat 9530	***Pinus nigra***	**14**	**34**
	Amelanchier ovalis	**10**	**24**
	Prunus spinosa	**10**	**24**
	Lonicera etrusca	**3**	**8**
	Pistacia terebinthus	**6**	**16**
	Crataegus monogyna	**7**	**17**
**Habitat 9340	***Rhamnus alaternus***	**10**	**24**
	D. pentaphyllum	**10**	**24**
Habitat 5210	***J. phoenicea***	**5**	**10**
Habitat 9240	***Sorbus domestica***	**10**	**24**
	Quercus faginea	**15**	**35**

** Species no initially planned for this unit, included to cover the 100% of the restoration unit.

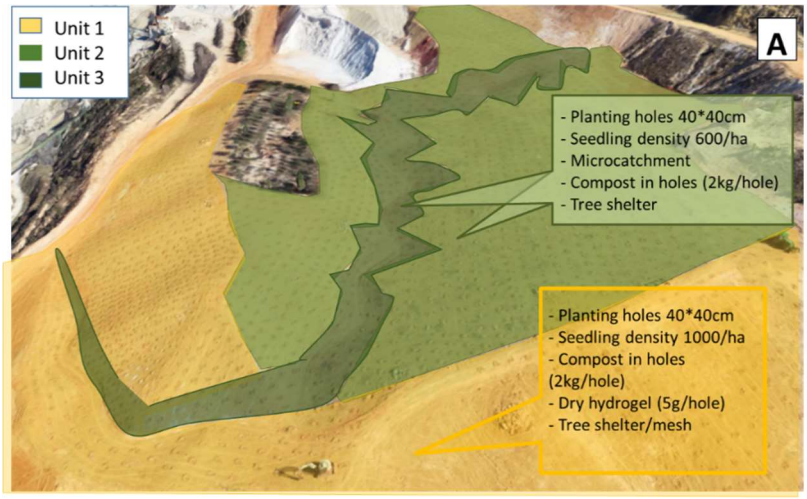


Figure 2. Scheme of final implemented treatments

- **Permanent Pond Area:** semi-permanent small lake (Unit 6) with banks surrounding the area (Unit 3). *Due to water table fluctuations, some species living semi-immersed in water will be introduced during next Autumn to determine the exact level of water.*

	Projected Area: 0.4 has. **Projected density:** 600/ha and 1200/ha **Total Projected plants**: 1080		**Final Area**: 0.4 has. **Current density**: 600/ha **Current plants:** 240	
	Habitat	**Species**	**Presence (%)**	**Number of plants**
Unit 3	**Habitat 9530**	***P. nigra***	**14**	**17**
		A. ovalis	**10**	**12**
		P. spinosa	**10**	**12**
		L. etrusca	**3**	**4**
		P.terebinthus	**6**	**7**
		C. monogyna	**7**	**8**

	Habitat 5210	*J. oxycedrus*	10	12
		J. phoenicea	10	12
	Habitat 9560	*J. thurifera*	5	6
	Habitat 9240	*S. domestica*	10	12
		Q. faginea	15	18
Unit 6	Habitat 92A0	*Populus alba*	25	30
		* *Fraxinus angustifolia*	---	---
		**Salix alba*	---	---
		Salix atrocinerea	25	30
		Salix purpurea	25	30
		Tamarix canariensis	25	30
	**Habitat 92A0	*Tamarix angustifolia*	50	
		Phragmites australis	50	

* Species not available for planting.
** Planned species to be planted during next Autumn 2019.

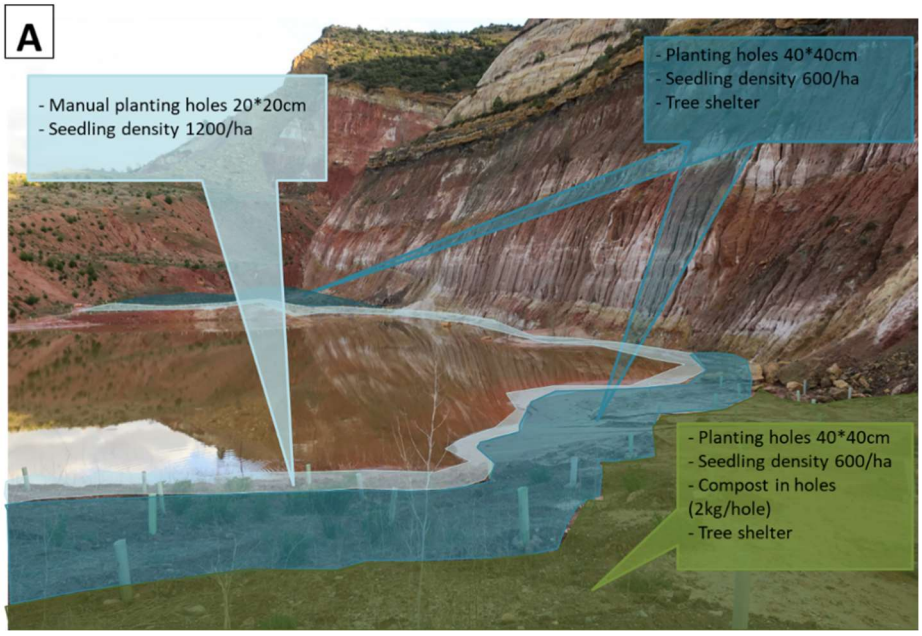


Figure 3. Scheme of final implemented treatments

- **Talus-Berm Area:** We designed combination of treatments with organic mesh covering the talus areas and plantation strips (20cm wide x 60cm long) with *B. retusum* and *D. pentaphyllum*. Plantation was also implement with compost (6 kg/strip) and hydrogels (5gr/seedling) as in Restoration Unit 1. Basal parts of the talus (Berm areas) were planted during next autumn with species from habitats 9530, 9340, 5210. As the consequence of delay in works for the stabilization, berm areas were planted with species from the same habitats as Units 2 and 3.

Projected Talus Area: 0.9 has. **Projected density:** 1000/ha **Total Projected plants**: 900		**Final Talus Area**: 0.9 has. **Final density**: 1000/ha **Final plants:** 900	
Habitat	**Species**	**Presence (%)**	**Number of plants**
Habitat 6220	***B. retusum***	**66**	**600**
Habitat 9340	***D. pentaphyllum***	**33**	**300**

Projected basal part of the talus: 0.18 has. **Projected density:** 600/ha **Total Projected plants**: 108		**Final Talus Area**: 0.18 has. **Final density**: 600/ha **Final plants:** 108	
Habitat	**Species**	**Presence (%)**	**Number of plants**
Habitat 9530	***A. ovalis***	**25**	**27**
Habitat 9340	***R. alaternus***	**25**	**27**
	Q. ilex	**25**	**27**
Habitat 5210	***J. phoenicea***	**25**	**27**

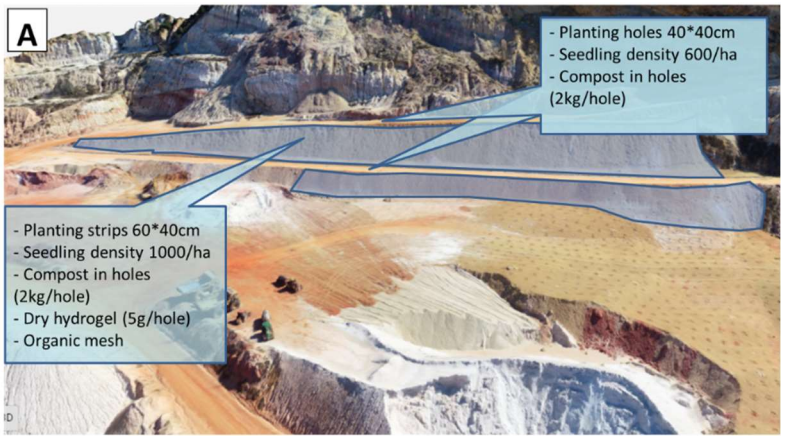


Figure 4. Scheme of final implemented treatments

Main findings and results:

After implementation, some results and recommendations can be launched:

- **Watering.** Despite the application of a regular watering was not initially contemplated, the lack of precipitations produced risky water scarcity levels for outplanted seedlings and, hence, the need to water the plants. We watered with moderate rates, consisting of 5 l/hole which corresponded to a 30 L/m^{2-} rainfall. This simulated amount of rainfall conformed with a normal monthly average for winterly months in the area. Watering was applied by means of a net of pipes within the restored area to avoid heavy machinery crossing the plantation. It was pumping from a water reservoir in the mine installations. Each seedling was manually watered.

- **The application of treeshelters** in windy areas should be planned. Specially, the systems to support the treeshelters as canes, sticks or similar devices since if they are too short or weak will fail for this function.

- It is important **to carry out the holes by means of mechanical devices** because soil can be very hard to penetrate specially in marly or clay soils.

Implementation results are obtained in Action C2.

Deliverable

Deliverable "Action B4_Map and Dron anaysis_CEAM" is attached in Annex 01.

This Deliverable has been delayed until the project's end in order to have a final assessment.

ACTION	TYPE	STATUS	
B5. Plant production and plantation	**Implementation**	**Completed**	
		Foreseen start date: Nov.2017	Foreseen end date: Feb.2019
		Actual start date: Mar2019	Actual end date: April.2019

Action B5 is composed of 3 sub-actions: (1) Forest reproductive material collection and preparation and (2) Plant production and nursery culture and (3) Plantations.

This action has been conducted as follow:

1. Seed collection
2. Seeding and pre-treatments
3. Germination
4. Cultivation
5. Transportation to "El Hontanar" nursery for hardening a acclimatisation
6. Plantation

How:

- Revision of available reproductive material in the seed bank at the CIEF.
- Begin of plant propagation and pre-treatments of some species with slow germination.
- Collection of reproductive material.
- Propagation of the rest of species.
- Cultivation and nursery culture in three nurseries: CIEF, "El Hontanar" and Aquatic plant Nursery of "El Palmar"
- Plantation

Who:

The responsible partner of this action is the GVA with the participation of partner VAERSA. The action is coordinated by the CIEF where GVA's and VAERSA's staff work together and share responsibility.

Besides, personnel of CEAM beneficiary has been also involved in the final species selection, particularly for the direct seeding.

Main issues and solutions

Some modifications of the original species list were made after reviewing seed availability (already informed in previous progress report):

There was one species of the first group that could not be collected and is not either available in the native seeds' market, this is *Stipa offneri.* This species had to be replaced by another species.

Another reason of changing the original list was a review of the convenience of planting them.

These are the following species:

Quercus coccifera, because reintroductions in the field are quite complicated and have very low survival rate. Direct seeding could be tried if the conditions are favourable.

Populus nigra*:* Because the availability of reproductive material of pure *Populus nigra* exemplars is quite improbable for the needed provenance. Poplars have suffered introgression with American, commercial aspen hybrids. The legislation in the Comunitat Valenciana does not allow the use of hybrids in habitat restoration in forest land. The species was substituted by *Populus alba* and *Agrostis stolonifera.* Direct seeding is more efficient in reintroducing this species.

Some other deviations in plant numbers are due to unexpected complications in their propagation. This is the case of *Thymus vulgaris*, *Santholina chamaecyparissus. Juniperus oxycedrus, Lonicera etrusca and Pistacia terebinthus* where the germination rate of the seed lot was lower than expected. From this group, *Juniperus oxycedrus* and *Pistacia terebinthus* are hard to propagate and germination of junipers could take two years long. The shrubs *Thymus vulgaris* and *Santholina chamaecyparissus* were seeded directly in the field. The achieved plant production numbers can be seen in its Deliverable.

Another modification to the proposal is the inclusion of direct seeding in the restored site. This decision was made after recommendations of the Expert Panel (Action A2) because of the high risk of erosion until the introduce plants may capable to cover the soil.

A non-substantial modification was the acquisition of seeds by partner GVA. The seed mixture was designed following previous experiences of the CEAM for other quarry restorations in the Mediterranean and also the seed availability in the market and cost. The proposed mixture and seeding density is the following:

Seeding density: 150 kg/ha

48,5 % *Dactylis glomerata*

48,5 % *Lotus corniculatus*

1,5% *Thymus vulgaris* .

1,5 % *Santholina chamecyparissus*

The reproductive material of the bought seeds proceed from natural populations but their origin can't be certified as there aren't provenance regions declared for these species and providing this information isn't compulsory in the seed market.

The above mentioned plant production deviations are not significant and did not modify the main project design for restoring vegetation cover. The vegetation units and habitat types as conceived in the proposal were maintained.

About timing, due to the delay on Slope area for remodelling, plantation of this area was also delayed. Plant species associated with wetlands were also introduced in October 2019. The water level of the permanent pond is extraordinarily high and we waited to see the final level after the summer period.

Main findings and results:

The activities of the sub-action 1 include the collection of seeds and stakes for vegetative propagation of some species. The seeds needed for the production of the projects' plants were collected before the project began. The season for seed collection of almost all species is late summer and autumn and there were no activities in the period that comprises this report. The seeds needed in the project came from the forest seed bank if the CIEF.

On the other hand, the collection of vegetative reproductive material did take place in January and February. Stakes of willows, poplars and tamarisks were collected in natural riparian forests of the Turia river. The seeds of some species that are not easy to collect and are not in the collection of the seed bank were bought from a seed provider (i.e. *Rosmarinus officinalis* and *Lavandula latifolia)*.

In respect to sub-action 2, plant propagation and nursery culture, almost all species could be propagated as outlined in the proposal. Plant propagation took place in three nurseries of the GVA: Mas de les Fites in the CIEF, the mountain nursery of El Hontanar and the aquatic plant nursery of el Palmar.

Deliverable

Deliverable "Plant production table" was included in 1st PR (Nov 2018).

Next image shows the result just after the implementation actions B3, B4 and B5.

	
Platform area before. June 2018	Platform area after. April 2019

ACTION	TYPE	STATUS	
B6. Guidelines	**Implement ation**	**Completed**	
		Foreseen start date: April 2021	Foreseen end date: October 2021
		Actual start date: September 2020	Actual end date: October 2021

The objective of this action is to provide useful tools to support professionals of public and private sectors with the decision support process regarding mine restoration.

This action includes the elaboration of 2 Guidelines:

Methodological guide for establishing plans and projects for the restoration of forest areas affected by mining activities

Objective: Facilitate the process of planning, decision-making and drafting of restoration plans/projects
Main users: Technicians drafting restoration plans and projects and public administrations involved in approval and supervision
Context:

- Non-metallic mining
- Opencast
- Forest land
- Mediterranean conditions
- Specific application rules (RD975/2009, June 22; Decreto 82/2005, April 22)

Languages and format: Spanish, Valencian and English. Digital format available on the website and some printed units for events.

This Guide provides information about the available techniques from the most conventional to the most innovative, assessing the benefits and limitations and including recommendation for a proper implementation. Additionally, Annexes with up to date bibliography and example of good practices as referents of restoration are also provided as practical and useful documentation.

Guide for control and monitoring mining restoration projects on forest land

Objective: Facilitate the process of control and monitoring of the restoration by means of a simple tool for the collection of information that allows to assess the compliance of the RP (Restoration Plan).

Main users: Technicians from the public administration, as well as from companies promoting restoration projects.

Context: Same than previous.

Languages and format: Spanish and Valencian. Digital format available on the website and some printed units for events.

This Guide includes a set of template to fill when the restoration is to be evaluated (field work). This provides a detail description of how to fill each box including pictures, criteria and thresholds. Besides annexes with useful bibliography and a glossary are also provided. The idea is to facilitate the information collection in the field and the homogenization of criteria to afterwards elaborate the assessment report.

Who:

The team involved in this action is the personnel from VAERSA and GVA.

Main issues and solutions

No issues have been faced in this action. The only comment in this regard is the underestimated time to complete it, which did not lead to a delay because we started before it was planned.

The second Guideline is based on the regional and national legal framework, which is different in other regions, that is why it is not in English too.

Main findings and results:

After the project and the elaboration of these Guidelines with the huge collaboration of the beneficiaries and also of other entities, we can conclude some items regarding Restoration Projects:

Methodological guide for establishing plans and projects for the restoration of forest areas affected by mining activities

- Restoration of mining sites is part of the activity to be sustainable and respectful of the environment and society.
- For a proper integration, PLANNING is necessary.
- Integrating the three components (morphology, soil and vegetation) is key to increase the chances of success.
- There are no recipes or techniques valid in any context; restoration must be a meditated and specific process for each case.
- SCIENCE-BUSINESS transfer is important and participate in MULTIDISCIPLINARY teams is an extraordinary opportunity.
- Monitoring restoration practices allow (to):
  - ✓ Early detection of possible shortcomings or deficiencies and their remedying.
  - ✓ Improve project implementation and results before the final evaluation.
  - ✓ Facilitate assessment of the dynamics of activated ecological processes.

Deliverable

Guidelines are available on the website in different formats (digital and printed) and languages (Spanish, Valencian and English) and attached to this report (Annex 02).

ACTION	TYPE	STATUS	
B7. Replicability and transferability strategy	**Implementation**	**COMPLETED**	
		Foreseen start date: Sep.19	Foreseen end date: Dec.2019
		Actual start date: April2019	Actual end date: May 2022

This action consists of implementing a proper strategy to guarantee a high impact of the TECMINE through quantified results in replicability and transferability.

(1) <u>Identification of areas to foster replicability</u>

In the Valencia province, there is a significant mining area where most of the clay mines are located; this is the "Comarca de los Serranos". More than 200 mines affect this region, some of them are old mines that were approved before the Royal Decree 2994/1982, October 15 which required the restoration of the mine sites. These are currently abandoned affecting public forest and the environmental impact persist. Besides, in this region, the social conflict regarding mining activities is patent. Despite the benefits that this activity has, in terms of local economy, people are organized in associations to show their opposition due to the existing impacts.

Hence, GVA selected one mine to partially replicate the TECMINE techniques. This mine (Cabezo-bis) is placed in a public forest and is affecting Natura 2000 network. The budget to draft the project (around €20.000) and to implement it (€124.663) has been assumed by GVA under FEDER funds.

Other regions in Spain such as Catalonia, Murcia, Andalucía, Castilla La Mancha are also under similar climate conditions and similar mining sites.

(2) <u>Identification and contact to stakeholders in Spain and Europe</u>

The best way to identify the main stakeholders has been through the transferability and training activities.

We promoted training activities for which we contacted Spain's leading experts in ecological restoration other than the beneficiaries. An intensive publication was made through social networks, the web and directly by mail to the most well-known mining associations and mining companies in Spain. On the other hand, mailings were also sent to public administrations in similar context (Catalonia, Balearic Islands, Castilla La Mancha, etc.).

The result of the 1st edition of the training (1st Technical conference) was a success, in only 3 days the places were filled (50) and 50 people were left on the waiting list (See Event Report "20190708_Curso UPM_FINALIZADO").

Given the immense interest, it was proposed to the attendees, the creation of a professional group to keep in touch and to be able to exchange knowledge and collaborate in further initiatives.

This group has become the 1st Network of Mine and Quarry Restoration in Spain with representation from the industrial sector, administrations and academia from almost all regions of Spain. In addition, some entities from other countries such as Sweden or Chile are included.

Through this Network, the 2nd edition of the course (2nd Technical conference) was organised, this time, online modality and aimed mainly at the public sector. Also, the places were quickly filled and we hope to make a 3rd edition during the after-life (See Event report "20201124_Curso ONLINE GVA-UPM").

As a result of this training, one of the replicas arose in San Luis Mine located in Cuenca at the initiative of the company SAMCA (see Annex 03 "Action B7_MapSanLuis").

In addition to this, the transfer of the project has reached professionals and experts at international level, with the presence at international conferences such as Quarries alive 2018,

Mine Closure Conference in Australia 2019, SERE Conference 2021, IUCN World Conference 2021.

Particularly with Catalonia, we have engaged personnel from the regional government in different training activities (action B1 and D) and we have collaborated with experts working on mine restoration such as Barcelona University and CREAF. Both have participated in LIFE projects (ECOQUARRY and ECORESTCLAY).

In Castilla La Mancha we have in-depth collaboration with the LIFE RIBERMINE. And with Balearic Island government we have collaborated in several occasions to assess the feasibility of replications.

At EU level, we have organized two visits to the mine to foster replicability:

- International Study Trip (see Annex 03 "Action B7_Program_Geomorphic Study Trip Spain")

-Visit of EU mining companies (see Event Report "20191009_Visita empresa sueca").

Coordinated by the UCM team and supported by VAERSA team, several Sweden companies have integrated GEOFLUV method in their projects and this year we have the first example (Fig 1).

Figure 1: GeoFluv method implemented in Sweden. Source: VAST

Other European stakeholders have been contacted such as IMA and UEPG (European mining association) and the beneficiaries of the LIFE IN QUARRIES that already involved many industry stakeholders (Fédération de l'Industrie Extractive et Transformatrice de Belgique, Directorate of Nature for the Department of Nature and Forests (DNF) and mining companies acting at European level). We exchanged information about TECMINE, although the visit had to be cancelled due to the COVID circumstances.

(3) Foster and implement replication

After assessing the feasibility of replication of the pre-selected areas, next replication has been conducted under the TECMINE period:

1. Cabezo-bis mine (La Yesa, Valencia) implemented by the GVA. Area: 2 ha.

Figure 2 Cabezo-bis mine during works

2. Fortuna mine (Ademuz, Valencia) implemented by SIBELCO. Area: 3 ha.

Figure 3 Fortuna II mine after works (march 2022)

3. San Luis mine (Arguisuelas, Cuenca) implemented by the Company SAMCA. Area: 9.7 ha.

Figure 4 San Luis mine after works (2021)

(4) Communication channels

Currently, the main mean for communication and exchange among the main stakeholder (professional target group) is the Network created. We use the Google Groups as a useful and free access collaborative tool (Annex 03 "Action B7_Dossier_Red de Restauracion de Minas y Canteras").

Who:

In general, the entire consortium has been engaged in activities to foster transfer and replication.

Technicians of VAERSA who participated in the training course of TECMINE (action B1) drafted the replica led by GVA; SIBELCO personnel has been in charge of the replica in Fortuna mine with the support of the rest of the team; UCM has supported the replica of San Luis mine.

Main issues and solutions

Some actions aimed at transfer and replicability have been unsuccessful due to the pandemic situation. This was the case with the planned trip for the LIFE in Quarries visit. This could not be resumed, but other actions have been carried out with Swedish companies as mentioned above. So the objective has been achieved.

Moreover, these actions will be taken up in the afterlife period.

Main findings and results:

- 3 replicas have been implemented under the project period.

- More replicas are being assessed to implement in old mines in Valencia Region supported by the Next generation funds.

- The First professional Network on mine and quarries restoration that gather 150 professionals from public and private sectors involving industry, administrations and research.

-A new LIFE proposal (LIFE SOIL4MINE) was submitted where the TECMINE techniques was to be replicated in a limestone quarry but unfortunately this was not pass the core to be successful.

- 2 scientific articles have been published

- 8 Conference at national and international level have counted with TECMINE presentations.

- 2 Guidelines (action B6) are specifically to support replicability of the methodology and the overall approach when dealing with mine restoration.

This action shares partially the objectives of D Actions. Hence, activities, results and impacts of actions D1 and D2 are considered. This action started in April 2018 before planned because opportunities already rose to enhance B7 objectives under D Actions.

Deliverable

Deliverable includes reports about the progress (e.g. events reports of the conferences, articles, reports about replicas, dossier of the professional network, etc.).

ACTION	TYPE	STATUS	
C1. Topography and hydrology monitoring	**Monitoring**	**Completed**	
		Foreseen start date: Feb 2021	Foreseen end date: March 2021
		Actual start date: Aug 2018	Actual end date: March 2022

The objective of this action is to assess the impact of the restoration actions regarding topography and hydrology evolution by measuring the proper indicators.

This action started with baseline data collection in August 2018, just prior to the start of earthworks for action B3.

This action is organized in 2 sub-actions:

- C1.1 Monitoring of topographic evolution and erosion rate
- C1.2 Monitoring of water flows and sedimentation

How:

C1.1 Monitoring of topographic evolution and erosion rate

The geomorphological evolution of the restored area has been measured in terms of the formation and development of rills and gullies and the incision of the streams and channels. The main indicator to assess erosion has been the **density of rills** (m/m2).

Surface water erosion – which acts in restored areas – has two forms: concentrated erosion (rills and gullies) and sheet erosion. The first is responsible for most of the erosion and is easily measurable, which is why it is used to assess erosion in restored mining areas (Nicolau & Asensio, 2000).

To estimate slopes geomorphic evolution: both, rill and gully erosion have been measured and quantified in the restored area by applying two approaches:

a) Field measurements
b) Comparison of Digital Elevation Models (DEM) by 3 drone flights (2019/20/21)

C1.2 Monitoring of water flows and sedimentation

The hydrological response of the restored area has been measured in terms of soil moisture content. The indicator has been: weight of water in the soil in %. It has been measured in three areas:

a) GeoFluv restored areas;
b) Conventional restored areas;
c) Natural Ecosystems

It has been taken monthly measurements for 2.5 years and after extraordinary events.

Study of seed germination in restored landscapes following the GeoFluv method

Complementarily to the C1.2, the role of the temperature in the establishment of vegetation has been analysed which, together with humidity, determines the probability of seed germination. The report, contracted to the UNIZAR team, is attached (Annex 04_Action C1_Action C1.3 Seed germination report).

Who:

The team involved in this action is the personnel from UCM beneficiary, which have counted with the participation of the University of Zaragoza (UNIZAR) team.

Main issues and solutions

The main issues faced are:

-Regarding the DEM methodology to assess erosion. Due to the fact that the growth of the vegetation from the second year of restoration distorted the DEM, generating significant errors in the

measurements. It is a well-known technical problem that, currently, can only be solved by incorporating LIDAR technology into drones, which is done by very few companies and at very high prices. For this reason, it was decided to carry out direct measurements of rills (sampling).

- Regarding the measurement of suspended solids concentration upstream and downstream of mined areas sheer difficulties were found as informed during the 3rd mission. It was decided to change the method to assess erosion considering the density of rills as a suitable indicator.

- According to Hanckok et al. (2016) erosion rates in restored mining areas reach the highest values in the first year after restoration -when rill networks are formed- and decrease exponentially until stabilizing in the fourth year. The rill erosion values recorded in Fortuna mine correspond to the initial phase of rill formation. Therefore, it is foreseeable that the values recorded will decrease in the coming years until they stabilize. To verify this, field measurements will be carried out in the next years, under the After LIFE period.

- About humidity measurement: The first campaign took place in August 2019, so it should end in August 2021. During several reports, the Commission has been informed that it was not possible to measure for a few months due to a failure in the measuring device and during the months of confinement (March, April and May). Therefore, in the Progress report (November 2020), we committed to measure until November 2021.

Main findings and results:

The results show that the canonical geomorphological restorations (GeoFluv) - where it has been possible to build a smooth topography and provide a colluvium substrate - are very little erosive. In fact, in the eastern zone, the formation of streams has been practically nil, and in the western zone, few streams have developed (0.15 m/m2). However, in the areas where canonical geomorphological restoration could not be applied, the density of seepage is close to the threshold value. The absence of colluvium-type substrate also favours the formation of seepage, although at values within the tolerance range.

Rills network development:
• In Eastern GeoFluv no rill networks have been developed.
• In Western GeoFluv has evolved from 0.03 to 0.16 m/m2 in rill density between 2020 and 2021.
• In Western GeoFluv, the zone restored by "Abrupt GeoFluv" has evolved from 0.01 to 0.62 m/m2 in rill density between 2020 and 2021.
• In Western GeoFluv, the restored zone with overburden substrate has evolved from 0.24 to 0.32 m/m2 in rill density between 2020 and 2021.

With regard to **humidity**, we can say that in the areas restored using the GeoFluv method, the humidity levels are higher than in those restored in the conventional way (slope-ditch); in other words, they offer more water to the plants.

On the other hand, the colluvium substrate had moisture levels similar to those of the natural soil of the reference ecosystem (entisol with ochric epipedion) and always higher than those of the "sterile" type substrate, which indicates its good water properties. Our results reveal that the substrate controls the water supply to plants more than topography.

The variety of GeoFluv landscapes favours environmental heterogeneity and therefore biodiversity, far from the uniformity present on conventional slopes.

The study of **seed germination** showed that the main germination window occurs in spring which may be relevant because in Mediterranean climates, sowing usually takes place in autumn.

Deliverable

There are three deliverables Annex 04: (1) Action C 1.1 Topography and erosion; (2) Action C1.2 Water flows and sedimentation and (3) Action C1_3 Seed germination report.

ACTION	TYPE	STATUS
C2. Ecosystem services assessment and monitoring	**Monitoring**	**Completed** Foreseen start date: Feb 2021 Foreseen end date: Mar 2021 Actual start date: Oct 2018 Actual end date: January 2022

The objective of the Action is the evaluation of the effectiveness of the techniques used for soil preparation (Action B4) and planting (Action B5).

This action is organized in 4 sub-actions:

- C2.1 Survival and Growth
- C2.2 Soil water availability monitoring
- C2.3 Biodiversity and carbon sequestration
- C2.4 Ecohydrological assessment

How:

C2.1 Survival and Growth

Assessed by measuring seedling morphological features (height and basal diameter) in the planted seedlings. These samplings were conducted twice per year for seedling survival and growth (before and after summer period).

C2.2 Soil water availability monitoring

The monitoring of soil moisture represents an early warning signal and a test for the effectiveness of field treatments (Action B4). This subaction encompasses the installation, maintenance and effectiveness of soil moisture probes installed in the field. They have been addressed in two ways: i) by introducing soil probes that record moisture content data in a continuous way, and ii) by TDR probes bimonthly recorded to complement the soil probes recordings.

C2.3 Biodiversity and carbon sequestration

This subaction was implemented in a subset of plots. Another subset of plots was selected out of restoration area to compare the same parameters with natural areas (native vegetation) and old (traditional) reforestations. Plant cover and flora biodiversity was determined by means of linear transects (line-intercept method) in reforested and control areas. RestoCat protocol did serve as guide to assess the plant cover by species (Carabassa et al., 2015). These measures were complemented with visual observations of low represented key species in order to have a high accuracy of such determinations. At the same time, we have determined the total plant cover of the whole restored area by using a DRONE. Visible and red and NDVI sensors have been used to identify changes in plant cover in different abiotic conditions (soils, treatments, slope aspects) as well as to compare the presence of vegetation and an estimation of the quantity with similar adjacent areas with native vegetation.

Carbon sequestration and soil nutrients were determined at the same time that biodiversity and plant cover, at the beginning and at the end of the project. Selected plots were the same as for biodiversity analysis. C sequestration assessment was carried out in soil and plants. Soil samples were taken to determine soil organic carbon fixed by the soil as consequence of soil preparation action (B4). In addition, C sequestration was measured in plants (aboveground and belowground biomass estimations) in five of the most relevant species after survival treatments.

In addition, wildlife biodiversity monitoring have consisted of sampling campaigns to collect quantitative and qualitative data about populations of insects, small mammals and mammals by means of sound identification, raptor pellets analysis, fingerprints and night camera traps.

C2.4. Ecohydrological assessment

This subaction was carried out by means of HYDROBAL model application applied in the main units to assess the water balance of the community. The model calculates the water flows across structure of the vegetation and the net precipitation. Other outputs of this model are runoff, actual

evapotranspiration, total evapotranspiration, soil water content and aquifer recharge (deep drainage) as blue and green water.

This model integrates the soil characteristics, structure of the vegetation, as well as climatic conditions, it determines the daily water flows and water balance.

Data on soil water content have been obtained from C1 and C2 (sub-action 2) and data about vegetation and plant cover have been obtained from C2 (sub-action 1 and 3). Related to precipitation and other climate data a Weather Station was acquired. Determinations have been done at the end of the project.

Who:

The team involved in this action is the personnel from CEAM beneficiary, which have conducted the field campaigns for assessing seedling survival and growth in all habitats with plantations. The same team also have monitored the other sub-actions.

Main issues and solutions

Action has been carried out as expected.

About wildlife monitoring, according to the GA, SIBELCO was responsible for this action but it was decided to be transferred to GVA to "compensate" the extra cost of the earthmoving work (internal agreement). However, the time needed for the proper process under GVA rules was too long.

To solve this, we agreed:

1) Contract the first campaign (already done when this agreement) with GVA beneficiary. This is around 2,631.75€ and there is no need for any specific procedure.

2) Sibelco subcontract the rest of the campaigns (8.700€) and its EU contribution is increased in that amount at the end of the project (explained in Financial chapter).

Main findings and results:

Results obtained:

- Survival results can be considered positive, with high survival rates (75% on average), compared to results found in the literature and previous CEAM experiences.

- The results regarding growth in height and basal diameter also show an adequate establishment and development of the introduced species. The results for slow-growing species stand out as they have responded very positively to soil preparation techniques and soil improvers such as organic amendments and micro-basins.

- In terms of reproductive activity, the early activation of this capacity with the appearance of flowers and fruits, and in some cases the development of new seedlings, in various species is noteworthy, which indicates the correct establishment of the plants and good ecological conditions, as well as favouring interactions with the fauna.

- Based on these species' permanence in the first 2 years, we highlight the good adaptation of the selected species to the area into which they were introduced.

- All the restorations tasks performed in the TECMINE area improved the carbon pools in the mining area. In the initial assessment (winter 2019), before any restoration action, the total organic carbon estimated from soil analysis was 5.04 Mg in the whole Geofluv West area. After restoration actions (June 2019), the total organic carbon estimation ranged from 1.6 Mg C ha-1 in RU3 to 6.7 Mg C ha-1 in RU2 (Table 15). Then, the total carbon pooled in the whole restored Geofluv West area was 20.0 Mg C ha-1 in RU2 (Table 15). The total carbon pooled in the whole restored Geofluv West area was 28.1 Mg C. In contrast to the baseline, 2 years after restoration, soil organic carbon was the carbon pool with the highest associated values. Plant productivity also accounted for a considerable carbon stock at this time.

Finally, the total carbon fixed 2 years after restoration was calculated, resulting in a carbon uptake rate of 4.05 Mg C yr-1. The change in carbon stocks showed gains for living biomass, necromass and soil

organic carbon as main carbon sinks, while all restoration tasks showed some loss in carbon stocks as main carbon sources at the end of the monitoring period. The balance after 2 years in the carbon stock was positive. Therefore, we consider that the restored area has an active carbon sink dynamic.

Regarding wildlife, during the las biodiversity surveys carried out (June 2021), a significant increase in the number of species detected was observed, and this increase was even greater than in previous surveys carried out at the same time of year. In total 98 species of birds, 9 mammals, among others.

This increase is largely due to the increase in potential niches resulting from the increase in the biomass of the restoration processes. Numerous species are gradually colonising and establishing themselves in the restored area, and it is hoped that this trend will continue over time.

In general terms, there has been an increase from 38.26% in 2019 to 64.61% in 2021 of the species detected in the areas of influence of the study area, based on the MITECO list of species in the 10x10 grid, which is a very positive value that highlights the benefits of using the selected innovative methodologies.

The results obtained serve as a baseline of knowledge to implement improvements in the management of restored areas using GeoFluv methodology, as the fauna species can be taken as bio-indicators of the conservation status of these areas.

Deliverable

Deliverables: (1) report on establishment success of plantations, (2) report on ecosystem services including a database about vegetation cover, biodiversity, carbon sequestration and ecohydrological main variables as blue and green water (3) Report on wildlife establishment (one per campaign) are attached in Annex 05.

ACTION	TYPE	STATUS	
C3. Socioeconomic Impact Assessment	**Monitoring**	**Completed**	
		Foreseen start date: Feb2021	Foreseen end date: March 2022
		Actual start date: Jan2019	Actual end date: March 2022

This action is a necessary step to understand the potential range of impacts of the project implementation. To analyse impacts associated with the project´s actions, monitoring activities are needed from the beginning. That is why the action has started before planned, at the beginning of the implementation actions.

This action consists of:

1. Describe the baseline scenario
2. Defining objectives
3. Identifying activities, impacts and indicators
4. Define the methodology to measure the defined indicators
5. Analyzing results

How:

1) Describing the base line scenario (Office work)

The process consisted on analysing the social, economic and environmental situation of the project's area of influence. Through bibliographic analysis, surveys, records and technical consultations.

2) Defining objectives (Office work)

The general objective of the socioeconomic study is the evaluation of the social, environmental and economic impacts generated by the TECMINE project.

Specific objectives in this Evaluation are:

- Understanding the potential impacts derived from the development of the project.
- Estimation and evaluation of the effects in the social, economic and environmental areas.

3) Identifying activities, impacts and indicators (Office work)

For the identification of impacts, an integrative approach has been used in which related impacts are grouped together. Eight large blocks have been established; (1) dynamization of the area, (2) feeling of territorial relevance, (3) awareness raising, (4) increase in accessibility in the area, (5) transfer of technical knowledge, (6) foster cooperation and (7) innovation and (8) environmental impacts (included in the Life Cycle Assessment).

An impact identification matrix is defined for each group in which the positive and negative sense of each of them is valued. Several indicators included in the Deliverable measure each groups.

4) Methodology (Office work)

The way to report information on the indicators depends on whether they are qualitative or quantitative.

Qualitative indicators: through surveys, scientific technical consultations, communication plan, consultations to the public of the holidays houses, bars, restaurants, other like social networks, Facebook, Twitter or LinkedIn.

The measurement and evaluation of the indicators has been carried out in 3 phases: Phase 1 corresponding to the Baseline (2018); Phase 2 for those indicators measured during the project implementation (2019/20) and Phase 3 corresponding to the project's end (2021).

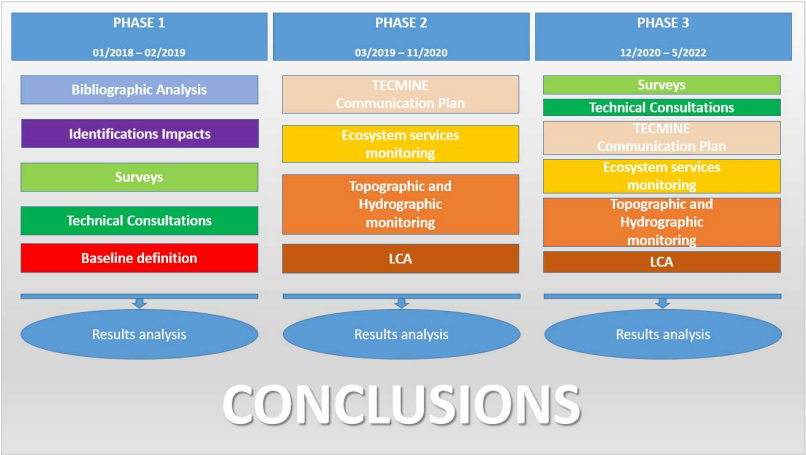


Figure 1: Phases and measurement methods in the socioeconomic study. Self elaboration.

5) Analyzing results (Office work)

Who:

The team involved in this action is the personnel from VAERSA beneficiary.

Main issues and solutions

Action has been carried out as expected, except for the LCA that has been subcontracted by VAERSA because we did not have the enough expertise in this kind of studies.

Main findings and results:

LCA results:

The TECMINE restoration project, like any project that uses materials and energy, has an environmental impact mainly due to the use of machinery during the earth moving works. These impacts are offset by the benefits of recovering soil and vegetation.

Taking into account emissions and removals for a period of 20 years and according to the results obtained, the establishment of the vegetation can compensate in a period of 20 years 3 times the gases of greenhouse effect produced by the TECMINE project.

Socioeconomic impact:

The socio-economic impact has been studied according to the different target groups; local population, public administrations, and company staff and researchers. At the beginning and at the end of the project, surveys were carried out in order to assess the perception and impact of the project.

Questions aimed at identifying the degree of knowledge of professionals about the restoration techniques available beyond the conventional ones and the assessment of the TECMINE techniques, made possible to verify the need for alternatives which, despite being known in the scientific sphere, are not known in the sphere of administration and industry.

Likewise, the result of the restoration of this project in comparison with conventional restorations, as well as the participation and collaboration between the administration, the company and science, have been highly valued aspects.

On the other hand, the local population perceives the activity as positive, despite the environmental impacts derived from it, as it contributes to generating employment. However, most of those surveyed were unaware that after the exploitation of minerals there is an obligation to restore the affected area. This was also due to the fact that the images of the previously restored areas did not seem to give the image of a properly restored area. After the restoration carried out in the TECMINE project, the respondents appreciate and value the landscape improvement of this area in comparison with other areas in the surroundings, also affected by mining activity.

Moreover, the vast majority of respondents consider that the TECMINE project can contribute to the knowledge of the territory and its revitalisation.
Deliverable
Deliverables C3_1_Socioeconomic Impact Assessment and C3_2_Life Cycle Assessment in Annex 06.

ACTION	TYPE	STATUS
C4. Performance Indicators Monitoring	**Monitoring**	**Completed** Foreseen start date: Dec.2017 Foreseen end date: Feb.2022 Actual start date: Dec.2017 Actual end date: June 2022

Actions C4 corresponds to monitoring of the impact of the project actions.

This action includes to monitor and measure the indicators considering in the Key Indicator Project (webtool), proposed by the European Commision.

The project indicators have been submited and validated into the KPI webtool https://webgate.ec.europa.eu/eproposalWeb/kpi/module

How:

All indicators have been measured at the beginning and at the end and the webtool has been updated in June 2022.

Who:

The action has been conducted by personnel of VAERSA and supported by all beneficiaries involved in C Actions, UCM (Action C1) and CEAM (Action C2).

Main issues and solutions

Some KPI and units are different to those from the proposal because of the needed adaptation to the new webtool and the new indicators considered by the Agency. We have tried to complete them the best way possible. Main issues:

- KPI assigned as "deprecated" have been eliminated and substituted by other descriptor.
- 7.5.1 Invasive Alien Species, has been eliminated because after a better inventory, there is no *Arundo donax* to be eliminated.
- 2.3.5.2 Water abstraction/diversion. No irrigation was expected in the design of the project, however due to an extraordinary dry summer it was needed.
- 4.3 Resource efficiency – soil. Additional indicators are to be included that better explain the erosion process in this project but the webtool does not provide the option to included them, neither in the descriptor nor in the comment box. It is attached to this report (Action C4_Additional KPI 4_3 Annex 07).

Main findings and results:

In general, KPI has been reached and some of them has been overpassed. Particularly those related to transferability and reached people.

Regarding technical achievements, as seen in C actions we can say, the project has been a success.

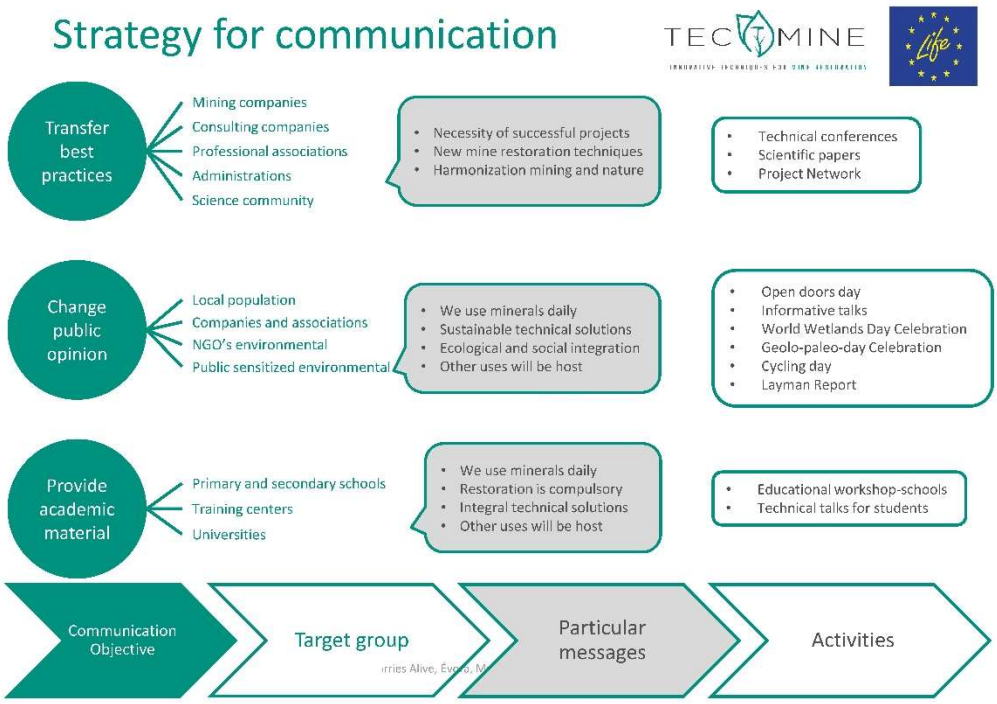
Deliverable

The action C4 Performance Indicators monitoring, has associated 4 deliverables. However, due to the format of the KPIs on the platform where you only have to respond at the beginning, at the end and beyond three years of the project. Values have been provided, validated and uploaded to the platform.

Action D. Public awareness and dissemination of results
This section considers actions and results from the beginning of the project.

Objectives

A strategy for communication has been designed, which includes the communication objectives, the target groups, messages for each group and actions to be developed for each group.



Objective 1. To disseminate mine restoration best practices and transfer knowledge at national and international level.

- Target audience: mining companies, forestry and mining consulting companies, professional associations, public administration, and science community related to ecological restoration.
- Main message: necessity to implement new mine restoration techniques for successful projects
- Particular messages:
    - It is observed that after implementing restoration practices, some impacts such as erosion, landscape intrusion and lack of biodiversity persist.
    - The proposed demonstrative practices will allow to achieve optimal conditions to enhance Natural Capital in a mine area
    - The integration of approaches that consider morphological, ecological and social principles is crucial for a better harmonization of mining activities with nature conservation.
- Activities:
    - Technical conferences
    - Scientific papers/Participation in technical and scientific international forums
    - Project Network

Objective 2. To change public opinion on negative aspects of mining activity and to ensure the implication of general public in the project life-cycle through participation actions. This, in turn, has a multiplying effect to raise more audience.

- Target audience: local population, companies and associations, NGO's focused on environmental protection and conservation and general public sensitized of environmental problems.

- Main message: minerals are part of our lives, it is possible to implement sustainable technical solutions and the environmental services of the restored area.
- Particular messages:
    - Mining activities have a high economic importance. These activities supply to strategic sectors such as construction, road infrastructures or ceramics. In addition, mining give us products for daily use.
    - Innovative techniques focused on stabilization of the strata, erosion reduction and landscape integration will allow to achieve the integration of ecological and social problems of mine restoration.
    - After the project, the restored area will offer new opportunities for rural development (jobs, new companies, investments, etc.) and new socio-cultural uses (rural tourism, educational activities, outdoor activities, etc.)
- Activities:
    - Open doors day
    - Informative talks
    - World Wetlands Day Celebration
    - Geolo-paleo-day Celebration
    - Cycling day
    - Layman Report

Objective 3. To raise awareness in academic communities by educational activities and providing teaching material.

- Target audience: primary and secondary schools, training centers and universities
- Main message: mining activities, mineral uses, mine restoration best practices, harmonization between the activity, environment and people.
- Particular messages:
    - Mining activities are necessary for extracting minerals that we use daily (e.g. crockery, kitchen tiles, decor, etc.)
    - Mining areas have to be restored after extraction activities according to environmental legislation
    - Innovative technical solutions have to integrate landscape, to reduce erosion and to achieve optimal ecological conditions for flora and fauna.
    - After restoration the area can be host other uses such as rural tourism, educational activities for schools, family days, etc.
- Activities:
    - Educational workshop for schools
    - Technical talks for students (Universities and Training Center)

In addition, activities and events are publicized on the website, social media, newsletter, posters, brochures, etc., using the most appropriate tool according the activity and the target group. Most of the dissemination events and activities are being taking place at mine facilities.

During the life project the following communication tools are being developed:

- Website
- Social Media
- Newsletters
- Mailing list
- Technical-Didactic Itinerary
- Dissemination material (press releases, noticeboards, itinerary panels, posters, brochures, images, videos, layman report, merchandising)

Dissemination: overview per activity

ACTION D1: Public awareness and dissemination of results

Three technical conferences of the project have been conducted in 2019, 2020 and 2022. The latter corresponds to the Final Conference additionally included after the project extension.

The participation in at least 2 technical and scientific international forums programmed in the technical application form has been surpassed with 20 technical and scientific international forums.

The publication of two scientific papers (articles) in national or international scientific journals programmed in the technical application form have been published:

- ✓ Turrión, D., Morcillo, L., Alloza, J. A., & Vilagrosa, A. (2021). Innovative techniques for landscape recovery after clay mining under mediterranean conditions. Sustainability, 13(6), 3439 (Annex 08_1).
- ✓ Martín Duque J.F., Tejedor M., Martín-Moreno C., Nicolau J.M. & Zapico I. (2019). Geomorphic rehabilitation in Europe: recognition as best available technology and its role in LIFE projects. Mine Closure 2019 - AB Fourie & M Tibbett (eds) © 2019 Australian Centre for Geomechanics, Perth, ISBN 978-0-9876389-3-9 (Annex 08_2).
- ✓ An additional one is expected to be published in 2022 about the topography and erosion progress.

About the 12 local events programmed in the technical application, TECMINE has participated in more than 10 event organized by the team besides an entire summer campaign where our presence has been in more than 7 local events with an stand and talk to rise awareness. We consider more than 943 people risen at local level.

The Layman Report is already available on the website and has been distributed in technical forums under the AfterLife Plan (Annex 08_3 and 08_4).

The organization of 3 educational days for children had to be cancelled due to the pandemic circumstances. In exchange, we elaborated 3 Didactic Units (UD) for infants, primary and secondary school levels (informed by e-mail dated on Feb23, 2021 and accepted by e-mail on Feb 24) (Annex 08_5). Following the recommendation of the PM in her e-mail, the UD have been distributed to every educational center in Valencia Region, published in our social networks and newsletter and other specific educational networks. Social posts are published periodically to remember that this material is uploaded on the website to be used. So far, 589 downloads have been registered. In addition, VAERSA team presented the project and materials in the Course organized by the Education Administration in Valencia. During the Afterlife period, we will continue with this training and include a workshop within the educational program of the GVA "Eduacabosc".

4 technical talks for students (training centers and universities) were programmed in the technical application. LIFE TECMINE has been presented in 17 educational centers, attending 462 students of universities, training center and two secondary schools.

As general indicator, we have reached 5,183 people; among which more than 2,500 are professionals that are considered part of our network.

ACTION D2: Project Network

The first **project network** meeting took place in Fortuna mine on March 2019 as expected. Five LIFE projects met (ECOQUARRY, ECOSRESTCLAY, REGROW, ECOMED, TECMINE). As a result of this meeting, REGROW and TECMINE collaborated in the proposal of a new LIFE project "Soil4Mine" that unfortunately did not succeed (Annex 08_6_Action D2_Meeting).

Previously, VAERSA made a search to identify similar projects that could be interesting to include in this meeting. Thus, VAERSA team visited the LIFE ECORESLAY in Amposta on February 13, 2018 in other to learn and exchange knowledge about the restoration model.

It was programmed a second project network meeting but in exchange we have participated in several networking events with other LIFE projects. Besides, we have engaged many mining companies in Spain in TECMINE activities and we consider this within this action too (see Events report in Annex 08_07 and the updated Communication Plan_V9 in Annex 08_08).

D actions evaluation:

Communication activities have surpassed the expected. A total of 81 events have been organized which have been reached each public target identified in the communication plan.

Moreover, the project has been presented both in national and international level **conferences** regarding ecological restoration as well as in **training courses and articles**. The international ones are: Quarries alive 2018; 13th International Conference on Mine Closure in The Westin Perth (Australia) 2019; IUCN World Conservation Congress in Marseille 2021; SERE Conference 2021. So the dissemination of the project results and the transfer of knowledge at international and national level has been achieved.

The implication in education and public awareness is also remarkable in this project considering that is a technical project dealing with environmental and social impacts of an economic activity among the most impacting ones, which is highly controversial and difficult to handle.

In the Final Conference, the conclusions reached in these years of monitoring using innovative techniques in mine restoration have been revealed.

In conclusion, much more events that the project had programmed have taken place. So, **the objective are reached**. The **reactions and feeback** from different stakeholders and organizations in contact with the project are more positive that we could expect at the beginning. They are communicating us their necessities and collaborative actions have been taken of.

A description in quantifiable terms, responsible and comparison with the planned activity for each activity and output are summarize as follow:

Objective 1. To disseminate mine restoration best practices and transfer knowledge at national and international level.							
Conferences or technical forums where LIFE TECMINE has been presented							
Nº/anexx 08_7_X	**Event**	**Place**	**Date**	**Responsible**	**Type of presentation**	**Programmed**	**Number of attendees**
1-R	TECMINE presentation in the Mesa Forestal	Valencia, Spain	20/11/2017	Juan Uriol-GVA Beatriz Olmo-VAERSA	Speech	Additional	40
2-R	IV Conference in mining and sustanaible development	Villar del Arzobispo, Spain	20/01/2018	Juan Uriol-GVA	Speech	Additional	Not known
3-I	Quarries Alive 2018 Enhancing biodiversity and ecosystems services in quarries challenges, strategies and practice	Evora, Portugal	02/05/2018	Daniel Arizpe y Cristina Beseler-VAERSA Cristina Martín-UCM	Speech	Yes	140
4-I	Course Landform design and modelling for best practise in mine rehabilitation (organized by the UCM partner, LIFE TECMINE collaborates)	Madrid, Spain	18-21/09/2018	José Francisco Martín Duque- UCM	Speech	Course Landform design and modelling for best practise in mine rehabilitation	
5-R	Curso de Gestión Integral de proyectos europeos	Valencia, Spain	04/10/2018	Juan Uriol-GVA Beatriz Olmo-VAERSA	Speech	Additional	20
6-N	V Congreso Nacional de Áridos	Santiago de Compostela, Spain	24-26/10/2018	Beatriz Olmo-VAERSA	Speech	Yes	800

7-R	Curso de Gestión Integral de proyectos europeos	Valencia, Spain	12/11/2018	Juan Uriol-GVA Beatriz Olmo-VAERSA	Speech	Additional	20
8-I	Foro internacional: El futuro de los municipios mineros	Bembibre, Spain	19-20/11/2018	José Fco. Martín Duque-UCM	Speech	Additional	150
9-N	X Congreso AEIP APENA EFIB ECOMED	Madrid, Spain	21-23/11/2018	José Fco. Martín Duque-UCM	Speech	Additional	115
10-N	Congreso Nacional de Medio Ambiente CONAMA 2019	Madrid, Spain	26/11/2018	Nobody - VAERSA	Poster	Additional	Not known
11-N/**08_7_3**	I Seminario Canteras y Biodiversidad	Valencia, Spain	03/04/2019	Juan Uriol-GVA Beatriz Olmo y Cristina Beseler-VAERSA Juan Carlos Santiago-SIBELCO	Speech	Additional	93
12-I/**08_7_5**	Jornada de Networking NEWEST	Valencia, Spain	12/04/2019	Beatriz Olmo- VAERSA	Speech	Additional	33
13-N/**08_7_7**	Segundas Jornadas Técnicas Life+Regrow	Toledo, Spain	02/05/2019	Luna Morcillo y Alberto Vilagrosa- CEAM	Speech	Additional	70
14-N/**08_7_8**	Reunión del grupo Ecología, Ecofisiología y Suelos Forestales de la Sociedad Española de Ciencias Forestales	Alcalá de Henares, Spain	09/05/2019	Luna Morcillo y Alberto Vilagrosa- CEAM	Speech	Additional	67
15-R/**08_7_10**	II Jornadas Morella/Teruel de minería sostenible	Ademuz, Spain	31/05/2019 y 01/06/2019	Juan Uriol-GVA Beatriz Olmo, Cristina Beseler-VAERSA José Fco. Martín Duque – UCM Luna Morcillo, Alberto Vilagrosa- CEAM	Speech and visit field	Additional	18
16-R/**08_7_11**	Visita del Colegio de Ingenieros de Minas de Levante	Ademuz, Spain	12/06/2019	Cristina Gil-VAERSA Juan Carlos Santiago-SIBELCO	Speech and visit field	Additional	12
17-R/**08_7_12**	3ª Edición Universidad de Verano de Ademuz	Ademuz, Spain	25-27/06/2019	Cristina Beseler-VAERSA	Speech	Additional	41
18-R/**08_7_14**	Technical meeting with the forestry research team of CEAM	Ademuz, Spain	03/07/2019	Luna Morcillo, Alberto Vilagrosa- CEAM	Speech and visit field	Additional	7
19-I/**08_7_18**	13th International Conference on Mine Closure	Perth, Australia	1-7/09/2019	José Fco. Martín Duque-UCM	Speech	Additional	625
20-R/**08_7_20**	Curso de Gestión Integral de proyectos europeos	Valencia, Spain	18/09/2019	Juan Uriol-GVA Beatriz Olmo-VAERSA	Speech	Additional	30
21-R/**08_7_21**	Visita de empresa minera de Kiruna (Suecia)	Ademuz, Spain	9/10/2019	José Fco Martín Duque-UCM Juan Uriol-GVA Beatriz Olmo-VAERSA	Speech and visit field	Additional	12
22-R/**08_7_25**	Jornada sobre estabilidad de taludes y su importancia en la Restauración de explotaciones mineras	Mallorca, Spain	28/01/2020	Beatriz Olmo-VAERSA	Speech	Additional	50
23-R/**08_7_36**	Presentation of the LIFE TECMINE project in the GVA Webinar about Green strategy of the GVA	Online	11/05/2021	Bea Olmo-VAERSA	Speech	Yes	50
24-R/**08_7_39**	Visit of the Vaersa management staff	Ademuz, Spain	20/05/2021	Beatriz Olmo, Antonio Ibañez-VAERSA	Speech and visit field	Additional	3
25-I/**08_7_40**	VII CONGRESO IBEROAMERICANO SOBRE AMBIENTE Y SUSTENTABILIDAD	Online	31/05/2021-04/06/2021	Diana Turrión Cerrejón, Alberto Vilagrosa, Luna Morcillo Julià, Jose Antonio Alloza-CEAM	Speech	Additional	>300

26-N/**08_7_41**	Visit to the replica applied in the mine "San Luís"	Arguisuelas, Cuenca	10/06/2021	Beatriz Olmo, Antonio Ibañez-VAERSA José Francisco Martín, María Tejedor-UPM	Speech and visit field	Additional	6
27-R/**08_7_42**	5ª Summer University of Rincón de Ademuz	Ademuz, Spain	21/06/2021	Beatriz Olmo, Antonio Ibañez-VAERSA	Stand	Yes	20
28-R/**08_7_43**	Visita científica en el proyecto TECMINE	Ademuz, Spain	5-6/07/2021	Alberto Vilagrosa Carmona, Luna Morcillo Juliá, Jose Antonio Alloza Millán y Diana Turrión Cerrejón-CEAM	Speech and visit field	Additional	9
29-I/**08_7_45**	IUCN World Conservation Congress	Marsella, France	3-11/09/2021	Beatriz Olmo, Daniel Arizpe-VAERSA	Speech	Additional	25
30-I/**08_7_44**	12th SERE CONFERENCE	Online	7-10/09/2021	Diana Turrión, Luna Morcillo and Alberto Vilagrosa-CEAM	Speech	Additional	--
31-N/**08_7_49**	1ª reunión técnica Red de Restauración	Arguisuelas, Cuenca	27/10/2021	Beatriz Olmo, Cristina Gil y Guillem Peiró- VAERSA	Speech and visit field	Additional	28
32-N/**08_7_52**	Curso Postgrado University of Barcelona	Cataluña	8-11/10/2021 12-15/11/2021 22-25/10/2021 26-29/11/2021	Ana Cuchi, Montse Jorbà-UB	Comunication material	Additional	
Technical conferences of the project							
	Event	**Place**	**Date**	**Responsible**	**Type of presentation**	**Programmed**	**Attendance (number of person)**
33-N	GeoFluv-Natural Regrade course. Technical training (Action B1)	Valencia	28/08/2018	GVA-UCM	Training	Additional	
34-N/**08_7_15**	Curso Nuevas tecnologías Aplicadas en la Restauración de Explotaciones mineras (1st Technical Conference)	Madrid, Spain	8-10/07/2019 30/09/2019 01/10/2019	Raquel Checa-GVA Beatriz Olmo, Cristina Beseler, Cristina Gil-VAERSA José Fco UCM Alberto y Luna CEAM Juan Carlos SIBELCO	Training	Yes	50
35-N/**08_7_28**	Curso Nuevas tecnologías Aplicadas en la Restauración de Explotaciones mineras (2ª Edición)	Online	24-27/11/2020	Juan Uriol-GVA Beatriz Olmo, , Cristina Gil e Ibán Hurtado-VAERSA José Fco UCM José Manuel UNIZAR Alberto y Diana CEAM Juan Carlos SIBELCO	Training	Yes	51
36-I/**08_7_48**	Geomorphic Reclamation Study trip	Riodeva-Ademuz, Spain	21/10/2021	Jose F. Martín José M. Nicolau María Tejedor Cristina Martín-UCM-UNIZAR Beatriz Olmo Cristina Gil-VAERSA	Trainning	Additional	12
37-I/**08_7_57**	FINAL CONFERENCE LIFE TECMINE	Polytechnic University of Valencia (Valencia) and in streaming	31/03/2022	Juan Uriol and Cristina Gil (GVA) Beatriz Olmo, Ibán Hurtado, Guillem Peiró and Aida Moreno (VAERSA) José Fco. Martín, María Tejedor and José Manuel Nicolau (UCM/UNIZAR)	Speech		122 (35 in person)

				Alberto Vilagrosa and Diana Turrión (CEAM) Juan Carlos Santiago (SIBELCO)			
Network							
	Event	**Place**	**Date**	**Responsible**	**Type of presentation**	**Programmed**	**Attendance (number of person)**
38-I	1st meeting between Life Projects (Network)	Riodeva, Ademuz	08/03/2019	Cristina Beseler, Beatriz Olmo VAERSA	Speech and visit field	Yes	11
39-I	Jornada de Networking GLOBAL OMNIUM	Valencia, Spain	12/04/2019	Beatriz Olmo-VAERSA	Speech	Additional	33
40-N	Segundas Jornadas Técnicas Life+Regrow	Toledo, Spain	02/05/2019	Luna Morcillo, Alberto Vilagrosa- CEAM	Speech	Additional	70
41-R/**08_7_24**	Living Lab about valorization of water treatment residues	Valencia, Spain	4/12/2019	Beatriz Olmo-VAERSA	Speech	Additional	20
42-N/**08_7_31**	Visit to several projects of restoration of mines	Barcelona and Tarragona, Catalonia	15-16/04/2021	Beatriz Olmo, Cristina Gil-VAERSA	visit field	Additional	6
43-N/**08_7_32**	Visita científica-técnica al proyecto RIBERMINE y TECMINE	Peñalen, Guadalajara y Rincón de Ademuz, Valencia, España	21-22/04/2021	UCM-UNIZAR: Jose Manuel Nicolau Ibarra, CEAM: Alberto Vilagrosa Carmona, Luna Morcillo Julià y Diana Turrión Cerrejón	Speech and visit field	Additional	9
44-N/**08_7_33**	Visit to the restoration area of a mine site	Nijar, Almería (Andalucia)	27/04/2021	Beatriz Olmo, Sara Rosell-VAERSA	Speech and visit field	Additional	3
45-N/**08_7_37**	Visit to restored mines in Catalonia	Barcelona and Tarragona, Catalonia	13-14/05/2021	Beatriz Olmo, Sara Rosell-VAERSA	Speech and visit field	Additional	6
46-R/**08_7_46**	INFODAY "LIFE PROGRAMME" COMUNITAT VALENCIANA	Online	17/09/2021	Antonio Ibañez-VAERSA	Speech	Additional	89

Objective 2. To change public opinion on negative aspects of mining activity and to ensure the implication of general public in the project life-cycle through participation actions. This, in turn, has a multiplying effect to raise more audience.							
Nº/annexx 08_7_X	**Name of event**	**Place**	**Date**	**Responsible**	**Type of presentation**	**Programmed**	**Attendance (number of person)**
47-R	Presentation of LIFE TECMINE project in Ademuz	Ademuz, Spain	26/06/2018	Juan Uriol-GVA Menchu Cabanes, Cristina Beseler, Daniel Arizpe-VAERSA Susana Tejada-SIBELCO José Antonio Alloza-CEAM Cristina Martín-UCM	Speech	Additional	27
48-R	La plaça canvia pel clima	Valencia, Spain	11/11/2018	Emilio Valls-CEAM	Attendance	Additional	Not known
49-R/**08_7_02**	Visita del personal administrativo de TECMINE a la mina	Ademuz, Spain	11/03/2019	Juan Uriol-GVA Beatriz Olmo, Cristina Beseler, Menchu Cabanes-VAERSA Susana Tejada-SIBELCO	Speech and visit field	Additional	6

50-R/**08_7_13**	1st Open doors day in the mine	Riodeva, Spain	28/06/2019	Cristina Beseler-VAERSA Luna Morcillo-CEAM Alfredo Soriano-SIBELCO	Speech and field visit	Yes	12
51-R	Campaña difusión verano 2019	Rincón de Ademuz y Riodeva	7-10/2019	Marisa Miguel Martín-Dinamizadora TECMINE	Attendance	Additional	239
52-R/**08_7_17**	1st Cycling-day (Carrera Titanica Riodeva)	Riodeva, Spain	25/08/2019	Marisa Miguel Martín-Dinamizadora TECMINE	Attendance	Additional	44
53-R/**08_7_19**	Mining and environment days: Ornithology	Riodeva, Spain	21/09/2019	Beatriz Olmo-VAERSA	Speech and field visit	Yes	20
54-R/**08_7_19**	Mining and environment days: Botany	Riodeva, Spain	28/09/2019	Beatriz Olmo, Marisa Miguel-VAERSA	Speech and field visit	Yes	16
55-R/**08_7_19**	Mining and environment days: Wetlands	Riodeva, Spain	05/10/2019	Beatriz Olmo, Marisa Miguel-VAERSA	Speech and field visit	Yes	22
56-R/**08_7_19**	Mining and environment days: Mining	Riodeva, Spain	26/10/2019	Beatriz Olmo, Marisa Miguel-VAERSA	Speech and field visit	Yes	12
57-R/**08_7_23**	Stand Feria de la Manzana en Ademuz	Ademuz, Spain	23-24/11/2019	Marisa Miguel Martín-Dinamizadora TECMINE	Attendance	Additional	233
58-R/**08_7_26**	Día Mundial de los Humedales: La biodiversidad de los humedales, ¿por qué son importantes?	Valencia, Spain	02/02/2020	Juan Uriol-GVA Beatriz Olmo, M.ª Carmen Cabanes-VAERSA	Attendance	Yes	270
59-R/**08_7_29**	Día Mundial de los Humedales	Online	02/02/2021				
60-R/**08_7_35**	Celebration of the Geolodía in the Albufera of Valencia	Devesa del Saler, Valencia	09/05/2021	Beatriz Olmo, Antonio Ibañez-VAERSA	Speech	Yes	118
61-R/**08_7_47**	Día de las comarcas	Valencia, Spain	24/09/2021	Antonio Ibañez-VAERSA	Attendance	Additional	
62-R/**08_7_50**	2on OPEN DAY	Ademuz, Spain	06/11/2021	Beatriz Olmo, Guillem Peiró-VAERSA	Speech and field visit	Yes	11
63-R/**08_7_54**	Día del Árbol de la Comunitat Valenciana	Centre de Educació Ambiental (Sagunt), Spain	30/01/2022	Víctor Benlloch - VAERSA			72

Objective 3. To raise awareness in academic communities by educational activities and providing teaching material.							
University							
Nº/anexx 08_7_X	**Name of event**	**Place**	**Date**	**Responsible**	**Type of presentation**	**Programmed**	**Attendance (number of person)**
64-I	Course Landform design and modelling for best practise in mine rehabilitation (organized by the UCM partner, LIFE TECMINE collaborates)	Madrid, Spain	18-21/09/2018	José Francisco Martín Duque-UCM Cristina Beseler and Beatriz Olmo- VAERSA	Speech and field visit	Additional	42
65-I	Visita del Master en Restauración de Ecosistemas a la mina	Ademuz, Spain	18/01/2019	Susana Tejada, SIBELCO Cristina Beseler, VAERSA	Field visit	Yes	35

				José Fco. Martín Duque, UCM			
66-N/**08_7_6**	Visita de estudiantes de grado de ingeniería del medio natural y forestales de la Universidad Politécnica de Madrid	Ademuz, Spain	24/04/2019	Beatriz Olmo, VAERSA Eduardo Pérez Laorga, GVA	Field visit	Additional	29
67-I/**08_7_9**	Conferencia en Pontificia Universidad Católica de Santiago de Chile (Chile)	Santiago de Chile, Chile	17/05/2019	Alberto Vilagrosa-CEAM	Speech	Additional	50
68-R/**08_7_16**	Visit to the Tecmine Project of Eduardo Arellano and Pablo Becerra from Pontificia Universidad Católica de Santiago de Chile	Ademuz, Spain	17,18/07/2019	Alberto Vilagrosa-CEAM	Field visit	Additional	2
69-N/**08_7_22**	Clase Máster en Ingeniería Hidráulica y Medioambiente UPV	Valencia, Spain	11/11/2019	Beatriz Olmo, Ibán Hurtado VAERSA	Speech	Yes	20
70-R	Visita estudiantes del grado de Ciencias Ambientales de la Universidad de Zaragoza	Ademuz, Spain	30/11/2019	José Manuel Nicolau UNIZAR	Field visit	Additional	20
71-R/**08_7_27**	Jornada sobre impacto de la actividad minera y su restauración. El Modelo Tecmine	Cartagena, Spain	02/03/2020	Beatriz Olmo, Ibán Hurtado VAERSA	Speech	Additional	29
72-N/**08_7_30**	Seminar for the master of the University of Alicante: MÁSTER UNIVERSITARIO EN CONSERVACIÓN DE LA BIODIVERSIDAD Y RESTAURACIÓN DEL MEDIO MARINO Y TERRESTRE Subject: Restauración de medios antropizados	Online	09/03/2021	Diana Turrión Cerrejón	Speech	Additional	12
73-R/**08_7_34**	Visit of the Master in Ecosystem Restoration (UPV)	Ademuz, Spain	05/05/2021	Beatriz Olmo, Antonio Ibañez-VAERSA	Field visit	Additional	14
74-R/**08_7_38**	Visit of Forestry engineering degree students from the UPV	Ademuz, Spain	17/05/2021	Beatriz Olmo, Antonio Ibañez-VAERSA	Field visit	Additional	14
75-R/**08_7_51**	Visit of the Master in Ecosystem Restoration (UPV)	Ademuz, Spain	22/11/2021	Beatriz Olmo, Guillem Peiró-VAERSA	Field visit	Additional	12
Training Center							
76-R	Visita del CIPF San Blas a la mina	Ademuz, Spain	25 y 27/02/2019	Beatriz Olmo, Cristina Beseler VAERSA Susana Tejada-SIBELCO	Field visit	Yes	26
School							
77-R	Visita de Instituto de Enseñanza Secundaria de Chelva a las instalaciones del Centro para la investigación y experimentación forestal (CIEF)	Valencia, Spain	03/12/2018	Daniel Arizpe-VAERSA	Visit	Additional	16
78-R	Jornada de plantado de árboles	Los Serranos, Spain	11/04/2019	Ibán Hurtado-VAERSA	Participation	Additional	70
79-R/**08_7_53**	Curso CEFIRE (Servicio Formación Profesorado)	Online	25/01/2022	Beatriz Olmo-VAERSA	Speech		45
80-R/**08_7_55**	Visita del Instituto de Educación Secundaria de Alcoy (Valencia)	Valencia, Spain	08/02/2022	Beatriz Olmo, Guillem Peiró-VAERSA	Speech		20

81-R/**08_7_56**	Visita del Instituto de Educación Secundaria de Ademuz (Valencia) a la mina	Valencia, Spain	16/03/2022	Beatriz Olmo, Guillem Peiró-VAERSA	Field Visit		41

Notes: R: regional level; N: national level; I: international level

List of deliverables:

- Erection of notice boards: Six noticeboards were installed in the project access (1st PR).
- Web site: The website is operative since February, 2018 (http://www.agroambient.gva.es/en/web/life-tecmine).
- Mailing lists: a mailing list to subscribe to is activated (http://www.agroambient.gva.es/en/web/life-tecmine/newsletter). Suscriptors receive the project newsletter each 6 months (9 newsletter have been delivered).
- Project Documents: 16 reports hosted on web site (https://agroambient.gva.es/en/web/life-tecmine/documents-projecte)
- Audio-visual products: 2 promotional videos (Annex 08_9) and other videos produced have been disseminated in the project´s dissemination tools. All of them are available on the web site (http://www.agroambient.gva.es/es/web/life-tecmine/videos-promocionals).
- Photographs. A bank of images and videos is available: https://agroambient.gva.es/es/web/life-tecmine/galeria-imatges where it is possible to see the Photograph exhibition (Annex 08_10) done to be itinerant during the After-Life Plan. Currently it is placed at the Riodeva facilities to promote tourism.
- Brochures, handouts, leaflets, teaching units:
  - 6 informative posters (1st PR).
  - 2 scientific papers (Annex 8_01 and 02). 389 times have been downloaded.
  - 3 leaflets downloaded 600 times (MR).
  - 32 documents from the second edition of the Mine Restoration Course. 4524 times downloaded.
  - 6 Didactic Units. Have been downloaded 584 times.
  - 5500 units of project brochures have been produced. Available online in English and Spanish. https://agroambient.gva.es/es/web/life-tecmine/material-divulgativo
  - 2 roll up have been produced (1st in MT and the 2nd in Annex 08_11).
  - 1,000 units of cotton bag, 500 units of notebook, 400 units of pendrive and 200 units of children bag have been produced (MT).
  - 6 interpretative panels have been design in Spanish and English and installed in the TECMINE route (1st PR) which has been also uploaded on Google.
  - https://www.google.com/maps/place/Ruta+Life+Tecmine/@40.1124332,-1.1563763,15z/data=!4m5!3m4!1s0x0:0x18b2337186b7cb86!8m2!3d40.1124332!4d-1.1563763
    and wikiloc https://es.wikiloc.com/rutas-senderismo/ruta-interpretativa-de-restauracion-de-minas-life-tecmine-79810724
- Press dossier: it includes press cuttings published on digital press, TV, radio, etc. 25 media reviews. (Attached 11 additional to the deliver in the MT report. Annex 08_12)
- Social Media used:
  - Facebook (https://www.facebook.com/LIFE-Tecmine-Innovative-Techniques-for-mine-restoration-2176004369342608/?ref=bookmarks)
  - Twitter (https://twitter.com/LIFETECMINE?lang=es)
  - Linked In (https://www.linkedin.com/company/18730577/admin/)
  - TECMINE identity
  - The Communication Plan has been uploaded to the web on June 30, 2022.
  - Social Network plan of contents
  - Editorial calendar for Social Network

The LIFE logo and communication requirements have been used on documents, deliverables, merchandising, communication materials and durable goods.

ACTION	TYPE	STATUS
E1. Project management	**Project management**	**Completed** Foreseen start date: Nov 2017 Foreseen end date: Nov2021 Actual start date: Nov2017 Actual end date: July 2022

This action corresponds to the management of the project so that it lasts the duration of the project (November 2017 to May 2022). Main activities have been the Partnership agreements and the Coordination meetings. Actions to facilitate a proper project management are indicated in Section 2 (Administrative part)

The management of this project has been supported by:

- Coordination Meetings (CM):

Every 6 months the consortium had a CM with a total of 10 (6 from the MidtermReport, Meeting minutes in Annex 09). The main items covered in each CM are:

- A general overview of the project progress including updated timeline conducted by GVA and VAERSA personnel
- Review on the status of the project's actions, indicating if they are completed, in process or finished. In case of delay, it is indicated the reason and how to address it. Conducted by VAERSA personnel
- Review on the financial status. Personnel from VAERSA reviews the Financial report of each beneficiary and make an overview of the project progress in terms of budget. It is also highlighted the differences with respect to the proposal, identifying savings and extra-costs and warming about the main issues.
- Review action by action. Each beneficiary makes an overview of their actions' progress and next steps.
- Conclusions and discussion. We take advantage of these meetings to (1) solve doubts and problems and (2) propose new activities, especially about transferability and replicability.

Templates

CT provided the templates for: Events and meetings: Agenda, Meeting Minutes, Mailing list, Attendance sheet, Presentations; Deliverables and technical reports; Communication: Twitter, News, Event reports; Timesheets to (1) assure that deliverables responds to the EASME requirements, (2) guarantee that documents have similar format, structure and style and (3) facilitate beneficiaries to complete any documentation required.

Internal meetings

Internal meetings ha been agreed each moment beneficiaries have needed to better develop a task that depends on others.

Main issues and solutions

About the On-line management tool, after testing another tools (Trello and Basecamp), ASANA was selected as Management Tool. Asana's free services covered the coordination needs of the project. Despite it was well accepted by all beneficiaries, most of them have not used it. In general, they prefer the traditional way of communication, i.e. via email because they are already used to. It also implemented a Google drive as repository/stock the main documents (deliverables, reports, pictures, designs, etc.) to share and exchange the documents.

Modifications to EASME are included in next table:

Subject or Modifications	Date e-mail/report	Date answer EASME	Response
Kick-off **and first monitoring visit** M1: Postponement of actions A2 (*Expert panel*) and B1 (*Technical training*). M2: Bring forward the implementation of the monitoring actions M3: Bringing forward the implementation of action B7 M4: Increase the number of attendees to this course (Action B1)	1 CM dated on November 28, 2017	February 14, 2018	Accepted

M5: Change in action C1 M6: Elimination of the interim audit report M7: EASME ask for an official commitment to subrogate the SIBELCO commitments with this LIFE project in the event of sale of the mine			
Change in Action A2 and B2 about the Slop Area	February 12, 2018	February 19, 2018	Accepted
Changes on budget of the beneficiary UCM	November 6, 2018	November 21, 2018	Accepted
Comunication about the administrative problems with UCM	December 12, 2018		
First PR and 2nd monitoring visit Modification 1 about Action A4, B1 and B5 included in the Progress report Modification 2: Postponement of the elaboration of the brochures Modification 3: Transfer of the responsibilities for the purchase of the wood necessary for the construction of the technical-didactic itinerary form GVA to VAERSA	3 CM dated on Nov 22, 2018	January 15, 2019	Accepted
Delay in Action B2	February 21, 2019		Accepted
Adition to organic mesh to slope areas	February 21, 2019		Accepted
Not planting in the GeoFluv of the Pond area	March 6, 2019	March 11, 2019	Accepted
The date to send the MidTerm Report	Marh 25, 2019	March 28, 2019	Accepted
Attendance to a Congress about mining in Australia	June 10, 2019	June 12, 2019	Accepted
Mid-term report Organic meses installation Non-substancial changes Action B4 Watering of the plantations (B4) Cost for implementing the Course of mining restoration (B7) Tranfer budget for Wildlife montiring cost (C2) Aditional brochures (D)	July 15, 2019	August 30, 2019	Accepted
3rd Monitoring mission Aditional brochures (D) Informed the need for change the method to measure sediments The summer campaign for local dissemination cost	December 2, 2019	January 24, 2020	Accepted
4 th project visit and progress report (Nov 2020) No modifications	October 21 and 30, 2020	December 18, 2020	
Amendment request Project extension Changes in the EU co-financing share of beneficiares	September 24, 2020	October 19, 2021	Accepted

Main findings and results:

Beneficiaries agreed that the coordination of the project has been useful and clear.

Deliverable

- Meeting Minutes are delivered (Annex 9)
- Partnership Agreements were delivered in the MidTerm report.
- Action E3_Deliverable_AfterLife Plan in Spanish and English (Annex 10_1 and 2) including:
  (1) a summary of the project
  (2) actions to be implemented during the 3 years period, and
  (3) the budget

6.2. Main deviations, problems and corrective actions implemented

The main difficulties encountered are reported in the previous section, action by action. In general, we can say that no major problems have arisen and the project purpose has been widely achieved.
Modifications of each action have been informed to NEEMO and EASME before executed, by justifying the need for the change and providing an alternative to keep the project goals and/or to correct a possible deviation (see action E).

About the deviation from the proposal, there are no substantial variations. Perhaps the biggest change has to do with the implementation of the Talus Royal Technique for the restoration of the Slope area. The collaboration of the inventor of the patent was foreseen in different actions such as the Panel of Experts (A2) and the Training (B1), but as EASME was informed by e-mail dated on February 12, 2018, it was ruled out both by budget and by criteria. It did not guarantee the possible replicability since you have to accept the conditions of the patent and it will not always be feasible. Anyway, the criteria under which the restoration has been designed in this area are based on this technique. The design has been advised by different experts in geomorphological restoration. The action guarantees the stability and landscape integration, so the project's objectives are maintained.

6.3. Evaluation of Project Implementation

We can say that the project implementation has not had any technical, financial or management problems that have affected the project's targets. On the contrary, the project has had a much greater impact than expected and the consortium has worked in a coordinating and collaborative way. In this sense and acknowledge by the monitoring team and the Agency, the project has been a success.

This project has transcended and has marked a turning point in the restoration of mines and quarries in Spain and in time it will also be reflected in the rest of Europe.

Project methodology and particularly some of the methods applied are pioneering in Europe. Both successes and failures have allowed us to maximize the lessons learned that we have shared with the stakeholders and are included in the available reports, deliverables and Guidelines.

The project budget has been a bit higher than planned mainly due to the uncertainties of the method, the lack of experience of machinists and labourers as well as minor deviations in designing and execution. All of this is quite usual in restoration projects but they will be reduced once capacity building and experience are acquired by the companies.

This extra cost has been done only in actions involving earth moving works. The rest has been fairly well adjusted, compensating for minor extra cost with savings in other categories or actions.

The implemented restoration actions consisted of:

1) Geomorphological restoration

Mine face: Stabilisation and integration by blasting at the upper slope and remodelling.

Successes:

- ✓ Landscape integration by (1) taking the natural landforms as reference instead of a set of benches (2) using natural materials to control erosion (stones from the landslides) and conduct water (clay as impermeable substrate instead of concrete).
- ✓ Overall slope stability while minimizing land affection by accurate design blasting.
- ✓ Effects of runoff water on berms and slopes controlled by increasing roughness and sowing.
- ✓ Water infiltration in the berms by applying rough and loose technique.
- ✓ Efficiency of the drainage network and individual elements.
- ✓ Habitat viability taking advantage of the heterogeneity of the lithology and the mine face elements (slopes, berms, scree…).

Deviations:

- ✓ The effect of the strong runoff along the security berm caused internal soil movements between the rough and loose holes in which it was planted, resulting in the death of many individuals. Perhaps planting is best done once the area has stabilised after several heavy rainfall events

East and west zone: Remodelling with the GeoFluv-Natural Regrade method, based on the replication of landscapes similar to natural ones.

Successes:

- ✓ Landscape integration by (1) considering the natural landforms as reference instead of a set of benches.
- ✓ Maximise resources availability for seeds and plants (water and nutrients) by reducing the loss of these resources through the gullies (formed in conventional methodologies). This leads to a better vegetation development and accelerate the process of recovery and renaturalization.
- ✓ Reduce the sedimentation in natural water courses.
- ✓ Avoid the use of artificial material to control erosion which have also been shown to be inefficient in these environment (i.e. concrete ditches).
- ✓ The extension of a colluvium layer on the surface improved soil physical properties that reduce the erosive capacity of water in addition to other favourable aspects for vegetation discussed below.

Deviations (with no significant impact as explained in previous sections):

- ✓ Lack of precision in the connection of the newly constructed drainage networks with their base levels.
- ✓ There have been spaces left without colluvium cover.
- ✓ In some areas, the inflow of runoff from the outside into the restored areas has not been adequately managed.

A functional and visual integration and adaptation to the environment of the mining areas requires that the landforms are 'mature', with smooth and hilly topographies, and with channels that replicate natural drainage networks.

COST EFFICIENCY ANALYSIS

- ✓ In general, in restoration projects, the main cost is associated to earth moving works (about 70% of the total).
- ✓ TECMINE unitary costs of the GeoFluv methodology are: 2,14€/m2 in East zone and 3,54€/m2 in West zone (including the construction of the security berm).

- ✓ The remodelling of GeoFluv versus traditional way requires different resources it terms of hours of mobile plant. It means that this methodology requires more hours for the final remodelling than the berm/slope model. However, this is mainly due to the lack of previous planning.
- ✓ In case the remodelling design had been in advance at time of closure and so, during the extraction stage of the mining works, every cubic meter of waste had been placed close to the final location, the additional cost necessary to achieve the model, would have been not necessary.
- ✓ In this regard, SIBELCO has made the calculations of the cost under this assumption and the results shown 16,000 €/hectare which is similar to the use of the traditional, and not usually successful, techniques.
- ✓ Other factors that have increased the cost may be the lack of experience in the methodology and so that, the need for training of technicians and machinists, the uncertainty of the innovation and the needed coordination with other partners. These are particular circumstances of a kind of project like this, but in usual project are not.
- ✓ Therefore, this innovative methodology may results in significant cost savings depending on the status of the land before remodelling and the mining planning, and the capacity of the company.

2) Soil supply and stabilisation

Substrates such as colluvium and mixtures of mine wastes have been selected and improved with organic matter (compost) from water waste treatment. In addition, sowing of herbaceous species, organic blankets and strips of wood chips were also put down to protect against erosion processes.

A suitable selection of available substrates, together with mixing and improvement treatments, have allowed the reconstruction of a functional soil, which guarantees the stability and development of the new ecosystem.

3) Establishing vegetation

Before planting, techniques have been applied that optimise the use of rainwater, such as "microcatchments", and other actions aimed at improving the survival and growth of the plants: protective tubes, hydrogel, organic amendments and nursery cultivation techniques, adapted to the functional characteristics of Mediterranean species.

Subsequently, around 9,000 plants of 31 different species of trees and shrubs have been planted, representing up to 8 different habitats, of which 3 are priority habitats.

Successes (2 and 3):

- ✓ The use of organic amendments from other activities has been key to increase soil fertility and as a consequence have favoured plant survival and vegetation development. The combination of the addition of compost on the surface and in the planting hole allowed achieving fertility values close to those recommended for reference soil parameters in mine restoration.
- ✓ The colluvium layer improved soil properties in terms of stoniness, texture, initial nutrient content and water availability. Over time, this substrate showed the lowest soil compaction values, allowing some main ecological processes such as seed germination, water infiltration and nutrient recycling.

- ✓ The combination of the selected techniques allowed an early soil cover where the herbaceous sowing play a key role. Other elements covering the soil surface, such as stones, leaf litter or organic debris (e.g. organic hedges), were also important in increasing surface roughness, favouring seed germination and the establishment of new native colonising species.
- ✓ The successful selection of species introduced, together with the restoration techniques implemented, generated the right ecological conditions to favour the establishment of new colonising species in the restored area, indicating the beginning of ecological recovery. In classical mining restoration, however, natural plant colonisation is often hindered by the high presence of few competitive species.
- ✓ The results obtained in terms of carbon sequestration and carbon balance, highlight the importance of implementing appropriate restoration actions aimed at improving carbon storage and progressively establishing a carbon sink throughout the restored area.

Deviations:

- ✓ Plant survival in the security berm and lagoon showed the worst results. The first case is already commented above regarding the rough and loose technique. In the second case, several factors had an influence. Planting and irrigation were carried out somewhat late within the ideal conditions for doing so, and the species selected considering the distance to the sheet of water were not suitable, since, despite being close to the lagoon, the clay substrate does not allow the necessary permeability.

Note: In next section, 6.4, more benefits obtained with the applied methodology are explained.

COST EFFICIENCY ANALYSIS

The unit cost (€/ha) for site preparation plus planting was approximately €13,835, which compared to the €10,000 average for traditional projects, is considered to be quite similar. This is due to the compensation of some units for others. For example, micro-basins and other treatments can be more expensive to implement than traditional techniques, however, the methodology used means lower densities and lower maintenance costs, which compensates for this cost. Furthermore, after knowing the results of survival, growth and cover, among others, it can be concluded that the cost/benefit analysis of these actions is very positive.

In any case, this comparison should be taken with caution since, (1) we do not have examples with similar starting conditions, (2) the data on traditional techniques are based on projects (not real costs) and (3) the cost of innovation related to a lack of training and experience on the part of the implementing company may also have an influence.

Next table shows a summary of the achieved objectives compare to the expected ones when we submitted the proposal. Throughout the document, further details about the results, including quantitative indicators, are described:

ENVIRONMENTAL PROBLEMS	MAIN EXPECTED RESULTS/HYPOTHESIS	OBJECTIVES ACHIEVED
Lack of landscape integration	-New technical solution to stabilize steep slopes in mine areas while increasing landscape integration	-The upper part of the slope has been integrated and main stabilization is achieved. -Created profile is similar to the surrounding natural relief.

		-GeoFluv areas are perfectly integrated with the landscape due to the smooth shapes and the vegetal cover.
Hydrological problems	-Reduction of 50% in erosion rate -Improvement in water quality of natural channels by reducing sediments from mine area -Increase of soil water content and aquifer recharge (blue and green water)	-It is suggest a more suitable indicator to measure erosion in mine context, that is erosion density (m/m2) where the restored areas show values 0,15 m/m2 (below the threshold above which erosion prevents vegetation development in restored mining areas). Less erosion means less sedimentation, so this is also achieved. -GeoFluv method presents higher moisture levels than conventional restoration. (See Action C1)
Low biodiversity and vegetation cover	- 13.6 hectares of forest land restored - 8 habitat types, of which 3 are listed in annex I of the Habitats Directive as priority habitats - 10,000 plants of 34 different species - Reduction in water consumption for irrigation - Increase Carbon sequestration from plants and soil - Increase wildlife	Targets in this sense have been all achieved even if the nº of plants are less (9.000ud) because in the Zone east we decided not to include plantation. -Biodiversity is much higher than in traditional project with <15 sp. usually. -Only 1 emergency irrigation (less than usually projected) -Increase C sequestration below and above ground due to higher plants development -Higher nº od wildlife species
Lack of transferability	Regarding social issues: -Higher participation and involvement of local population in mine projects -Involve associations directly related to environmental and cultural aspects -Regarding transferability and replicability, we expect that mining sector and public administration implement the new approach and techniques as part of the best practices in mine restoration. This project will support this by technical documents and advising as well as training.	- More than 5,000 people reached - Training of more than 120 professionals - 20 technical conferences reaching more than 2,500 professionals and experts from the public and private sector - 4 scientific publications; 2 technical guides on planning and evaluation of mine restoration projects. -Scientific-technical reports on the environmental and socio-economic monitoring campaigns -17 activities where 460 students from Universities and Training Centres have received training - 550 people have visited the restoration of the Fortuna Mine. - Participation in more than 20 events, aimed at the general public - 2 TV reports, 2 radio reports and 5 articles in the press -3didactic units for infant, primary and secondary schoolchildren -3 replicas

-Compared to the initial expected results, we can say that we have widely achieved the overall objective and the main specific ones. The only result not achieved is concerning the elimination of alien species (i.e. *Arundo donax*) because after a thorough inventory there were no individuals along the river to be eliminated. Remarkable are the achieved results regarding transferability and awareness, which have been higher than expected.

-Environmental and social benefits in forest restoration are easily shown form the beginning but most of them (e.g. landscape integration, biodiversity, vegetal cover, C stock, wildlife) are going to increase overtime.

-Regarding the impact of the modifications; the watering and changes in species have led to guarantee a sustainable ecosystem with no need to replanting and re-planning, the organic mesh has allowed to avoid erosion and subsequent slope repair, the decision of not to plant in the GeoFluv East provided us with more information about the geomorphic reclamation method.

-As a result of the replication efforts, we have implemented 3 replicas:
1.- Cabezo-bis mine (La Yesa, Valencia) implemented by the GVA under FEDER programme founds. Area: 2 ha.
2.- Fortuna mine bis (Ademuz, Valencia) implemented by SIBELCO. Area: 3 ha.
3.- San Luis mine (Arguisuelas, Cuenca) implemented by the Company SAMCA. Area: 9.7 ha.

-Regarding dissemination activities, the Communication Plan has been one of the major successes of the project from the beginning. This plan was well valued by the expert in social engagement (Dan Ryan) during the Expert Panel (action A2) and has been implemented with no major drawbacks. The only issue that affected was the COVID 19 when the restrictions had not allowed us to carry out the activities planned. In general, and due to the fact that we had already achieved the targets, this did not have an impact on the dissemination objectives. Besides, some activities were developed before the project's end and some other were adapted. The latter is the case of the Educational days for children that were substituted by 3 didactic units for infants, primary and secondary school (informed by e-mail dated on February 23, 2021 and preliminarily approval by the PM).

-Policy impact:

- ✓ The most important project achievement related to legislation development has been the elaboration of technical guidelines (Action B6) that could be the starting point to improve environmental mine restoration regional regulation. The guidelines include detailed information about conditions and requirements for transferability and replicability of the techniques implemented in TECMINE.
- ✓ A regional regulation on applicability criteria of different mine restoration techniques in Mediterranean areas is required by Forestry Administration (GVA partner). This administration is determined to work to elaborate this regulation based on the guidelines elaborated by TECMINE. They will be disseminated to other regional and national authorities to be taken into account in new regulations regarding ecological restoration and mining.
- ✓ The main barrier to carrying out this initiative is the complex relationship between the different administrations (mining, environment and forestry) in charge of supervising mine restoration projects. TECMINE project is contributing to change this situation since these three administrations are involved in the transferability actions (e.g. technical training, technical conferences), although there is still a need for improving the coordination in the administrative processes of mine restorations.

6.4. Analysis of benefits

1. Environmental benefits

i. The most direct and visible environmental benefit is the restored surface and its integration into the landscape since the terrain shapes are undulating and pleasing to the eye. In total, 13.6 hectares have been restored in addition to the 14ha in replicas.
ii. Other benefits are: biodiversity increase (flora and fauna), recovery of functional soil, C stock, higher water infiltration, erosion control.

iii. The GeoFluv technique creates a drainage network that reduces the erosive capacity of the water and generates lower slopes, thus preventing erosion and allowing access to the restored area.
iv. Using materials such as wood chippings from nearby forests, or organic amendments from nearby composting plants, are efficient solutions and contribute to the circular economy.
v. Seedlings have been specifically produced for this project from local seed provenances and cultivated under the most demanding protocols and highest quality standards.
vi. Microcatchments capture water runoff to the seedlings, maximizing the efficiency of precipitations and facilitating the seedlings survivorship.

2. Economic benefits

i. The project has demonstrated that the new approach is environmentally positive and economically viable. The replication is suitable and sustainable for mining companies. This will help to create new work niches, since there will be a need for professionals with the appropriate training to use the right software and have adequate training to operate the machinery. TECMINE has also increased the capacity building of public administration and companies.
ii. Cost-benefit analysis shows that these types of restorations do not require more investment, yet the environmental and social benefits are far superior to conventional models.
iii. In economic terms, the main conclusion is that is it necessary a right design in advance of the final shapes at time of closure to avoid additional cost than necessary. During the extraction stage of the mining works, mining waste should be placed close to the final location. Doing so, the new methodology can provide significant savings.
iv. During the project, it has created new temporary jobs in the area for the placement of the wooden fence, transporting and unloading forest chips or the production of information panels, brochures and roller panel of the project.
v. The local economy has been enhanced, since technicians, scientifics and workers of the project have made use of the Ademuz and Riodeva services (restaurants, accommodation, shops, etc.). In addition, local suppliers have also provided services during the project visits (more than 650 people has visited the project area under TECMINE activities).

3. Social benefits

i. A new space to enjoy nature has been provided to local and foreign visitors, fostering the socio-economic activity of the area.
ii. The newly restored space has provided a high landscape value appreciated by citizens, which contributes to greater social acceptance.
iii. The new itinerary with 6 panels has increased the accessibility and knowledge transfer and awareness. This route has been also uploaded to google for virtual visits (so far more than 5,000 people has visited it).
iv. After surveys under Action C3, local people have more information about the mining operation in their territory and the regulatory framework about restoration. Besides, they are more aware about the available techniques so to be able to demand high quality restoration projects in future mining activities.

4. Replicability, demonstration, transferability.

i. TECMINE has a huge potential of replicability since mining sector is a key growing sector in Europe. After the significant transferability effort made in this project we have reached more than 2,500 professionals and we have created the first Network of experts and professionals in mine restoration. As a result, we have 3 replicas and programmed more under Next generation funds.
ii. TECMINE is now a referent in Spain and Europe of ecological restoration, receiving demands to be visited and for training on the techniques applied. From now on, the entire consortium is committed to support the sector and the administrations to implement the techniques.
iii. As said before, the model is suitable and sustainable but with better planning and coordination of the mining operation and restoration works, results may be much satisfactory.
iv. The impact on replicability will be evident after some years since the usual procedure to open new mines or increase the mine sites takes more than 4 years from the application to the approval.

5. Best Practice lessons

MORPHOLOGY

i. GeoFluv-based morphological restoration allows better water resource management, so limiting in Mediterranean environments, reducing its erosion capacity and increasing its infiltration compared to the conventional berm and slope model.
ii. The model replicates natural reliefs, and adapts and integrates into the environment, both in terms of landscape and hydrology. The new morphology is stable and functional in the long term, so the footprint generated by the activity can disappear in a relatively short period.
iii. Morphologic restoration is a necessary condition for the success of open pit mine restorations, but it is not sufficient. Providing a substrate with good physical properties reduces the erosive capacity of water and increases its availability for plants.

STABILISING SOIL

iv. Organic amendments applied to sterile substrates have positive effects on soil fertility and vegetation development. In TECMINE, an average survival rates of 75% and growth up to 3 times higher than the original size of the seedlings after two and a half years of follow-up have been obtained.
v. Native herbaceous species sowing in adequate doses plays a key role in soil stabilization and avoids the competitive effect for introduced or spontaneous plants. After one year of restoration, the herbaceous coverage exceeded 60%, which may be enough to effectively control erosion processes.

VEGETATION RECOVERY

vi. The determination of ecosystem references such as the Natura 2000 Network allows for an appropriate selection of species to suit the physiological characteristics of the restoration area, and an increase in vegetal biodiversity.
vii. The local origin of seeds and acclimatisation of seedlings to the abiotic conditions of the area ensures proper adaptation and development of newly planted vegetation. Having a Seed Bank of local and certified varieties, together with appropriate cultivation techniques, enables a high level of quality in forestry plants.

viii. The use of low-cost techniques that favour water catchment such as Microcatchments may be a good option to reduce maintenance practices such as irrigation and/or replanting. Our results show an increase in soil moisture levels of around 7%.

6. Innovation and demonstration value

i. TECMINE is the first restoration mine project where GeoFluv method has been implemented in the Valencian Region and the first in Europe with such a combination of ecological techniques under Mediterranean climate conditions.
ii. The TECMINE project demonstrates that it is possible to implement more efficient and sustainable restoration models, thus contributing to a more responsible mining.
iii. Collaboration and transfer between Public Administration, science and companies has demonstrated also to be key in the success of ecological restoration and the impact of the TECMINE project.
iv. The demonstration of innovative techniques has enabled other mining companies to replicate the model in their restorations.
v. Dissemination of results improves the perception of mining operations by the public.

7. Policy implications

The main problem detected related to environmental mine restoration process is the lack of coordination between the administrations in charge to evaluate and approve the Integral Restoration Project (PRI, the Spanish acronym) that companies have to implement once the extractive activity ends. TECMINE project has contributed to strengthen the relationship between administrations and to change the opinion of technicians in the necessity for sustainable mine restorations techniques. Beyond the project lifetime, GVA partner is determined to work on these issues in cooperation with the other administrations involved. In order to improve this situation a regional initiative will be foreseen:

- Updating the the minimum contents of PRIs by taking into account the lessons learned and the Guidelines.

7. Key Project-level Indicators

Actual values of the KPIs for TECMINE project have been provided in the online KPI database (https://webgate.ec.europa.eu/eproposalWeb/kpi) making sure that values reported are justified and consistent with the environmental, economic and social benefits reported in the preceding section.

See Action C4 in previous section.