

Rehabilitation Ecology by Revegetation: Approach and Results from Two Mediterranean Countries

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ABSTRACT: Human activities greatly affect the environment causing its degradation. Urban development and road networks construction cause main impacts on ecosystems and particularly on vegetation cover: road constructions induce complete degradation of the vegetation cover and often leaves a bare land, sometimes without even a soil cover. Reconstitution of vegetation cover is necessary to limit superficial erosion and land slipping on the road, towards a reintegration of the site in the neighbouring landscape. Many approaches have been studied over the last 30 years aiming at this reconstitution of vegetation cover. At first, the main purpose of land reclamation was to create a new ecosystem. At this time, the environment created was rather a "garden" with a new soil adapted to the plantation of "decorative" species. Then, in early 90' s many studies on the restoration ecology concept rather focused on adapting the vegetation to the existing conditions on the site, as in a side road embankment for example. Nowadays, we notice a large tendency towards the use of such adapted native species instead of industrially produced seeds. In southern France, our team have led research on the potentials of those local species for their use in revegetation processes with hydro-seeding. We therefore developed an approach combining the use of different types of species: Industrially produced, native and wild cultivated species. This method integrates the benefits of using available low costing seeds that are already used on large scale projects with better adapted species, issued from the cultivation of native species and seed production for their use on smaller scale and more costly but more effective results. The use of wild cultivated species seeds was developed in order to limit the cost and reduce harsh natural seed withdrawal in the natural environment in the case of the use of native species. Besides, the use of such seeds allowed a larger geographical scale of use than with local native seeds. In addition, our team began two years ago a research project in Lebanon aiming at the introduction and development of the revegetation techniques in Lebanon. In fact, this country bared since 20 years the consequences of urban pressure on its environment especially by the development of quarries and road networks. Therefore, pioneer work is necessary to aim at the adaptation of these techniques to the local environment.

Key words: Native species, Rehabilitation ecology, Revegetation, Vegetation cover

INTRODUCTION

Human activities greatly affect the environment inducing its degradation. Urban development and road building have a major impact on the vegetation cover. Quarries which are necessary to the development of cities, roads and railways have nonetheless a severe effect on the local landscape. In each case, the process begins with a complete removal of the vegetation. This phenomenon occurs in wide range of habitats (forest, grassland, riparian forest) and in wide range of geographical positions (from the sea-side to the mountain).

During a long time, up until the 70' s, land rehabilitation was

based on a technical approach, aimed at surface stabilization of the ground (or soil). The soil stabilization is always an important problem especially along the road sides because of the lack of vegetation, and the surface erosion caused by rain. This phenomenon can be intense, for example during the autumn season in the Mediterranean region, when storms occur. Various technical approaches are used to stabilize the soil, for example mulching with straw.

In the 70' s and 80' s, an important development of highways occurred in France and revegetation by hydro-seeding became the most important means to do land rehabilitation on side road embankments. Hydro-seeding is often combined with planting

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(especially for trees), but in the following paper we will focus on the hydro-seeding technique. Hydro-seeding (Plate 1) is a cheaper method to sow seeds along road sides, especially when embankments are very large and the slopes are very steep. The hydro-seeding process starts by mixing cellulose fibre, mulch and seeds. Water is then pumped into the tank to be mixed by the machine. Once the mixture is fully blended it is then sprayed on to the ground. The sprayed mixture on the ground is referred to as a blanket or a mat, the material in the mat enhances the seed germinating process and will stimulate the seeds to grow a deep and healthy root system along with an even pattern of leaf stock. Today this technique is commonly used for quarries, road sides and ski runs revegetation.

For the last 15 years, these technical solutions have been associated with conscientious scientific studies on the biological material involved in revegetation processes.

The approach on ecological rehabilitation processes will be to focus on the species used for revegetation. For in fact, up until now, operations consisted to adapt the environment for landscaping, by using mulching techniques for example or by adding high doses of nutrients. On the contrary today, in accordance with the principles of ecological restoration, we will be choosing the adapted species to the environment. The objective being to obtain an autonomous ecosystem which will not be needing any up keeping, such as mowing or using phytosanitary products.

The species of seeds used for revegetation through hydro-seeding will for the bigger part originate from selected species already in use in agriculture or for lawns. These species belong to the families of *Poaceae* or *Fabaceae*.

However the environmental conditions of a road side are radically different to those of a pasture or golf course. Furthermore, difficult climatic conditions (dryness, cold) intensify the environmental constraints during the germination of the sowed species. Thus, revegetation with the selected *Poaceae* or *Fabaceae* is often destined for failure in areas of strong climatic constraints. For example, the Mediterranean region has very dry and warm

summers, in the mountains, the vegetation period is very short.

Fifteen years ago, in France, studies were done with the objective of mass producing "wild species" who were better adapted to the climatic and edaphic constraints of the areas needing revegetation. Today, some species are being multiplied especially for hydro-seeding revegetation.

In the next part we will be explaining the role of revegetation and we will be developing our thoughts on the type of species used, through our experiments particular to the Mediterranean part of France. Then we will develop the first results obtained on research undertaken in Lebanon. That country has a great amount of quarries on which an ecological rehabilitation must be undertaken. In Lebanon, we have been doing research for over 2 years to optimize the rehabilitation ecology of the country, working on species selection and ecosystem analysis.

The role of revegetation

During the building of roads, railway tracks or quarries, the local environment suffers considerable alterations. The vegetation disappears and the newly created surroundings, for example, a highway embankment, are completely different to that of the local environment. More often than not, the ground is completely taken away, leaving the parent rock barren. The parent rock may have very diverse origins. It may be sand, for example, in the form of a granitic arena, basalt, limestone (hard or marly), etc. Sometimes, part of the ground which had been put to a side during the road works is then laid over the embankment during the earth works. When the road is built, the embankment is either an excavation consisting more often than not of a parent rock which has been taken apart or an embankment formed of destructured substratum with sometimes a layer of brought back earth. In both cases, these surroundings are characteristically artificial and completely different to the local environment.

In a natural environment, after a disturbance which has ravaged the vegetation, the ecosystem evolves following the mechanisms of vegetation succession (Egler, 1954 ; Drury & Nisbet, 1973 ; Connell & Slatyer, 1977). When the environment is completely new, this succession is known as primary (Clements, 1916 ; Whittaker, 1975). When the disturbance has ruined only part of the ecosystem, the succession is called secondary, because the environment already has living organisms, for example, seeds belonging to the soil reserve (seed bank) or rhizomes which will germinate or regenerate after the disturbance (Keeley & al., 1981 ; Pickett, 1982). In either cases the vegetation will evolve towards a climax community. In temperate zones, the first stages of the vegetation succession are herbaceous and the last stages are forests. The vegetation dynamic is generally much faster in a secondary succession than in a primary one. In a primary succession the length of time needed is very big because at the start we have no soil. The regeneration of the ground takes varying lengths of time depending on the type of



Plate 1. Hydroseeding.

parent rock or substratum.

During the building of a road, will the newly created surrounding give a primary or a secondary succession ?

The answer depends of course on the quality and quantity of ground brought back to the embankment. If no soil is brought back, it will then be a primary succession. In this case there may be a spontaneous and very fast vegetation colonising. This vegetation is first of all greatly dominated by annual species : wind dispersed seeds that are scattered over long distances. In temperate zones, many Asteraceae species have such characteristics (genus *Coniza*, *Crepis*, *Taraxacum*, *Inula*, etc.).

If we have a vegetation succession taking place, then why carry out a revegetation ?

The main purpose of revegetation is to accelerate the process of vegetation dynamics, more particularly by bypassing the stage where vegetation is dominated by annual species. Most of annual species are inefficient to limit superficial erosion. Revegetation is usually accomplished with perennial species, which, in the best case will take up the space instead of the annual species. These perennial species have a substantially bigger vegetative system, but mainly an aerial/root ratio which is much inferior to that of annual species. Such characteristics enable them to better stabilise the superficial part of the embankment. The second function of revegetation is to better heal the environment and help the vegetation reinsert itself in a surrounding which was ravaged by mankind. This has become compulsory in many countries where legislation over environmental issues have gradually been taking place. Today, in many of these countries, the "rebuilding" of the vegetation has become law for all major road works or railroad track building.

Ecological restoration and revegetation.

The idea of *ecological restoration* dates back to 1935 (Jordan *et al.* 1987) and has led to numerous studies over the later years (Cairns 1980, Bradshaw 1983, Aber and Jordan 1985). The land rehabilitation affects areas which have been disturbed by human activities (because of the infrastructure of communication routes, agriculture, industry and tourism). But ecological restoration is more concerned with the rebuilding of the ecosystems such as they were before the anthropic disturbance occurred. For an exhaustive review of the concepts of land rehabilitation and restoration see Aronson *et al.* (1993, a, b) and Le Floch and Aronson (1995). Restoration of an ecosystem may be defined as the intentional transformation of an environment in order to re-establish there what is viewed as the native and historical ecosystem. Rehabilitation consists rather in enabling an ecosystem to regain its primary functions, thanks to a powerful yet limited in time intervention ("jump start"). "Rehabilitation and restoration have a common target, that of re-establishing autonomous ecosystems" (Le Floch and Aronson 1995).

Revegetation is a technique which implies bringing biological

material to a depleted environment. This technique may be applied to both rehabilitation and restoration. In the following text we will be using the term revegetation, because our scientific approach was aimed at making operational a technique for the major road and railroad works. We will only be mentioning revegetation on behalf of sowing.

Which species for revegetation?

Nowadays, we can assume that there are three groups of species used for revegetation by sowing :

1. marketable species: in vast amounts and on a large scale according to international norms. These are industrially produced seeds.
2. natives species, collected near the area to be revegetated.
3. wild species which have been cultivated to obtain seeds : wild cultivated species. (this being the case for French Mediterranean species).

Marketable species: in vast amounts and on a large scale according to international norms. These are industrially produced species.

These seeds are the result of industrial processing, selection and multiplication of seed. They are submitted to very strict international norm and are being distributed by big international companies. A major part of these species belong to the Poaceae family and are the result of thorough selection for use in agriculture and for lawns, being used both by private individuals and for sports. There are also a few species of the Fabaceae family, which are used particularly for their capacity to fixate atmospheric nitrogen. The main interest in those species are their relatively cheap price (less than 3 USD per Kg, 1m² of revegetated space with these species through hydro-seeding costs roughly 0.1 USD). The main inconvenient with these species is that they don't withstand strong environmental constraints such as dryness or lack of soil.

These species are still widely used for large scale revegetation projects, such as, on highway or railroad tracks embankments. The necessary amount of seeds can sometimes be very high, and these species are the only ones marketed in such huge quantities. For example, in the case of the layout plan for the new "TGV Méditerranée" (high speed train), for a length of 250 Km, with an embankment of roughly 50 metres of width, it would take 150 tons of seeds using the hydro-seeding technique for revegetation. In the southern part of France, during 2000 and 2001, for 250 km of new highway, 350 tons of seeds were used to revegetate roughly 20 millions square meters.

Natives species, collected near the area to be revegetated.

Some studies have reported that the use of native species in revegetation gives better results than commonly used alien species (Pickart 1988, Wilson 1989, Putwain and Gillham 1990),

Lippitt *et al.* (1994) describe the process of collection and storage of native seed for a revegetation project.

Native plants are adapted to the soil, temperature, and precipitation regime of their environment. They are genetically adapted to local ecology, to survive in diverse communities, and to support local flora/fauna ecology. They can give an ultimate stability in the long run when seeking zero maintenance in restoration of sites. Nevertheless, when using natives for revegetation, one of the obstacles that still presents itself is availability of plant materials (seeds). Many native seeds must still be harvested by hand in their wild habitat and debate goes on about whether or not seeds of native species should be harvested from naturally occurring stand or through production or specially seeds stands. In this case, contracts for seed production are needed up to three years in advance. Today, the demand for native seeds increase more and more for revegetation or landscaping project. Also, many homeowners are looking to use native plants as an alternative for the maintenance-intense urban lawn.

Nevertheless, use of native species lead to two important problems :

1. In many locations, human activity has so altered the soils and soil structures that survival of native vegetation might be unlikely and prohibitively expensive.
2. Revegetation with native species must cause only a minimum disturbance on native communities, and sometimes these communities are not able to give enough biological material.

Wild species which have been cultivated to obtain seeds : wild cultivated species. (This being the case for French Mediterranean species).

The rule is to choose the better adapted species to the environment needing rehabilitation and to multiply them on a large scale in order to diminish the cost of production, and so avoiding to great a taking on the natural habitat.

Since the early 80' s, our team has done many studies on the germination characteristics and the biology of the species in the Mediterranean region. (Al Samman Winkel *et al.* 2001, Martin *et al.* 1996 2001, Martin and Puech 2001, Mineau 1987, 1990, Puech *et al.*, 1997). We have studied 360 pioneer species which spontaneously colonize the disturbed environments. The figures 1 and 2 give us the characteristics of these species. Theses species tend to be herbaceous perennials or shrubs and belong to these main families : Asteraceae, Poaceae and Fabaceae.

At the end of the 80' s , we had established a list of 110 mediterranean species which showed interesting characteristics for revegetation use. These species were selected following a list of biological and ecological criteria :

1. a good tolerance to dryness.
2. a good ability to root.
3. a good ability to develop on a poor substratum.

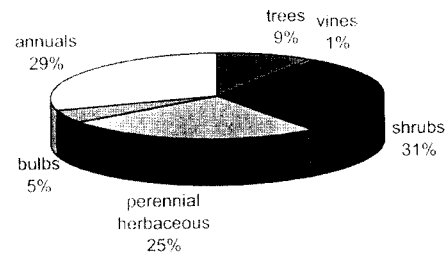


Fig. 1. Distribution of life forms among species involved in our studies.

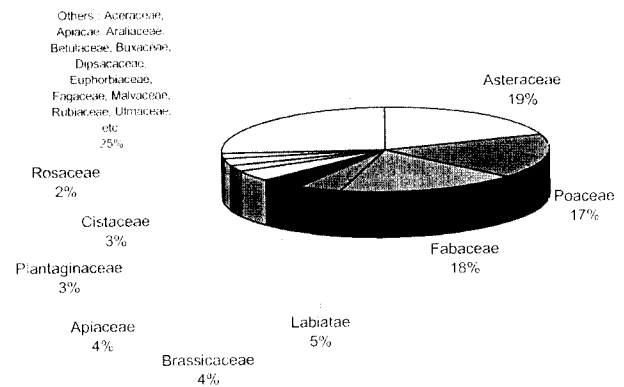


Fig. 2. Distribution of families for species involved in our studies.

4. a good perennation.
5. a good capacity to reproduce by seeding.

In the early 90' s, roughly 60 species (amongst the 110) were harvested by hand in their natural habitat. Some species were straight away used for revegetation and nearly 40 were sowed for cultivating. At this stage some problems arose . One of these problems was that in many species the scattering of seeds occurs right after physiological maturity (most species domesticated by man were selected to loose this trait). In which case harvesting by hand or machine is very difficult because the seeds may have scattered overnight. Another problem is the phytosanitary treatment of the cultivations. For, in fact, there may not exist any references on how to grow these wild species.

Today, 20 species, out of the 110 selected are produced by two companies and are regularly used for revegetation in the south of France. This being what we named wild cultivated species.

Table 1 shows a comparative list of the species used. It demonstrates that the price of industrially produced species is much less than that of native species or that of wild cultivated species.

Over the past 10 years, we have recommended the use of native and wild cultivated species for large revegetation sites

Table 1. Example of used species for revegetation in France and approximative price of seeds

Type of species	Name of species	Approximative price (USD per Kg)
Industrially produced species	<i>Lolium perenne</i> L.	2
	<i>Festuca rubra</i> L.	2.5
	<i>Dactylis glomerata</i> L.	3
	<i>Medicago sativa</i> L.	3.5
Native species, hand harvested.	<i>Coronilla glauca</i> L.	80
	<i>Bupleurum fruticosum</i> L.	120
Wild cultivated species. Most commonly used species	<i>Sanguisorba minor</i> Scop.	6
	<i>Plantago lanceolata</i> L.	6
	<i>Achillea millefolium</i> L.	13
	<i>Anthyllis vulneraria</i> L.	25
Wild cultivated species. Saxicoline or rupicolous species, used on the poorest and rockiest substratum	<i>Saponaria ocymoides</i> L.	70
	<i>Thymus vulgaris</i> L.	100
	<i>Centranthus ruber</i> (L.) D.C.	220
	<i>Salvia officinalis</i> L.	50
	<i>Helichrysum stoechas</i> (L.) Moench . (approx 10 millions of seeds per Kg)	850
	<i>Sedum sediforme</i> (Jacq.) Pau . (approx. 10 millions of seeds per Kg)	850

along highways in France.

Revegetation in the Mediterranean region

In the Mediterranean region, edaphic and climatic constraints are very hard on plants. The climate is very hot and dry in the summer, and in that season most plants are in physiological rest. The substratum is more often than not calcareous and very permeable and the soils are not very developed. When a road is built, the rubble is often without soil and very rocky. The embankments can be very steep and sometimes form vertical walls (cliffs). Such conditions are often very different from the nearby ecosystems. The objective of revegetation is to obtain an ecological rehabilitation, so that we create an autonomous ecosystem.

The procedure follows as such: search of the surroundings for old road embankments or abandoned quarries and drawing up an inventory of the local flora. The aim of this inventory will be to help establish a list of species to be used for revegetation. In these environments the majority of species are adapted to dryness and rock substratum.

The originality of our approach consists in defining a mix of seeds from various species with different characteristics. The mix contains herbaceous and ligneous species, saxicoline or rupicolous species and species with a wider ecological spectrum (cosmopolitan species, such as *Plantago lanceolata*). This mix of seeds uses the three previously mentioned types of species (industrially produced species, native species and wild cultivated species), it will allow a vegetation succession towards a lasting ecosystem. This succession is described in 4 stages.

The first stage is mainly dominated by an herbaceous vegeta-

tion made up of species with a wide ecological spectrum (*Plantago lanceolata*, *Sanguisorba minor*, *Lotus corniculatus*, etc.). This stage being a transitory step, it will last generally less than two years.

The second stage is dominated by the rock adapted and shrubby species (*Thymus vulgaris*, *Saponaria ocymoides*, etc.). These species begin to dominate only 2 to 3 years after sowing.

The third stage is dominated by shrubs, it begins 4 to 5 years after sowing. The main species will then for example be *Coronilla glauca* et *Spartium junceum*.

It will take 5 years for the first young trees to appear (for example pine trees) out of the sowing (fourth stage).

We wish our approach to be a pragmatic one, half way between industrial revegetation with less costly species and revegetation with native species which are far more costly and is harder to achieve. This approach still reflects the idea of ecological rehabilitation, because it aims to rebuild an autonomous ecosystem, adapted to the environmental conditions.

The following Plates (2 to 5) show different stages of the recolonisation on a side road embankment over one year assessment.

Plates 6, 7 and 8 show details of the vegetation state over time.

Lebanon, a landmark for ecological rehabilitation.

Awareness to the environment is only recent in Lebanon, it started only in the 90' s. The ministry of the environment was created only in 1993 and since various actions have been led on environmental issues. Lectures on the environment were in all the school programs only after 1997.

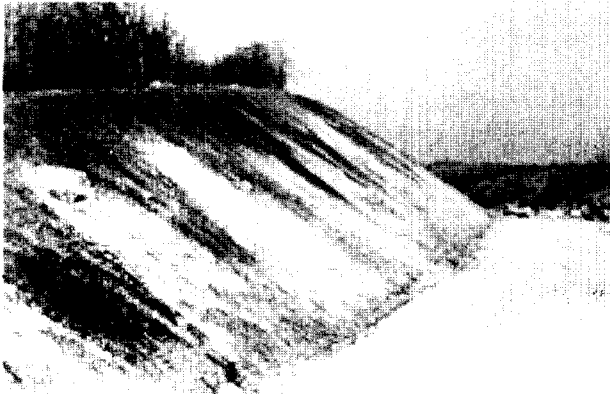


Plate 2. Newly created embankment before revegetation process. You can see that few quantities of ground was brought back on the top of the embankment while the bottom remained stony.

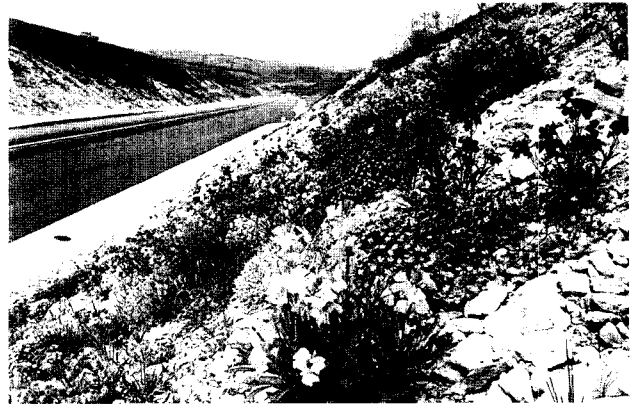


Plate 5. A section of the same site, one year after sowing in early summer. The flowered plants are saxicoline species.

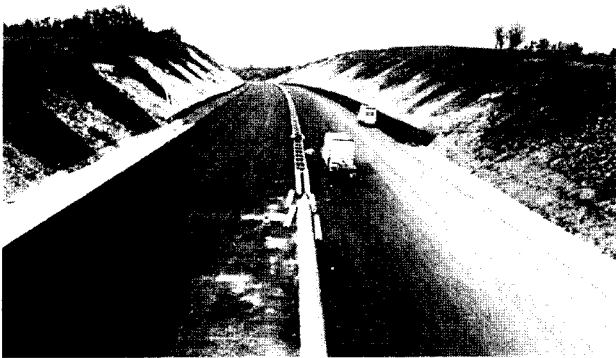


Plate 3. The same site, one month after sowing in spring. Plantlets appeared on zone covered with ground.

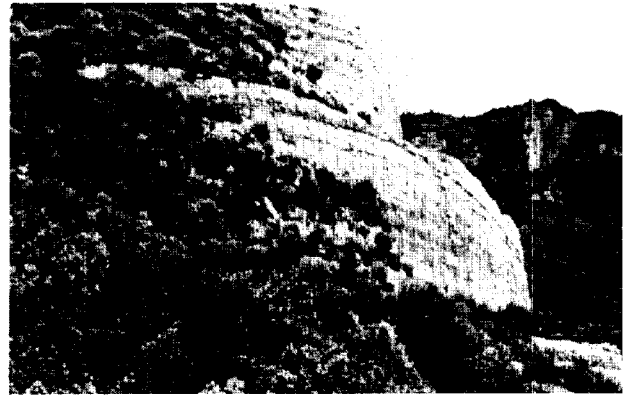


Plate 6. 4 years after sowing on a rocky place in south of France. *Centranthus ruber* in front and *Coronilla glauca* (with yellow flowers) in back. In this case, *Centranthus ruber* is from wild cultivated species, and *Coronilla glauca* is a native species (hand harvested).

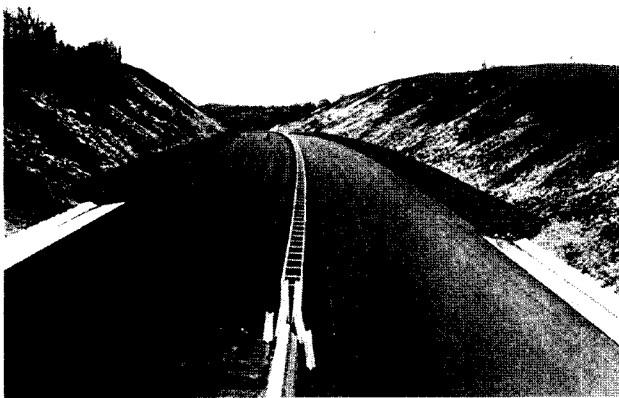


Plate 4. The same site, one year after sowing, in early spring. The vegetation colonize the stony zones.



Plate 7. 5 years after sowing. From the left to the right : *Pinus halepensis* plantlet, *Thymus vulgaris*, and *Sanguisorba minor*.

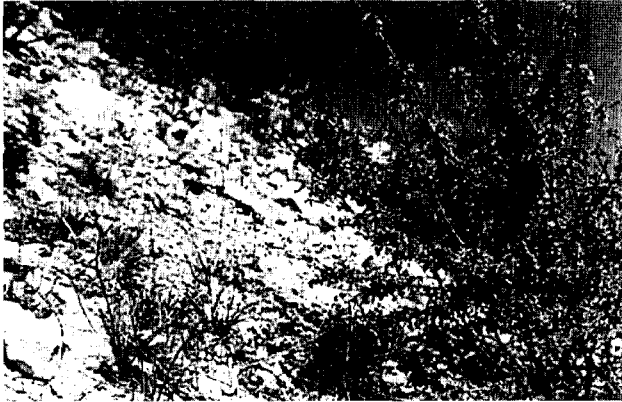


Plate 8. *Cercis siliquastrum*, 20 years after sowing along a highway in south of France near Spain. The embankment is not completely covered by vegetation, nevertheless, roots stabilize the soil and the side road is completely integrated into the landscape.

Lebanon and more particularly the coastal strip has suffered the consequences of a fast pace urbanizing during the last two decades. Some coastal towns¹ have witnessed an increase by 15 fold between 1970 and 1990 only. To insure the development of such town planning, an impressive number of quarries have opened, particularly on the western side of Mount Lebanon chain. The map 1 shows us the allocation of the distribution of the quarries in the Country, you can notice the high concentration of quarries on the western side of Mount Lebanon. In 1997, the directing plan for quarries imposes by law to stop exploiting all quarries up until an organised environmental management is set up.

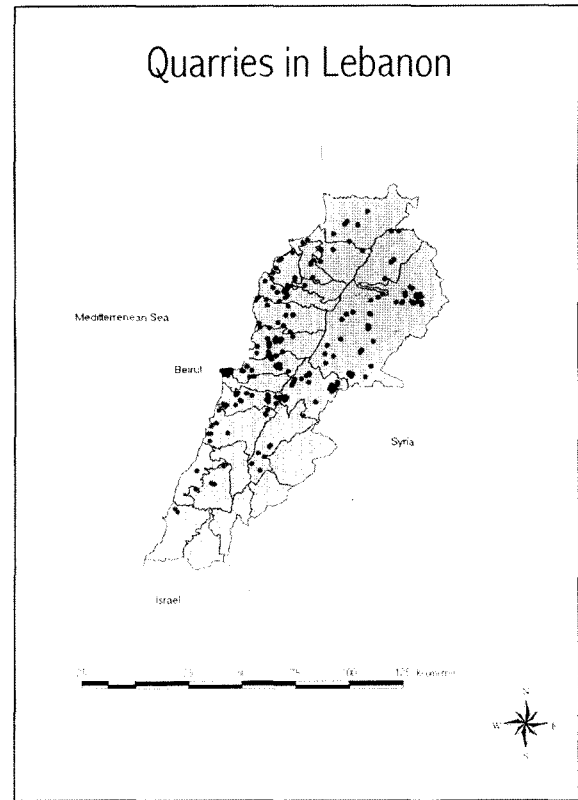
Nowadays permits for the exploitation of quarries are submitted to strict constraints. Many quarries have been abandoned which in turn means serious erosion problems, causing visually aggressive landscapes..

According to an official report from 1996, the total number of quarries amounts to 710 (Dar el Handassah, 1996), which is a considerable amount for a country of this size: 10 452 km².

These quarries are situated in very varying bio climatic areas due to the country's topography which rises from sea level to over 3,000m high. The vegetation level range from thermo Mediterranean to oro Mediterranean going through dry landscapes. Most quarries are situated between the thermo- and supra-Mediterranean levels, between 100m and 1500m high with a yearly pluviometry of 500mm to 1,500mm.

We have orientated our research on two working axis.

1. a detailed analysis of the vegetation that spontaneously colonises the quarries.
2. the creation of a Geographical Information System comprising data about the vegetation, climatology, geology and



Map 1. Distribution of Quarries in Lebanon.

quarries.

Our methodology is the following:

1. Establishment of a typology of the quarries in Lebanon (physical characteristics, climatic and socio-economical) in order to direct interventions for ecological rehabilitation of these sites.
2. To set up guidelines for rehabilitation interventions on debased areas in Lebanon with the possibility of extending this to the Mediterranean region.
3. Analysis of the adaptive strategies of the plants in a disturbed environment along with the succession mechanisms on strongly constrained areas of Lebanon: germination, survival, reproduction, scattering, etc.
4. Identification and setting up of different scientific tools and techniques to initiate the development of the revegetation by hydraulic sowing on debased areas in Lebanon.

The Table 2 shows a list of species best suited for revegetation. These species have been chosen for being the most commonly encountered after the first analysis was concluded concerning the pioneer species of the quarries.

¹ Since 1973, the Beyrouth Charta notified that the Mediterranean coasts were quickly becoming urbanized, leading to an increase of 100 to 200 million inhabitants between 1973 and the XXth century (Dejeant, 1985).

Table 2. A list of species best suited for revegetation in Lebanon

Species	Family	Life form
<i>Smiranium connatum</i> L.	Apiaceae	Herbaceous, perennial
<i>Phagnalon rupestre</i> (L.) DC	Asteraceae	Shrub, chamaephyte
<i>Ptilostemon chamaepeuce</i> (L.) Less.	Asteraceae	Shrub, chamaephyte
<i>Ptilostemon diacantha</i>	Asteraceae	Shrub, chamaephyte
<i>Capparis spinosa</i> L.	Capparidaceae	Shrub, chamaephyte
<i>Cistus creticus</i> L.	Cistaceae	Shrub, chamaephyte
<i>Lotus corniculatus</i> L.	Fabaceae	Herbaceous, perennial
<i>Medicago polymorpha</i> L.	Fabaceae	Herbaceous, annual
<i>Spartium junceum</i> L.	Fabaceae	Shrub, chamaephyte
<i>Trifolium stellatum</i> L.	Fabaceae	Herbaceous, annual
<i>Cercis siliquastrum</i> L.	Fabaceae	Tree
<i>Origanum syriacum</i> Sieb.	Labiataeae	Herbaceous perennial
<i>Salvia triloba</i> Mill.	Labiataeae	Shrub, chamaephyte
<i>Stachys distans</i> Benth	Labiataeae	Herbaceous, perennial
<i>Alcea setosa</i> (Boiss.) Alef.	Malvaceae	Herbaceous, perennial
<i>Glaucium flavum</i> Crantz	Papaveraceae	Shrub, chamaephyte
<i>Plantago lagopus</i> L.	Plantaginaceae	Herbaceous, perennial
<i>Plantago lanceolata</i> L.	Plantaginaceae	Herbaceous, perennial
<i>Avena sterilis</i> L.	Poaceae	Herbaceous, annual
<i>Oryzopsis miliaceae</i> (L.) Ascheron & Schweinf.	Poaceae	Herbaceous, perennial
<i>Sanguisorba minor</i> L.	Rosaceae	Herbaceous, perennial
<i>Centhranthus ruber</i> (L.) DC	Valerianaceae	Herbaceous, perennial

The seeds of these species were gathered in their natural habitat and are currently in a germination test phase in order to start up future production projects of wild cultivated species.

CONCLUSION

In the international context of the preservation of the ecosystems, many disciplines focused on the conservation of biodiversity. Truman (2000) states that restoration ecology will play, on the long run an essential complementary role to that actually played by conservation biology in this biodiversity crisis.

Nevertheless studies have focused on many applications concerning revegetation operations in many different conditions. The use of well suited, adapted species as well as native species has proven better efficiency in revegetation processes instead of commercially available grasses in the reclamation of metalliferous mines wastes (Tordoff & al., 2000), as well as in the rehabilitation of disturbed arctic sites (Forbes & Jefferies, 1999). Moreover, site rehabilitation should take into consideration not only the selection of the species to be used but also all the geomorphological aspects of the site, especially in sand quarries (Martin Duque & al., 1998). Thus, ecological rehabilitation is rather a global approach of the environment especially in Mediterranean countries where it implies a "co-evolution" of man in his surrounding landscape (Naveh, 1988; Zavala & Burkey, 1997).

Our experiments fall in the field of global rehabilitation ecology than in restoration *sensu stricto*. In fact, rather than restricting our approach to the conceptual part of restoration, we aimed at its workable aspect, trying to position ourselves at the interface between theory and feasibility.

Our results come from operational sites such as side roads and railways embankments (in France) or abandoned quarry sites (ongoing study in Lebanon).

These "real scale" experiments are not yet published probably because we still are far from scientific experimental fields and laboratories. Nevertheless, they allow to conclude on the major role played by the use of wild cultivated species in comparison to native species or industrially produced seeds.

Integrating those "real scale" results in a conceptual ideal for ecological restoration may reduce the gap between these two fields in order to best contribute to conservation of biodiversity.

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