Restoration Cases Flagship Collection

Case #6:

FLR in the Shouf Biosphere Reserve, Lebanon

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Contents

Restoring agricultural land in the Shouf.
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In brief

Overview

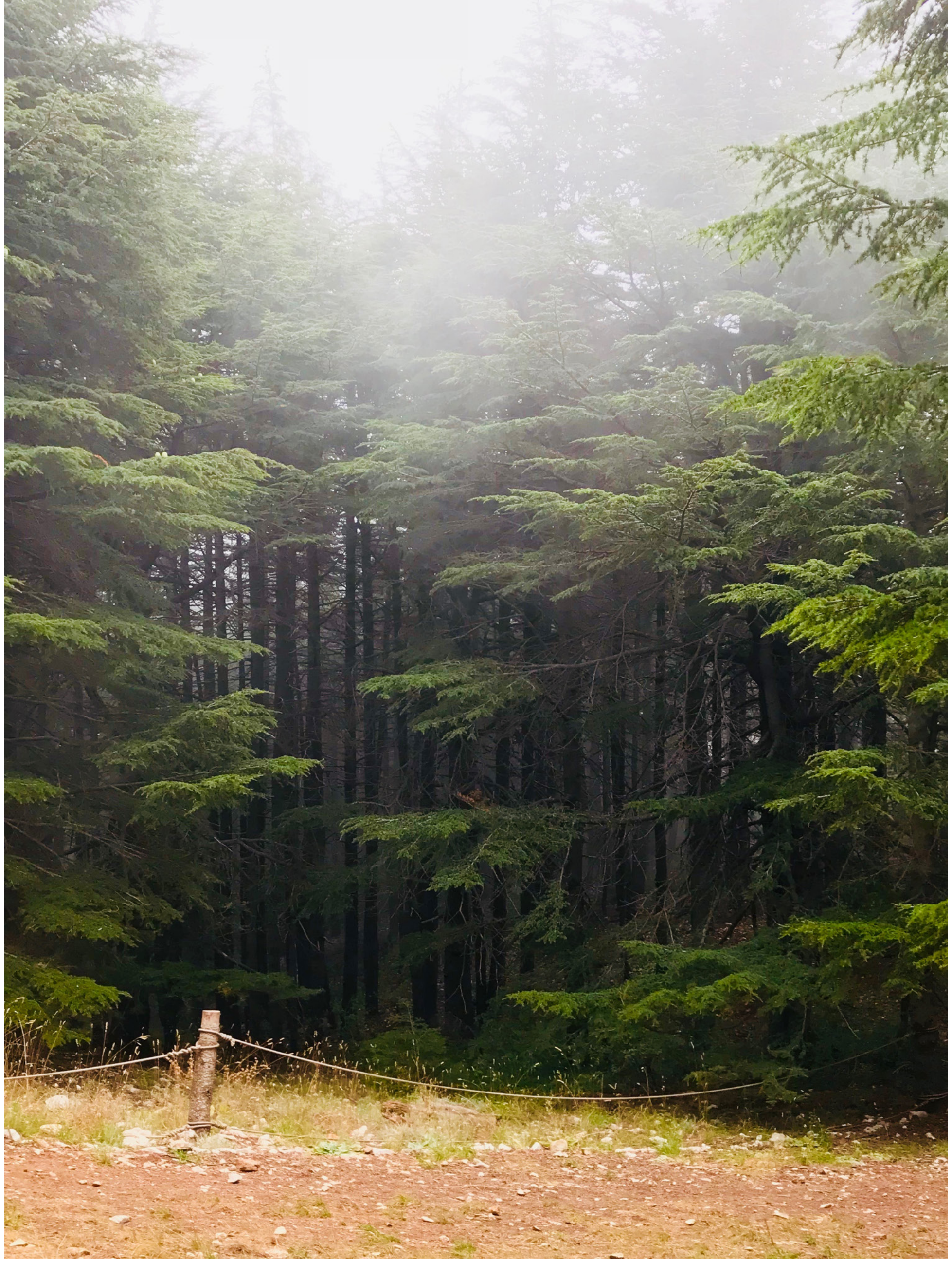
The Lebanese government initiated an extensive forest and landscape restoration (FLR) project in the Shouf Biosphere Reserve (SBR), Lebanon. The SBR spans ~50,000 ha of mountainous topography along the Mount Lebanon range. Home to a quarter of Lebanon's remaining cedar forests, it is highly diverse with a mosaic of different land covers created by a long history of traditional agrarian practices. Restoration was initially undertaken to restore and conserve the region's biodiversity but quickly evolved to include economic and social goals given the needs of the region. The Al-Shouf Cedar Society (ACS), formed originally to manage the Shouf biosphere reserve, was the main implementation partner. By piloting forest restoration and management interventions that provided synergistic environmental, social, and economic benefits, they demonstrated how FLR could address many challenges the region was facing.

Exemplary Practices

The ACS made exceptionally good use of pilot projects and demonstration plots. Pilots for each type of intervention were implemented with the appropriate stakeholders to demonstrate outcomes. Demonstrating results encouraged farmers to restore terracing and plant trees on private lands, changed government management regimes of overstocked secondary forests, and influenced policy to facilitate future interventions. Building capacity and providing support for all relevant groups at each step of the restoration process was essential to success: for example, they provided support for producing high-quality tree seedlings all the way through finding markets for tree-based products. A three-tiered governance structure with a larger coordinating body, a general implementation and management body, and local stakeholder groups allowed the project to promote policy change and remain coordinated while ensuring that each intervention met local needs.

Key lessons learned

- *Pilot/demonstration sites were essential for bringing local peovple, policy makers, and donors on board with activities and promoting their spread.*
- *FLR should be economically sustainable and costs should be recovered.*
- *Provide continuous support (technical and financial) from beginning stages to when an intervention can be self-sustaining.*
- *Promote continuous capacity development by "training the trainers" to teach peers.*
- *Restoration is an iterative process, learning by doing and using applied research to achieve success.*
- *Interventions should have economic, social, and environmental benefits that go hand-in-hand and should be demonstrated from the beginning.*



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Restoraton narrative

Background and context

The Shouf Biosphere Reserve (SBR) in Lebanon was established in 2005 and spans ~50,000 ha of mountainous topography along the Mount Lebanon range. Historically, sub-humid temperate Mediterranean forest[1] covered most of the area, which ranges from 1100–1900 masl (Hani et al., 2019). The Reserve is also highly biodiverse, containing at least 1,070 vascular plant species (25 of which are threatened), 275 bird species, 32 mammal species, and 31 species of reptiles and amphibians (Hani et al., 2019). The reserve is bordered by the Mediterranean Sea to the west and the Beqaa Valley to the east (longitude 35˚28’ to 35˚47’E and latitude 33˚32’ to 35˚48’N) (Figure 1).

The SBR has a long history of agricultural, pastoral, and forest use, and contains several archaeological, historical, and religious heritage sites. Tree worship is a traditional cultural practice, and several tree species have important ties to local cultures. Lebanese cedar trees (*Cedrus libani*) are found throughout the Shouf region—the SBR houses 25% of the remaining cedar forests in Lebanon—and have cultural, religious, mythological, and medicinal importance. Oak forests contribute significantly to both traditional livelihoods and ecosystem services, including “oak honey” (made from oak honeydew), acorns as food for livestock, and slow-burning firewood for heating homes. In this steep landscape, farmers traditionally terraced fields to prevent soil loss and enhance water retention. Terraced landscapes were often cultivated with useful trees such as mulberry for the silk trade, olives, walnuts, and fruits. Several agricultural practices still used today have ancient roots, including beekeeping and livestock herding. Herders and livestock moved from upland to lowland and vice-versa, influencing long-term ecosystem structure.

Restoring agricultural land in the Shouf.
Source: http://www.mediterraneanmosaics.org/gallery/

[1] *Supra-Mediterranean below 1500m asl and in the mountains to Oro-Mediterranean in the upper mountains.*

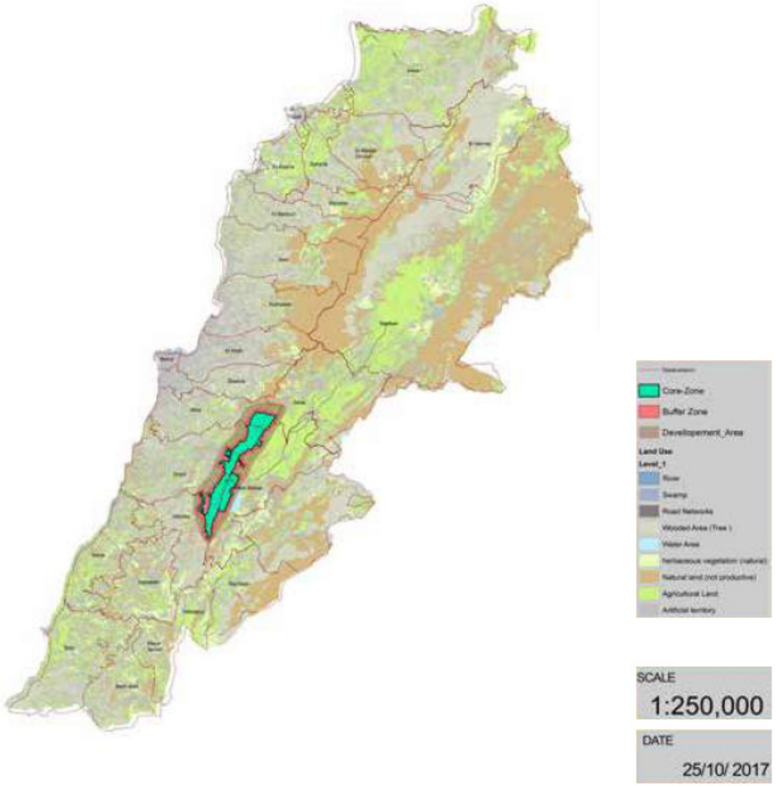
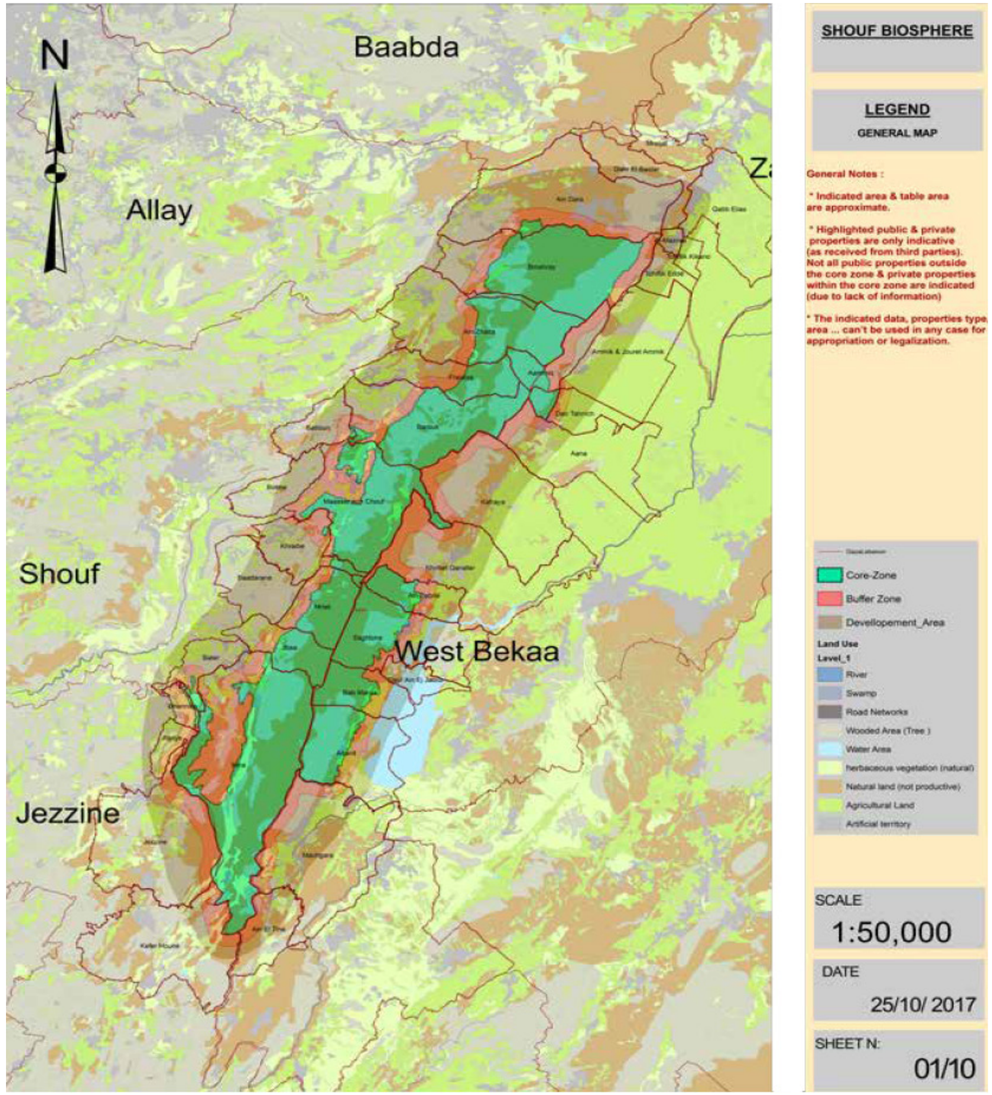


Figure 1. The Shouf Biosphere Reserve location within Lebanon (Below and to the left). Source: Hani et al., 2019



The landscape—forests, pastures, and agriculture—has been under intense and growingly unsustainable use for thousands of years, but in recent years deteriorating soils and a lack of local employment led many households to migrate for work and send home remittances, thereby increasing urbanization (Hani et al., 2019). Political instability in the region and weak legislation/enforcement made tenure systems unclear, and the formal creation of the SBR in 2005 (encompassing Al-Shouf Cedar Nature Reserve created in 1996) also caused concerns around land tenure as farmers claimed it infringed on their land and rights to farm.

[2] Both oak and cedar honeys are made from a honeydew that aphids release. The aphids consume the tree sap, digest it, and then expel this drop of honeydew which the bees then consume and use to make their honey.

These changes led to the loss of traditional cultural practices and customary governance around land use. In particular, farmers abandoned terraced farming, which led to soil degradation and reduced water retention. Intensified apple production—which was deemed more lucrative than traditional crops—also caused both water and soil pollution. Coinciding with a loss of traditional practices, an increase in the remittance economy, and lax enforcement of development regulation, was a sharp increase in development, including mining and building houses, further displacing agricultural and forest lands.

Baseline conditions

The Shouf Biosphere Reserve (SBR) in Lebanon was established in 2005 and spans ~50,000 ha of mountainous topography along the Mount Lebanon range. Historically, sub-humid temperate Mediterranean forest[1] covered most of the area, which ranges from 1100–1900 masl (Hani et al., 2019). The Reserve is also highly biodiverse, containing at least 1,070 vascular plant species (25 of which are threatened), 275 bird species, 32 mammal species, and 31 species of reptiles and amphibians (Hani et al., 2019). The reserve is bordered by the Mediterranean Sea to the west and the Beqaa Valley to the east (longitude 35˚28' to 35˚47'E and latitude 33˚32' to 35˚48'N) (Figure 1).

The SBR has a long history of agricultural, pastoral, and forest use, and contains several archaeological, historical, and religious heritage sites. Tree worship is a traditional cultural practice, and several tree species have important ties to local cultures. Lebanese cedar trees (Cedrus libani) are found throughout the Shouf region—the SBR houses 25% of the remaining cedar forests in Lebanon—and have cultural, religious, mythological, and medicinal importance. Oak forests contribute significantly to both

Agriculture was a primary source of income for about 20% of the households in the region, while about half were employed as civil servants or in private enterprise. Farm size averaged ~2.5 ha (range of 0.5 to 30 ha), and most farmers engaged in horticulture and tree crops (apples, olives, cherries, peaches, pears), with some apiculture, floriculture, and harvesting of wild plants. Some farms also raised cows for milk. While many people practiced some agriculture to supplement their income, increasingly people left their villages and traditional agricultural practices for urban jobs. Out-migration was largely due to an aging population, degrading soils, prohibitive input costs (e.g., large amounts of commercial pesticides and fertilizers), and ineffective marketing strategies for local goods. Political instability also impacted economic and livelihood activities, and high unemployment led to increased migration (permanent to abroad, and temporary/seasonal) and dependence on remittances. Remittances also fuel uncontrolled urban development, as many people used remittances to build new houses without sufficient regulation or planning. Urbanization caused soil, water, and air pollution; eroded soils and fragmented habitats; and increased the risk of fire.

The SBR also hosts about 57,000 Syrian refugees, mostly on the eastern side of the reserve. Refugees are largely dependent upon limited humanitarian aid and there are high levels of unemployment, although some practice agriculture.

The turning point

The Lebanese government created the SBR because of its high biodiversity value and presence of remnant old cedar forests in Lebanon. They set up the Al-Shouf Cedar Society (ACS) to manage it. As the ACS began to engage stakeholders in visioning and planning, it became apparent that social, rather than environmental, issues were front of mind for many—people were concerned with the lack of employment and economic development in the area, which subsequently led to heavy reliance on remittances. During the engagement process, the Syrian crisis and refugee influx began, which exacerbated these worries. The reserve became both a point of concern for local livelihoods and tenure, but also a potential opportunity to change conditions for the better. The forest and landscape restoration approach (FLR) is very well suited to this area, where managers are required to achieve and balance multiple environmental and socioeconomic goals and find solutions to acute problems to enable restoration.

Key to the success of the reserve was to tailor FLR interventions to address pressing local needs, and to clearly demonstrate that both ecological and social benefits can be achieved. Without demonstrating economic and social value, managers knew that it would be impossible to raise the interest, buy-in, and active involvement of people. "At a certain point, people stop being interested in restoration for environmental reasons alone. Without clear economic opportunities, people will listen, but after a while stop listening. It is essential to raise the buy-in of local people in this context—they were not in a healthy economic position and were looking for initiatives to fuel economic growth and livelihood opportunities," says Pedro Regato, a senior consultant for ACS providing technical advice, coordination, and training since the beginning of the project. The ACS demonstrated the benefits of restoring/keeping mountain ecosystems intact, and showed that biodiversity conservation is linked to people's lives. In all interventions they sought to find synergies between environment, social, and economic benefits. For example, they chose tree species for restoration by analyzing their social and ecological values. Because fire was a major concern, they used biomass management and reducing fire risk (e.g., by reducing the burning or accumulating of agricultural waste) as an entry point for engaging people. Forming local businesses to use extra biomass to produce briquettes was another entry point: it created employment opportunities, reduced diesel consumption, and reduced the cost of energy, demonstrating that daily needs could be met and improved through conserving, managing, and restoring the landscape.

Demonstration projects, or pilots, were a crucial approach to engage stakeholders and build support for restoration activities. "We managed to change minds and change policies that were against climate change adaptation, resilience, through pilot demonstrations. We invited people to participate, to come and see what was happening. Afterwards, people were willing to replicate activity in other places on their land," says Regato. Pilots make the benefits visible and demonstrate how they are linked to local people's lives. Small and quick to undertake, pilots were also designed to demonstrate results often in only 1–2 years, catalyzing action and raising the attention of other donors to the project. The ACS was innovative and creative, taking advantage of opportunities and targeting places where results would be most visible and most likely to raise awareness. Pilots were implemented on both public and private land to demonstrate results; bring people on board; attract attention, support, and funding; and change policy. All demonstrated that restoration is not necessarily costly but can be a viable "business"—pilots generally included a business plan to show what the return would be after 1, 2, 5, and 10 years to show that restoration is not temporary and can be self-perpetuating. They were also used to demonstrate how policies should be altered to better support FLR interventions moving forward.

Actors and arrangements

Implementing organizations and groups were developed for the FLR initiative. Together, they undertook an extensive planning and stakeholder engagement process. Implementation actions were developed based on stakeholder mapping, field assessments, consulting with experts, local people and communities, and project partners, and were tailored to specific land cover and tenure regimes within the region.

Three groups were responsible for planning and governing FLR in the reserve. Two decentralized governance bodies were developed explicitly for the FLR program—The Alliance for the Green Shouf Biosphere Reserve (AGSBR) and Forest Management Committees (FMCS). Both of these were important for connecting and communicating the FLR initiative to different stakeholders, at different scales. Today, both groups are making action plans for continued work in this region.

The AGSBR—"an informal network" of 18 members representing all major stakeholder groups—oversaw broader implementation, coordination across municipalities, and planning at the whole reserve level and was important for leveraging resources for the achievement of the FLR long-term goals. The ACS was responsible for planning at the municipal level, implementing, and managing activities in the protected area. FMCS were formed in 16 municipalities to address specific elements of planning and implementation within each municipality. Each was composed of 7–12 members and included a range of stakeholder types. FMCS were also connected to each other to share experiences and knowledge, and high-achievers often inspired action from other FMCS. Capacity development was provided to members through the FLR initiative (see Developing capacity, below).

FLR actions were planned at the landscape level. The federation of municipalities was engaged in a mapping and visioning exercise to lay out boundary issues and existing and future development plans, and the AGSBR facilitated the high-level discussion about reserve and municipal boundaries. Following these higher-level workshops, a series of meetings and workshops were held at the municipal level to engage local stakeholders and help project managers understand the unique goals and needs of each region, including details about the level of land degradation, land tenure, and so forth. Specific maps and plans for FLR were developed at the municipal level.

Planning and engagement

Engaging stakeholders was a critical component of the FLR program. From the start, the ACS was careful to include groups affected by the project both directly and indirectly, including both those in favor of and opposed to it (Hani et al., 2019). Key participants included farmer cooperatives, politicians, representatives from the tourism sector, forest and agricultural extension staff, small to medium business owners, school groups, and NGOs (see Appendix 1 for a more comprehensive list).

Municipal councils recruited participants for visioning events where the FLR project was introduced. "The ACS team introduced the FLR rationale, objectives, and methodologies to all the identified stakeholders, and sought information regarding their views, concerns, needs, and interest to be part of the FLR process in the SBR landscape. Consultation followed a gender- and age-sensitive approach, targeting separately women and men, and understanding the different realities of young and older populations" (Hani et al., 2019, p. 81). Efforts were made to include and empower women and minorities, including Syrian refugees (Hani et al., 2019). Since vulnerable populations were often challenging to reach to engage and inform of FLR opportunities, they used the United Nations High Commission for Refugees registration and records to contact Syrian refugees and the National Poverty Targeting Programme to identify families receiving food assistance.

A series of objectives were created based on the overarching goals of the ACS and the stakeholder engagement exercises, each integrating ecological, socioeconomic, and cultural resilience:

1. Enhance ecosystem services from the SBR area through conserving, managing and restoring its ecosystems using tested and also innovative practices.
2. Empower institutional and grassroots actors in the SBR landscape to sustainably manage, conserve, and restore natural and semi-natural ecosystems
3. Promote green growth through economic diversification and development of value chains for organic agriculture, livestock, and forest products, based on the appeal of the local identity.
4. Mainstream FLR best practices into policies and regulations concerning natural resources management and spatial planning in the SBR landscape, through policy dialogue.

Based on the mapping exercise, field assessments, and consultation with experts and project partners, FLR priorities to meet these objectives were identified in different land use and cover types.

ACS engaged international assistance to provide advice, scientific guidance, training, and technical support to develop the FLR program development and implementation, and to identify how best to improve water resources, agroforestry systems, and otherwise support implementation. They also hired two national organizations to assess water resources in the region, the impact of climate change on the landscape, and ways to restore agriculture and forests given local conditions and needs.

ACS created and distributed brochures and videos in municipalities, workshops, schools, local festivals and in meetings with ministerial staff, research organizations, aid agencies, and the corporate sector to communicate project goals and benefits. These highlighted progress and successful experiences from pilot projects and early implementers to demonstrate the potential of FLR and inspire others to participate.

The initiative used the Food and Agricultural Organization (FAO) of the United Nations Monitoring and Reporting Tool to monitor FLR pilot interventions in several municipalities. Monitoring was conducted at the municipal level, with different monitoring goals and strategies developed for different interventions.

Costs and funding

Restoration using native tree species cost about US$2.50-3.00 per planted seedling (including seedling production ($1.00 each), seedling transfer, soil preparation, planting seedling). An average density of 700 seedlings/ha cost US$1,750-2,100/ha depending on the site (e.g., slope, soil rockiness) (Hani et al., 2017).

Funding was provided by International and National sources including aid agencies, donors, and private companies including the European Union, MAVA Foundation, Italian Agency for Development and Cooperation, United States Agency for International Development (USAID), German Federal Ministry for Economic Development Cooperation (BMZ) through World Food Programme (WFP), FAO, and a number of private sector companies: Middle East Airlines, Byblos Bank, Porches Club Lebanon, Khalil Fatal and Sons, Advanced cars, Lycee National Schools, Four Seasons Hotel, HSBC Bank, and Patchi.

Implementation and outcomes

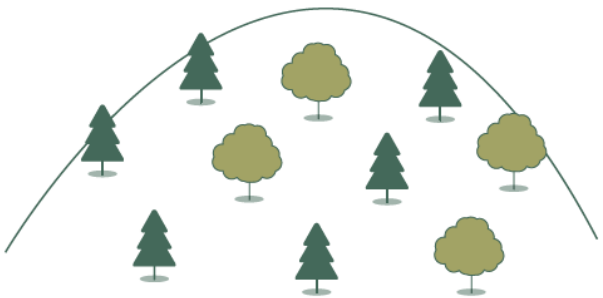
The ACS began the FLR project in 2012, and implementation is ongoing. Capacity development was critical for the success of the project. The ACS developed an FLR team with expertise to meet project goals, including: coordinators for field restoration and capacity development, a value chains and monitoring coordinator, two project assistants, a technical expert in field implementation, a monitoring and evaluation expert, an engineer in green infrastructure development, and administration and procurement staff. They also employed rangers and maintenance staff, and worked with volunteers for implementation. The first implementation step was to further build the capacity of this team while fostering a culture of problem solving and innovation. Capacity building included developing technical expertise and training to facilitate the connection with local stakeholders. ACS also hired international assistance to provide advice, scientific guidance, training, and technical support on FLR program development and implementation, including bringing in experts from Spain to Lebanon every two months for training in producing high-quality seedlings, organic agriculture, and other topics. ACS also provided annual training courses for project staff on different FLR-related subjects (e.g., ecological restoration techniques, adaptive management of natural resources, development of value chains, lobby and advocacy for policy improvement, program development and implementation).

Capacity development was also an important outcome of the project. The project ensured that all local actors had access to the appropriate types of capacity building. Local people were engaged and trained as professionals in their respective areas of work, and trained to help others, promoting both local employment opportunities and the ongoing continuity of the project. At the municipal level, FMCS were tasked with overseeing elements of implementation, and ACS "trained the trainers", hosting workshops for FMCS members and other resource managers and land users on FLR activities such as planting trees, managing biomass, restoring terracing, constructing dry stone walls, etc. They also provided on site-training and subsequent field visits and support to set up nurseries, manage biomass, monitor outcomes, and other elements of field restoration (Hani et al., 2017). This capacity building had an important catalytic effect—pilots demonstrated the skills that the workers acquired through capacity building activities, which impressed donors and brought more attention to the project.

The goal of most SBR pilots was to generate both ecological and socioeconomic benefits that would make each activity attractive to local communities and landholders in their own right. This greatly facilitated the "exit strategy" as activities were designed to be profitable and attractive from the outset.

Many implementation elements and pilots involved planting trees to achieve specific goals. Trees were planted at densities of 500–800 seedlings/ha, with the higher densities on areas with deeper soils. Trees were staggered to maximize water retention and minimize runoff on slopes (Figure 2). Sixty ha across 19 different pilot sites were restored using ecological techniques (Hani et al., 2017). Practitioners planted 38 plant species with 9–12 species in each system (see Pilots, below). These were mostly native trees (see Appendix 2 for a complete list of species), and mostly seedlings except for cedars and oaks which were planted from seed (Hani et al., 2019). Another 18.5 ha of oak and pine forest land (*Quercus calliprinos* and *Pinus brutia*) were sustainably thinned and pruned to reduce fire risk and encourage native regrowth.

Trees were planted in five pilots to demonstrate how five distinct goals could be achieved (see Pilots 2–6, below) (Hani et al. 2017, p. 112–13). After an initial planting in 2014, tree mortality in most sites was high due to a drought (pine, cedar, juniper and oak seedlings were the most affected) and high seed predation in the case of oaks. Dead seedlings (about 2,000) were replanted in 2015 using improved seedling stock (see pilot 1). After three years, the critical period for seedling establishment, pilots generally showed high survival rates of between 75% to 99%, with the exception of some areas directly seeded with acorns.



Quincunx Pattern

Figure 2. Quincunx pattern of planting trees to maximize water retention on slopes. Trees are not planted in lines, but staggered to maximize water retention (the curved line represents the top of a hill or mountain) (From Hani et al., 2019, p. 157).

Pilot demonstrations were used to engage local landholders, policy makers, donors, and other stakeholders. Each involved generating social, ecological, and economic benefits, and all were implemented in areas that were most appropriate for each based on participatory mapping and planning. Several pilots and outcomes are described below.

Pilot 1 - Improving tree survival through nursery management:
Standard nursery trees had weak root systems and low survival rates. ACS staff learned how to cultivate seedlings with a solid root system that would allow them to overcome summer drought periods. Initially, these seedlings were seen as small and "unattractive," but after being planted, people were able to see increased survival rates firsthand—it was many times higher than those previously planted. Improving seedling stock demonstrated that forests could be restored without additional watering, which lowered restoration costs and made forest restoration more feasible and attractive. Improved stock management was integrated into forest restoration plans at the national level, and ACS began to receive requests for training other nurseries to produce these seedlings (Hani et al., 2017).

Pilot 2 - Creating connectivity between isolated cedar stands:
A 6-ha area was planted with oak acorns (*Quercus calliprinos, Q. infectoria*, and *Q. brantii*) at 1800 masl to demonstrate that oak forests can effectively connect remnant cedar stands. Oaks can potentially facilitate cedar growth by reducing solar radiation, improving soils and water retention, protecting young regenerating cedars from herbivores, and eventually acting as nurse logs.

The survival rate of planted acorns was only 20% after three years (Hani et al., 2017). After an initial sowing in 2014 most were eaten by rodents. Implementers attempted to remediate this using small mesh wire boxes, which were ineffective, and individual plastic tubes, which were very effective at keeping rodents out while still allowing good germination and growth. The tube method showed 70-80% survival rate, significant as rodent predation can be a major problem for directly seed acorns (see Hani et al., 2019, p. 162 for a detailed description).

Pilot 3 - Enhancing tree and shrub diversity in high mountain forest habitats and facilitating upward climate-induced migration:

A site >20 ha characterized by steep limestone slopes, bare rock, and abandoned, unsuccessful terracing was restored between 1750–1925 masl. Prior to restoration with native trees, the site was sparsely vegetated with grass, low shrubs, and some small trees (including *Prunus ursina* and *Sorbus torminalis*). Planting included seeds and seedlings from dominant tree species (*Cedrus libani, Quercus brantii, Q. calliprinos*) and several companion small trees and shrubs (*Sorbus torminalis, Sorbus flabellifolia, Prunus ursina, Crataegus* spp., *Acer tauricolum, Malus trilobata, Pyrus syriaca, Styrax officinalis, Colutea cilicica, Cotoneaster nummularius*) to accelerate the recovery of the forest ecosystem, and planting techniques took advantage of the positive nursery-effect provided by the existing small cushion shrubs and junipers. Following restoration, seedling survival rates were upwards of 90% after three years.

Pilot 4 - Establishing "tree islands" for applied nucleation in overgrazed areas:

Species-diverse woodland islets were planted in degraded, overgrazed pasture land. The goal was to jump-start succession by providing a source of shade, seeds, and otherwise improving ecological conditions, and to improve pasture conditions especially during summer droughts (grass growth, increased soil moisture, and providing shade). Implementers planted fifteen 0.5 ha fenced sites in degraded pasture within the municipalities Fraidees and Barouk (1250–1500 m), Mrusti (1635–1680 m), and Baadarane (1135–1150 m) (Hani et al., 2017). Seedlings showed an exceptionally high survival rate of 95%, even without irrigation. The woodland islets technique holds great promise to restore other degraded pasture areas and demonstrated to the community (especially shepherds) that tree planting could simultaneously improve degraded pastures, increase biodiversity and livestock production, and enhance local livelihoods. "Once convinced of the benefits of the temporary enclosures, shepherds are usually ready to participate in the set-up and management of the fenced plots, with a reduction of the conflict between grazing and nature conservation in the Reserve" (Hani et al., 2017, p. 116). The species with the highest survival rates, *Crataegus monogyna, Sorbus flabellifolia*, and *Quercus infectoria*, attract seed dispersers and generate local livelihood opportunities including harvesting oak honey and wild fruit.

Pilot 5 - Restoring vegetation to abandoned quarry slopes:
The goal of this pilot was to demonstrate effective restoration practices for mining. The site was located in an abandoned limestone quarry. Seedling survival rates were very high, ranging from 85 to 95% after 3 years. Unlike in other areas, acorns did not experience high predation rates, likely due to the steep slope and loose debris in the area. Both directly sown seeds and seedlings were found to be effective at controlling erosion. The pilot demonstrated that restoration could be effective in previously mined areas elsewhere (Hani et al., 2017).

Pilot 6 - Protecting and restoring wetlands and diversifying wetland forests:
A pilot was undertaken in Ammiq (900 masl) where implementers planted seedlings, controlled grazing, and watered seedlings during summer droughts. The pilot was implemented in collaboration with private owners of the organic vineyards and other fruit tree crops bordering the Ammiq wetland. After three years the survival rate of planted trees was over 95%. Controlling grazing pressure and watering seedlings were critical to encourage fast seedling growth and survival. This pilot clearly demonstrated how private landholders can better manage wetland and riparian areas and raised awareness about the benefits of riparian forest conservation and restoration for maintaining both agricultural production and clean water supply (Hani et al., 2017).

Pilot 7 - Demonstrating the value of restoring agriculture terracing:
Traditionally, dry stone walls were used to prevent erosion and retain water in agricultural lands. Olives, fruit trees, vineyards and other crops grew on terracing. But when traditional agriculture was largely abandoned many came under disrepair, leading to soil erosion and a further deterioration of agriculture in the region (Hani et al., 2019).

To repair terraces, implementers removed loose stones from damaged areas, dug a trench (20–30 cm deep) and drainage system at the base of each wall, and rebuilt stone walls using reclaimed and new stones. Compost from waste biomass was added to the soil, and cultivated seedlings were planted while leaving natural forests and shrubs intact. Implementers created agreements with farmers to cover the cost of restoring a few hectares of terraced land. Farmers learned by doing, first restoring dry stone walls and then planting high value products. The project provided continuous support from start to finish, including connecting farmers to markets (the project established supportive partners in cities), key to its success.

This pilot demonstrated that abandoned land could be very productive. Around 150 ha of previously abandoned terraces were restored to produce fruit, olives, nuts, herbs, aromatic plants, and other locally adapted crops (Figure 3). They also showed that restoring terraces could both improve environmental conditions and provide income (Hani et al., 2020).

Pilot 8 - Reducing fires by managing forest biomass:
Fires were common in the SBR, especially in the fall when farmers prune their crops and burn the waste on the spot (Regato et al., 2020). Managing public forests in Lebanon requires government approval. Forestry officials are also often reluctant to allow new stand management techniques, which together made implementing biomass management in secondary forests difficult. The ACS dealt with this by piloting biomass removal in small areas and focusing on strips of forests along roads with higher fire risk and were thus easier to obtain approval to work in. The results were so positive that policy was altered to allow this type of stand management more broadly. Local landholders and other stakeholders were also invited to participate, and many were willing to replicate activity on their land.

Figure 3. Restored agricultural terraces planted with herbs, olives and native fruit trees. Source: Hani et al., 2019

Pilot 9 - Creating a local briquette production plant to make use of waste biomass and create an alternative energy source: :

A briquette plant was established near the village of Kfarfakoud. Waste biomass came from three activities: 1) thinning and pruning oak and pine forests for fire management, 2) olive pomace from olive oil pressing, and 3) pruning olive and fruit trees (Hani et al., 2019). A survey was conducted in 2013 to determine the available biomass resources and their potential to meet local energy needs. A sustainable harvest rate of 1000 tonnes/year of forest biomass was determined, which aligned with the amount needed for the briquette plant to meet maximum capacity in 2021 (Regato et al., 2020). There is abundant olive pomace (40% of the briquette) and prunings from fruit trees, and so wood (60%) is the limiting factor. Biomass collection was especially focused on areas prone to fire (e.g., the buffer zone of the SBR) (Figure 4).

Processing waste biomass into briquettes created jobs and local businesses; reduced pollution, energy costs, and CO2 emissions; and increased forest resilience. Thinning oak and pine woodlands—removing about 1000 tonnes of biomass each year—increased forest resilience by reducing competition for scarce water resources (Regato et al., 2020). Creating the plant and thinning forests also reduced the number of forest fires in the SBR, and reduced carbon emissions from both reducing fossil fuel use and forest fires (Regato et al., 2020).

Figure 4. Thinning forest biomass from fallow forests to reduce fire risk. Source: Encinas et al., 2015

Seasonal work collecting biomass from October to April employed ~100 workers (paid US$20/day) and five workers to manage the plant (average salary of US$600/month). The plant generates a profit of US$50/tonne of briquettes and is set to produce 5.6 million briquettes in 2021 (up from 1 million in 2013) (Figure 5). The predicted profit for 2021 is US$337,500. Part of the profits go back to manage and implement the FLR plan.

Energy costs were reduced by ~ two-thirds, because briquettes replace and are less expensive than diesel fuel, the main energy source (briquettes cost US$0.035/kWh versus US$0.11/kWh for the same heat generation) (Hani et al., 2019). Health problems and pollution caused by the burning of diesel or firewood in the home have decreased (Regato et al., 2020). It has also contributed to the “revival of traditional knowledge to produce charcoal from small tree branches commercialized for the local tradition of smoking waterpipe or shisha” (Hani et al., 2019, p. 195).

Figure 5. Briquettes produced from thinned biomass and olive pomace (Encinas et al., 2015).

Pilot 10 - Creating a waste treatment and composting factory (in Baadarane): :
The shreds from thinning oak and pine forests were also used to make compost for agricultural lands within the restoration site. This factory produced more than 400 tonnes of compost in 2018 (Hani et al., 2019) (Figure 6).

The ACS developed a hiking trail network of >480 km featuring sites of both high ecological and cultural value, which serves as both an ecotourism attraction and awareness-raising feature to promote sustainable management of the region (Hani et al., 2019, p. 88).

Figure 6. Compost production from the local briquette production plant.
Source: Hani et al., 2019

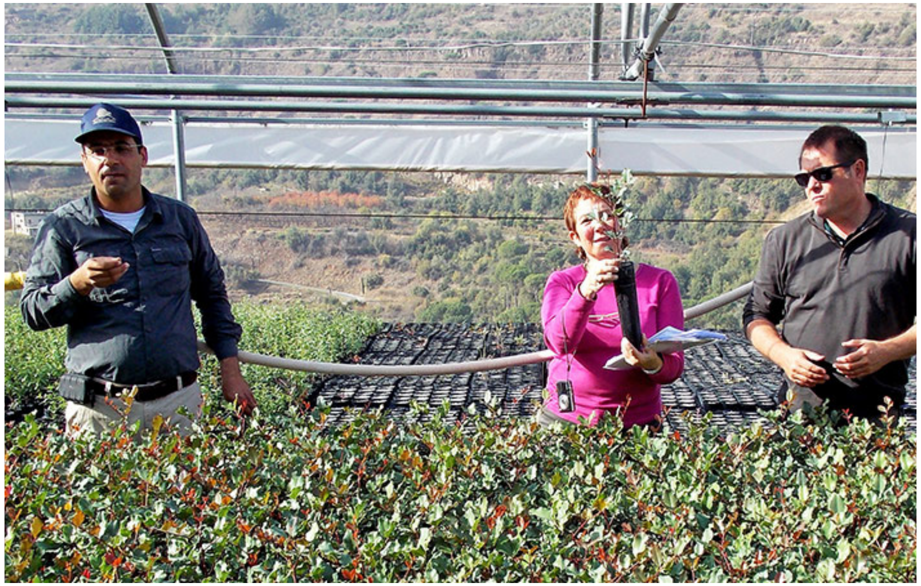


Figure 7. Examining seedlings in the nursery at Ramlieh, the main provider of seedlings for the FLR program.
Source: http://www.mediterraneanmosaics.org/gallery/

Key challenges

Tough economic conditions meant the idea of just creating a landscape that would be more ecologically resilient and attractive to the eyes of the visitors was not enough to convince people to participate and invest in restoration. Demonstrating social and economic value was needed to motivate and align restoration with pressing local needs (e.g., reducing fires, creating jobs).

Prior to the FLR project, typical seedlings available in the SBR were vulnerable to drought and had high mortality. The project then produced drought-tolerant seedlings with a solid root system, but these were seen as small and “unattractive,” and people did not want to use them. Pilots helped to overcome this challenge. Once people and agencies saw firsthand that survival rates were many times higher, the ACS began to receive requests for help training other nurseries to produce these seedlings.

Low rainfall, high temperatures, and longer than average drought periods posed a challenge for planted tree seedlings. Reducing water stress after planting, especially in the first year, is critical for restoration success (Hani et al., 2017). Using innovative soil and water conservation methods as well as higher quality seedlings and planting timing that matches ecological processes, planting techniques improved tree survivorship significantly (Hani et al., 2019).

Since the 1960s, Lebanon’s forestry sector has managed Lebanon’s forests on their own terms and were initially resistant to “ideas coming from the outside,” including practices proposed by the FLR project. Pilots showed that innovative FLR approaches (including planting timing, improved stock, and biomass management) produced visibly better results. Presenting the results of the pilots helped to engage the forestry sector in FLR and influence forestry practice elsewhere.

Laws in Lebanon governing forest management did not allow for certain management practices, including thinning and pruning of conifer forests. But after biomass-reducing demonstration pilots started to generate conversation, the government began to engage with the ACS, and after a few years of conversation made policy changes to facilitate these activities at larger scales in the future, including allowing management in pine forests to reduce fire risk.

Creating the SBR fueled disputes around boundaries between private lands (typically lower in the valleys) and municipal land (more often in the mountains). Changes to zoning implied restrictions and caused confusion and alarm for landholders. Disputes arose around boundaries between private land and municipal land, especially in (largely unused) remote mountain plots where people began claiming their rights to the land were being infringed upon by reserve activities. For example, when the restoration project started to plant trees, landowners sometimes protested that land selected was theirs. To address this problem, implementers mapped all the landowners in the area to prevent future disputes and identify which landholders owned the most ecologically sensitive areas and were most important to work with on sustainable opportunities (Figure 8).

Land tenure delineation and land-use regulation in the SBR

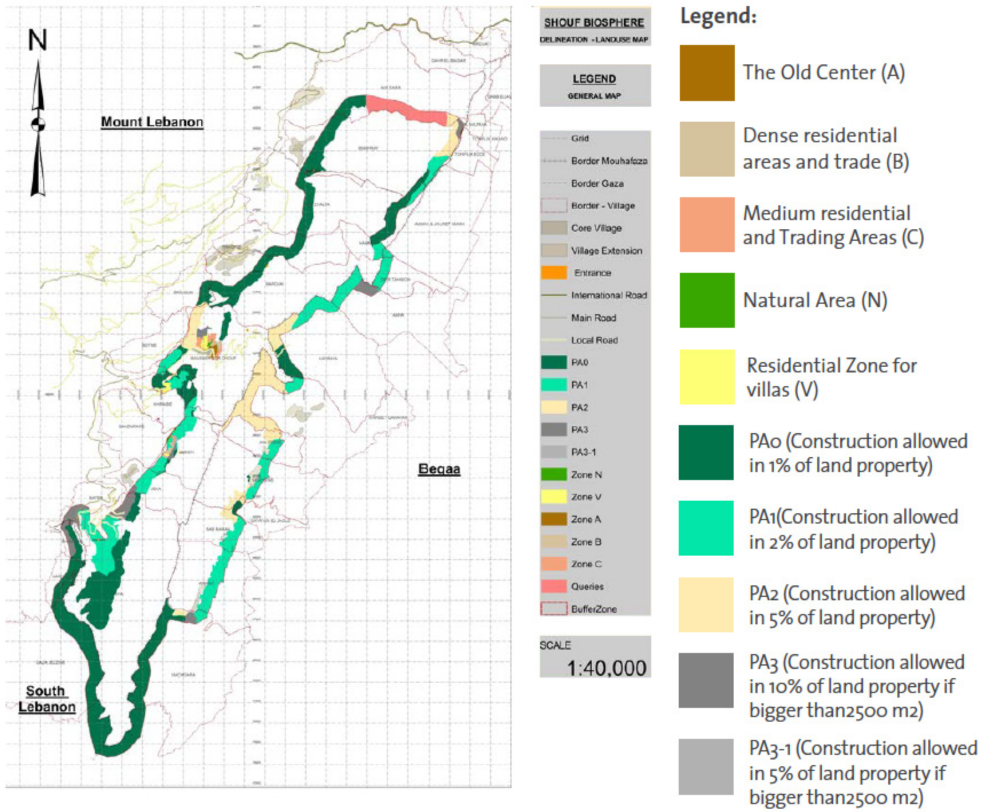


Figure 8. Map of results from land tenure delineation process in the SBR. Source: Hani et al., 2019

Enabling factors and innovations

The main enabling condition was that restoration was needed and that people came to recognize this. Deteriorating ecological conditions, including degraded farmland, high fire risk from overstocked secondary forests, and polluted waterways contributed to a lack of local employment opportunities and high reliance on external remittances. Using multiple, integrated approaches, FLR was able to improve these conditions and meet pressing local needs.

Practitioners also note that the culture in Lebanon lends itself to restoration. The country has suffered through decades of destruction, and the people possess a degree of resilience that has helped with the restoration effort. "If they destroy your house, the next day you are rebuilding it," says Pedro. They are an active society accustomed to taking matters into their own hands, provided it is a cause they believe in.

Figure 9. A cedar seedling being evaluated post-planting. Source: http://www.mediterraneanmosaics.org/gallery/

Although pilots and demonstration plots are often used in restoration, in this case, pilots were exceptionally well thought out from start to finish and carefully planned in strategic locations and with different relevant stakeholders. Outcomes were documented and showcased to a range of relevant stakeholders.

In the Shouf, capacity building was a central focus and was accomplished exceptionally. Implementers built capacity such that projects could be taken from start to finish (or from soil to market). They also provided ongoing support from start to finish for a given intervention. "Learning by doing" was a key part of their approach.

Helping communities to develop small businesses and having local entrepreneurs participate and lead training led to restoration that was economically beneficial, as well as having ecological and other social benefits. Ensuring that economic, social, and ecological benefits would be produced from each intervention—not just the project as a whole—provided both motivation and means for participation from many different stakeholders, in different ways. Demonstrating these benefits through pilots showed proof of concept and helped to get the word out.

Restoring agricultural land in the Shouf.
Source: http://www.mediterraneanmosaics.org/gallery/

Key lessons learned

- Pilot/demonstration sites can be a powerful tool to demonstrate benefits and bring people on board. Pilots were essential for bringing local people, policy makers, and donors on board with activities and promoting their spread.

- FLR should be economically sustainable, and costs should be recovered. Local business development or other activities should be developed that absorb the costs. Otherwise, if external funding becomes unavailable, the project risks failing. Start small and make sure there is a business plan.

- Provide continuous support from (*technical and financial*) beginning to when an intervention can be self-sustaining. For example, in the case of restoring terracing, support was provided from repairing stone walls through bringing goods to market and securing buyers for these products.

- Promote continuous capacity development, ideally through peers. For training and capacity building activities, rather than bringing in outside experts, ASC engaged people who have a small, successful business to train others in the same craft or activities (e.g., the production of aromatic plants). Many entrepreneurs were women, a strategic move to empower women in the community. Having local people in this role also creates continuity and allows for longer-term adaptive management and problem solving.

Figure 10. Seedling planting in process.
Source: http://www.mediterraneanmosaics.org/gallery/

- Restoration is an iterative process, incorporating learning by doing and using applied research to achieve success. Practitioners do not have all of the answers. It is important to test/experiment with different techniques, modify the strategy as needed, and test again. Otherwise, practitioners risk failing by not discovering what works. This process is both “learning by doing” and also “learning by research”—research as part of the learning process is a must.

- Interventions should have economic, social, and environmental benefits that go hand-in-hand and should be demonstrated from the beginning. Otherwise, projects will fail to motivate local communities. Communities want to know that there will be real economic and social benefits. An important exercise is thus understanding the priorities of people and where the locally meaningful values and benefits are.

Figure 11. Stone mulching after seedling has been planted
Source: http://www.mediterraneanmosaics.org/gallery/

Learn more

Further information and resources

Shouf Biosphere Reserve Website: http://shoufcedar.org/index.html

Mediterranean Mosaics Website: http://www.mediterraneanmosaics.org/mediterranean-mosaics-project/

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Appendix 1

Local, National, and International Stakeholders Identified by ACS Stakeholder Assessment and Mapping (Hani et al., 2019, p. 77-79)

Local	National	International
24 municipalities of the SBR; Federation of Municipalities of the Higher Shouf (Moukhtara)	Ministry of Environment; Ministry of Agriculture	IUCN Regional Office for West Asia; IUCN Centre for Mediterranean Cooperation
Deir et Kamar Forestry branch-offices, Ministry of Agriculture	Ministry of Finance; M. Interior & Municipalities; M. Energy & Water; M. Public Works & Transport	Private foundations MAVA Foundation pour la Nature, Ford Foundation, and Rotary Club
Al-Shouf Cedar Society (ACS)	Souk El Tayab	Italian NGOs: LIPU/BirdLife Italy and the Istituto OIKOS; Italian company ILEX
The SBR Appointed Protected Area Committee (APAC)	American University of Beirut; Lebanese University	The Royal Society for the Conservation of Nature of Jordan
Local NGOs: Green Orient, Friends of Green Environment, and Lebanese Home for Environment	NGOs: SPNL, AFDC, A Rocha Lebanon, Arcenciel, the Lebanon Mountain Trail Association	Mediterranean Centre for Environmental Studies (CEAM, Spain)
Land users: beekeepers, farmers, shepherds, and plant collectors	MORES s.a.r.l. consultancy firm	International experts on FLR, mainly from Spain
FLR-related enterprises: “Native Nurseries”; AFDC tree nursery; Kfarfakoud briquettes plant; women cooperatives	Eco-tour operators Responsible Mobilities, Lebanese Adventure, Esprit Nomade, Liban Trek	UN organizations: FAO, UNDP and UNESCO
Tourism operators, restaurants, guesthouses, hotel and hostel, local guides, and shops	Visitors to the SBR	International aid agencies: the European Commission, the Italian Cooperation, GIZ,
		USAID, SDC, AFD, WB and the embassies of donor countries such as Japan, USA, Finland, and Canada
Large agriculture-related enterprises, such as Kefraya winery	Lebanese Media (TV, radio, press)	Private companies: Middle East Airlines, Byblos Bank, Porches Club Lebanon, Khalil Fatal and Sons, Advanced cars, Lycee National Schools, Four Seasons Hotel, HSBC Bank, Patchi, Nestle
Land owners and citizens		Visitors to the SBR
Syrian refugees		
Public and private schools and education associations		

Appendix 2

List of Native Species Used During Restoration (replicated from Hani et al., 2017, p. 114)

Native plant species	Number of Seedlings
Acer tauricorum Boiss. & Bal.	325
Arbutus andrachne L.	50
Berberis libanotica Ehrenb.	500
Cedrus libani A.Rich.	10,595
Celtis australis L.	325
Cotoneaster nummularia Fisch. & Mey.	550
Crataegus azarolus L.	1,540
Crategus monogyna Jacqu.	1,235
Cupressus sempervirens L.	50
Fraxinus syriaca Boiss.	200
Gundelia tournefortii L.	20
Juglans regia L.	50
Juniperus drupacea Labill.	50
Lavandula officinalis Chaix	75
Laurus nobilis L.	50
Malus trilobata (Lab.) Schneider	825
Myrtus communis L.	25
Oryganum syriacum L.	1,275
Pinus brutia Ten.	300
Pinus pinea L.	775
Populus bolleana Lauche	450
Prunus dulcis (Mill.) D.A. Webb	75
Prunus prostrata Lab.	225
Prunus ursina Ky	625
Pyrus syriaca Boiss.	500
Quercus brantii subsp. look Mouterde	1,200
Quercus calliprinos Webb	505
Quercus cerris L.	200
Quercus infectoria Oliv.	100
Rhus coriaria L.	500
Salix alba subsp. micans (And.) Rech.f.	80
Salvia fruticosa Miller	225
Sorbus flabellifolia (Spach) Schneider	1,235
Sorbus torminalis (L.) Crantz.	2,135
Spartium junceum L.	300
Styrax officinalis L.	30
Thymbra spicata L.	75
Ulmus minor Mill.	475
Total	27,750

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