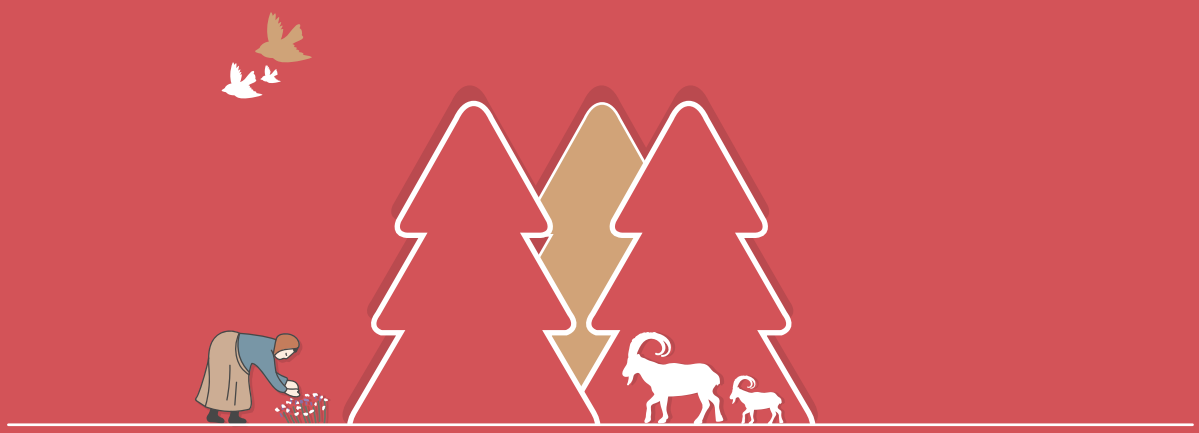

Forest and Landscape Restoration Guidelines

Regaining Landscape Resilience, Ecological Functionality and Human Well-being

Abridged Version

Shouf Biosphere Reserve - Lebanon

2020 Shouf Biosphere Reserve

Edited by: Nizar Hani, Marco Pagliani and Pedro Regato

Written by: Pedro Regato

Contributors: Pedro Regato, Rosa Colomer, Nizar Hani, Marco Pagliani, Rawya Bou Hussein, Monzer Bouwadi, Lina Sarkis, Khaled Sleem, Lara Kanso, Wael Halawi, Salam Nassar.

Elaboration of GIS maps and statistical data: Paul Ghorayeb

English editing: Faisal Abu-Izzeddin

Photos by: Shouf Biosphere Reserve team and Pedro Regato

Design Layout: Amir Abou Hamdan

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Contents

List of Abbreviations

ACS	Al Shouf Cedar Society
AGSBR	Alliance for the Green Shouf Biosphere Reserve
AICS	Italian Agency for Development and Cooperation
APAC	Appointed Protected Area Committee
BBI	Braun-Blanquet Index
BCE	Before Current Era
CBD	Convention on Biological Diversity
CEAM	Centre for Environmental Studies in the Mediterranean Region
CM	Cubic Meter
CSR	Corporate Social Responsibility
DGUP	Directorate General of Urban Planning
ENPI	European Neighborhood Policy Instrument
ES	Ecosystem Services
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FLR	Forest and Landscape Restoration
FLRM	The FAO Forest and Landscape Restoration Mechanism
FMC	Municipal Forest Management Committee
FRA	Forest Resources Assessment
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gases
GLOCHAMORE	Global Change in Mountain Regions
GPFLR	Global Partnership on Forest and Landscape Restoration
Ha	Hectare
IDAF	Centre for Agroforestry Development and Innovation
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
LBP	Lebanese Pound
LDN	Land Degradation Neutrality
LRI	Lebanon Reforestation Initiative
MFRP	Municipal Forest Restoration Plan
MM	Mediterranean Mosaics
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MOOC	Massive Online Open Course
MoU	Memorandum of Understanding
NBSAP	National Biodiversity Strategy and Action Plan
NC	Natural capital
NGO	Non-Governmental Organization
NARP	National Afforestation/Reforestation Plan
NTFP	Non-Timber Forest Products
NVS	Natural Vegetation Strips
RC	Reforestation Consortium
SALMA	Smart Adaptation of Forest Landscapes in Mountain Areas
SEA	Strategic Environmental Assessment
SM	Square Meter
SBR	Shouf Biosphere Reserve
T	Ton
UNFCCC	UN Framework Convention on Climate Change
UNCCD	UN Convention to Combat Desertification
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USD	United States Dollar
WFP	United Nations World Food Program
WWF	World Wildlife Fund
YR	Year

Foreword

The purpose of this document is to provide a general overview of the forest and landscape restoration program and implementation procedures since 2012 in the Shouf Biosphere Reserve. After 8 years of activities, we are able to describe results and show that the FLR initiative in Lebanon may rightfully be defined a best practice. We are well aware, however, that all the technical aspects and lessons learned from a broad and complex initiative cannot be fully captured in the few pages of this publication. Those who are willing to learn more about the initiative and get a full picture of how the FLR work carried out so far, are welcome to download the extended version of the Forest and Landscape Restoration Guidelines applied in the Shouf Biosphere Reserve at the following link:
www.shoufcedar.org/publications

Within the extended guidelines, you will find:

• A detailed background on the Shouf Biosphere Reserve, its geography, environment and socio-economy, and the rationale behind the FLR initiative.

• A full technical description of all the steps of the FLR process, from design to monitoring, to the latest aspects of the work, and the lessons learned through each step.

• Maps, graphics, pictures and tables to facilitate the understanding of each aspect of the program.

• Annexes describing the bio-climatic zones of the SBR, the multipurpose criteria adopted for the selection of the target native species, information on the species and their distribution in the Mediterranean region, and nursery production protocols for each species.

• An extended bibliography with references and key documents on FLR in Lebanon, the Mediterranean region, and the global level.

• Information on the governance and structure of the FLR process, the ACS team involved, the international technical assistance, all the stakeholders and the national and international partners.

This publication and other knowledge tools were produced as part of "Mediterranean Knowledge of Forest Landscape Restoration" the sharing and learning initiative jointly implemented by Al Shouf Cedar Society (Lebanon), Medforval and Istituto Oikos (Italy) with the financial support of the MAVA Foundation, with the ultimate goal to reach out to the community of all societal actors engaged in the challenge to preserve biodiversity, natural resources, and traditional landscapes across the Mediterranean ecoregion.

This learning initiative is closely linked to several regional initiatives:

a) Medforval (www.medforval.org) - a community of practitioners and scientists joining forces to protect, manage and restore forest sites. Since 2015 Medforval has brought together forest landscape sites of high conservation value in the Mediterranean, contributing to the integrity and resilience of high-value forest landscapes in the region. Medforval members work together to improve the management and conservation of forest landscape sites, developing and sharing good practices and organizing training courses for practitioners and policy makers, contributing to the political debate concerning Mediterranean forest landscapes and ecosystems, raising public awareness and encouraging a change in people's behavior towards more sustainable use of forest resources. The Medforval Network currently includes 18 sites from 12 countries bordering the Mediterranean Sea, including the Shouf Biosphere Reserve.

b) "Cultural Landscapes Programme" (https://mava-foundation.org/oaps/promoting-sustainable-land-use-practices-2/): The Mava Foundation promotes a programme of work in different locations in the Mediterranean region for preserving those cultural practices that help in conserving nature´s values. Currently the initiative focuses on the mountain landscapes of the Shouf-West Beqaa in Lebanon and the High Atlas in Morocco, the lowland silvopastoral Dehesas and Montados in Spain and Portugal, the islands of Menorca (Spain) and Limnos (Greece).

As a partnership between ACS and Istituto Oikos, and funding from the Italian Aid Agency, the project STONE – reStoration and enhancement of Traditional agricultural systems for the economic development and the environmental conservation of the Shouf Biosphere Reserve – helped upscaled the FLR work on restoring favorable conditions for sustainable agriculture in the landscape. This project has contributed to improve the wellbeing and economic opportunities of rural families in the SBR through: (i) the restoration of productive dry stone wall agriculture terraces and the development of green value chains around high value native plant species and local crop varieties; and (ii) the increase of ecosystem services supporting agriculture production and ecotourism development in the landscape.

1. Introduction: Why this Publication ?

Although several reforestation and afforestation initiatives had been undertaken in the Shouf region in the second half of the 20th century, the journey of the Shouf Biosphere Reserve towards a Forest Landscape Restoration (FLR) programme started full speed in 2012 under the umbrella of the "Mediterranean Mosaics (MM)" project that sought to strengthen the resilience of two Mediterranean landscapes – the Shouf Biosphere Reserve in Lebanon, and the Aterno river basin in the Sirente-Vellino Natural Park in Italy - to climate and socio-economic change, by promoting innovative and climate-adaptive knowhow and landscape-wide interventions for the restoration of ecosystem services, biodiversity conservation and sustainable rural development, in close collaboration with local communities and other socio-economic actors.

Almost ten years after the start of the FLR programme, the data collected yielded very encouraging results, with a survival rate of seedlings from about 45 native species and a cost-benefit ratio that stand unmatched in the history of forestation in Lebanon, and with the active participation of increasingly large sectors of the local society. ACS believed the time was ripe to share this experience and trigger a learning and dissemination process within Lebanon and in the Mediterranean Region. In March 2019, ACS published the Forest and Landscape Restoration Guidelines, a 262-page document that distils the lessons learned in the field of adaptive FLR. This publication is the result of an enormous effort undertaken by the SBR management team and their partners and distils six years of hard work, test and trial, lessons learned and field practice – from the inception of the FLR programme cycle to nowadays. The guidelines are meant as a contribution to the efforts of the Lebanese and international community of practitioners, not only in the field of forest protection, management and restoration, but also in those of biodiversity conservation, sustainable rural development, protected area management, and in the increasingly important challenge to achieve resilience and adaptation to the threats posed by climate change. The Guidelines were presented at the 6th Mediterranean Forest Week organised by FAO in April 2019 and are being disseminated making use of available fora, networks, and operational platforms.

This abridged version of the FLR guidelines of SBR is meant as a new effort to reach out to a wider audience of the Lebanese and international community of practitioners, including decision and policy makers, educators and researchers, donors, the media, and the general public.

It features a leaner, reader-friendly but scientifically rigorous version of the original guidelines, with a focus on the explanation of the process, the integrated approach adopted to increase landscape resilience, and the cost-benefit criteria embedded in the FLR strategy. It is part of a "learning and sharing" package designed by ACS and its partners Medforval and Istituto Oikos with the financial support of the MAVA Foundation, which includes a variety of learning tools and capacity development actions to disseminate and outscale the climate-adaptive FLR lessons learned that are now well grounded in the Shouf Biosphere Reserve.

***Nizar Hani**, Manager of the SBR and Author **Pedro Regato** with the recently-published **FLR Guidelines**, March 2019*

The package of learning and capacity development tools include:

- The original Forest and Landscape Restoration Guidelines (2019)
- The abridged version of the Forest and Landscape Restoration Guidelines (this report, 2020)
- A collection of FLR practices in the Mediterranean (2020)
- A MOOC (Massive Online Open Course) on FLR (2021)
- A professional presentation on FLR (2020)
- 6 video clips showing implementation of FLR on the ground (2019, 2020).

FLR guidelines video tutorial: **Planting**

Arabic version English version

FLR guidelines video tutorial: **Plant Nursery**

Arabic version English version

FLR guidelines video tutorial:
Biomass Management

Arabic version English version

FLR guidelines video tutorial:
Stone Wall Restoration

Arabic version English version

2. A short history

2. A short history of the FLR initiative in the Shouf Biosphere Reserve

In 2012 ACS joined the international project "Mediterranean Mosaics" (MM), whose goal was to build the resilience of Mediterranean biodiversity-rich rural landscapes to global change, through innovative adaptation and mitigation measures influencing natural resources management, markets and policy and governance frameworks. The Lebanese extension of the project was designed considering the specific context of the country, and the need to develop innovative FLR restoration work that would increase the ecological, social and economic resilience of Lebanese forest landscapes to the challenges posed by the root causes of ecosystem degradation and the synergistic impact of human action and climate change.

As a first step under MM project, ACS developed its first Forest Landscape Restoration plan, covering an ecological corridor connecting the Beqaa Valley and the Ammiq wetland in the east to the western slopes of the Shouf mountain range. The plan was designed and implemented under the guidance of a team of international experts. Production protocols for high quality plant material of approx. 30 native tree and shrub species where developed, and approx. 70 hectares of degraded land were restored, using a mix of innovative techniques and a rigorous protocol that took care of all the aspects of the work – from seedling production all the way to the monitoring of the result – with a climate change adaptation and mitigation focus. In order to regain landscape resilience in an integrated way, the plan incorporated adaptive forest and pasture management practices in the landscape with the purpose of reducing climate risks – mainly the exacerbation of fires and drought – while restoring conditions for socially beneficial and economic viable green growth. The FLR programme involved since its very start all the main stakeholder groups, including local municipalities, community members, especially farmers and small-medium size businesses in the agro-silvo-pastoral and tourism sectors, schools, agriculture and forest managers, NGOs, and other concerned institutional and non-institutional stakeholders. Special attention was given to the empowerment of women and vulnerable groups, namely young unemployed and Syrian refugees.

The adaptive FLR interventions were monitored and evaluated, demonstrating encouraging results that paved the way for a new partnership with the Lebanese Ministry of Agriculture, with funds from EU/ENPI. The project titled "Environmentally-sound and Socially-beneficial Forestation in the Shouf Biosphere Reserve" started in 2014, with a duration of four years.

The action carried out the mapping of restoration sites, and the implementation and monitoring of the FLR work, with active planting on a total of 25 hectares belonging to four municipalities of the Reserve, the setup of a briquettes factory making use of forest biomass and agriculture waste, and the restoration of 150 ha of agriculture terraces for the production and marketing of a wide range of products from locally adapted crop varieties and native edible and aromatic plants. As a complement to this integrated work, the program addressed the empowerment of the target municipalities on the restoration, adaptive management and monitoring of agro-silvo-pastoral systems, and sought the development of the capacity of beneficiaries at the community level to create small businesses related to sustainable rural development (non-timber forest products, handicraft, tourism-related services, biomass energy production, environmentally sound agriculture and diary production).

The third phase of the process widened the scope of the FLR program and its extension to other species and natural and semi-natural habitats of the Shouf Biosphere Reserve and its buffer zone, such as the reintroduction of the Nubian ibex, the balance of human-wildlife interactions in mountain silvo-pastoral areas, and the restoration of additional degraded forests and pastures, and abandoned dry stone wall terraces and other agriculture lands subject to traditional farming practices. This phase is being developed in the framework of an ambitious 5 years program launched in 2017- 2018, with the financial support of the MAVA Foundation and AICS - the Development Agency of the Italian Government. The program has enhanced 30 hectares of agro-forestry and pastoral land so far, placing special focus on the empowerment of the weakest sectors of the rural society, namely women and young unemployed, and applying the lessons learned and practices of the previous FLR work to the restoration of extensive agro-silvo-pastoral systems, promoting value chains of high-quality products, the conservation and monitoring of the rich biodiversity associated to these habitats, and specific tourist measures for the valorisation of the natural and cultural heritage.

Nowadays, the restoration of agro-silvo-pastoral landscapes is solidly embedded in the strategic guidelines for the Shouf Biosphere Reserve, and well aligned with the governmental commitment (40 million trees' programme) to the FLR Bonn Challenge - the restoration of 350 million hectares of deforested and degraded lands by 2030. ACS is committed to keep working in this domain, further refine its technical practices(know-how), and disseminate the lessons learned on FLR and the related fields of biodiversity conservation, climate change adaptation, rural development and poverty alleviation throughout Lebanon and at the global level.

3. Forest degradation and climate change in Lebanon

3. Forest degradation and climate change in Lebanon

Lebanon is well known in the Middle East as a land of forests and the home of the world-famous cedars (*Cedrus libani*), but the country - with its mountain terrain, steep slopes and high population density- is particularly vulnerable to deforestation, land degradation, and desertification. Between 1960 and 1998, forestland decreased by 32.5% in Lebanon and the area covered by wooded crops – olive and other fruit trees, vineyards – also decreased significantly, with the consequent increase of barren and desertified land[1]. Although according to FAO (FRA 2015)[2]the situation showed reverting trends between 1990 and 2015 with an average annual increase of the total forest area of about 250 ha, many forest landscapes currently maintain an increasing degradation and state of threat, and other wooded lands have decreased 440 ha annually in the same period.

Forest landscapes in Lebanon are mainly threatened by the extractive industry (quarries), urbanization, forest fires, overgrazing and uncontrolled extraction of forest resources, and an outdated legal framework matched with poor law enforcement. Like in other Mediterranean countries, fires have been especially damaging to Lebanon's forests in recent years, representing one of the most important elements that destroy the country's natural assets. All these threats will be increasingly exacerbated by climate change.

The Mediterranean region is one of the areas in the world where a greater impact of climate change is foreseen. Average annual temperatures are now 1.4 °C higher in the region than during the pre-industrial area, well above the global warming average. In Lebanon, climate change is expected to have major implications for the environment, economy, and social structure. The Third National Communication of Lebanon to the United Nations Convention on Climate Change (UNFCCC)[3] forecasts a temperature increase between 1.2°C and 1.7°C by mid-century and up to 3.2°C by 2100, and a decrease in precipitation of 4 to 11% with drier conditions by the end of the century, compared to the baseline period of 1986-2005. Higher temperatures, together with less water availability and an extended dry summer season, will result in a hotter and drier climate. The extreme weather events will also intensify, with more frequent, intense and extended drought periods and heat waves.

The Intergovernmental Working Group of UNCCD defined Land Degradation Neutrality as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems". There is a positive feedback between land degradation and climate change.

The former is a major contributor to climate change, while the latter can exacerbate the impacts of land degradation and reduce the viability of some options for avoiding, reducing and reversing the degradation trends. According to the latest Lebanese report to the UNCCD[4], 39 % of the country's territory can be classified as having very high exposure to land degradation. In Lebanon, a net decrease of 12% in CO_2 removals from the forests was recorded between 1994 and 2012, mainly due to the conversion of vegetated lands into settlements and to forest fires. By 2050, with a projected global warming of up to 1.7 °C, the combined effect of human-induced land degradation and climate change could reduce crop yields by 10% globally and by up to 50% in certain regions, and significantly increase the likelihood of wildfires, pest and disease outbreaks in scenarios where droughts and heat waves are projected to be more frequent[5].

The following table highlights on-going and projected impacts of climate change for Lebanon and the Mediterranean region as a whole[6]:

Climate feature	Lebanon	Mediterranean region
	40% reduction of snow cover with an increase of 2°C. Snow residence time reduction from 110 days to 45 days. Shift of snow fall from 1,500 m altitude to 1,900 by 2090.	Many mountain regions are experiencing reduced snow cover, and loss of glacier mass in the Alps, Pyrenees, Turkish and Balkan mountains since 1980s, with dramatic downstream effects as melt water contributes up to 60–70 % to annual river flows.
	Earlier snow melt with reduced water availability in the soil, rivers and springs during summer.	90 mm reduction in annual precipitation and 20 mm reduction in summer precipitation in some parts of the Mediterranean region.
	Drought periods 9 days longer by 2040 and 18 days longer by 2090. The dry summer season will extend in length.	Droughts are projected to increase in frequency, duration and severity: 7% more drought period with a 1.5 °C of global warming, and 11% more drought period with a 2 °C.
	Soil moisture reduction.	Soil moisture has significantly decreased since 1950, and summer soil moisture content is projected to significantly decrease for the coming decades.
	43 additional days with maximum daily temperature higher than 35°C.	Number of warm days almost doubled since 1960. Very extreme heat waves every two years are projected in the 2nd half of 21st century.
	Higher risk of forest fires.	Annually burned area by forest fires is expected to increase by a factor of 3 to 5 by 2100.
	40% reduction of maize production by 2040 and 64% by 2080. 16% reduction of wheat production by 2040 and 30% reduction by 2080.	25% reduction of crop yields by 2080 under a 5.4 °C warming, with an estimated loss of 1% gross domestic product (GDP).

[1]: Masri, T. et all (2002) Land cover change over the last 40 years in Lebanon. Lebanese Science Journal, Vol. 3, N° 2.
[2]: Global Forest Resources Assessment 2015 (http://www.fao.org/forest-resources-assessment/past-assessments/fra-2015/en/)
[3]: MoE/UNDP/GEF (2016). Lebanon's third national communication to the UNFCCC. Beirut, Lebanon.
[4]: Final National Report on Land Degradation Neutrality Target Setting Programme LEBANON - February 2018
[5]: Ibid
[6]: European Environment Agency (2017) Climate change, impacts and vulnerability in Europe 2016. An indicator-based report.

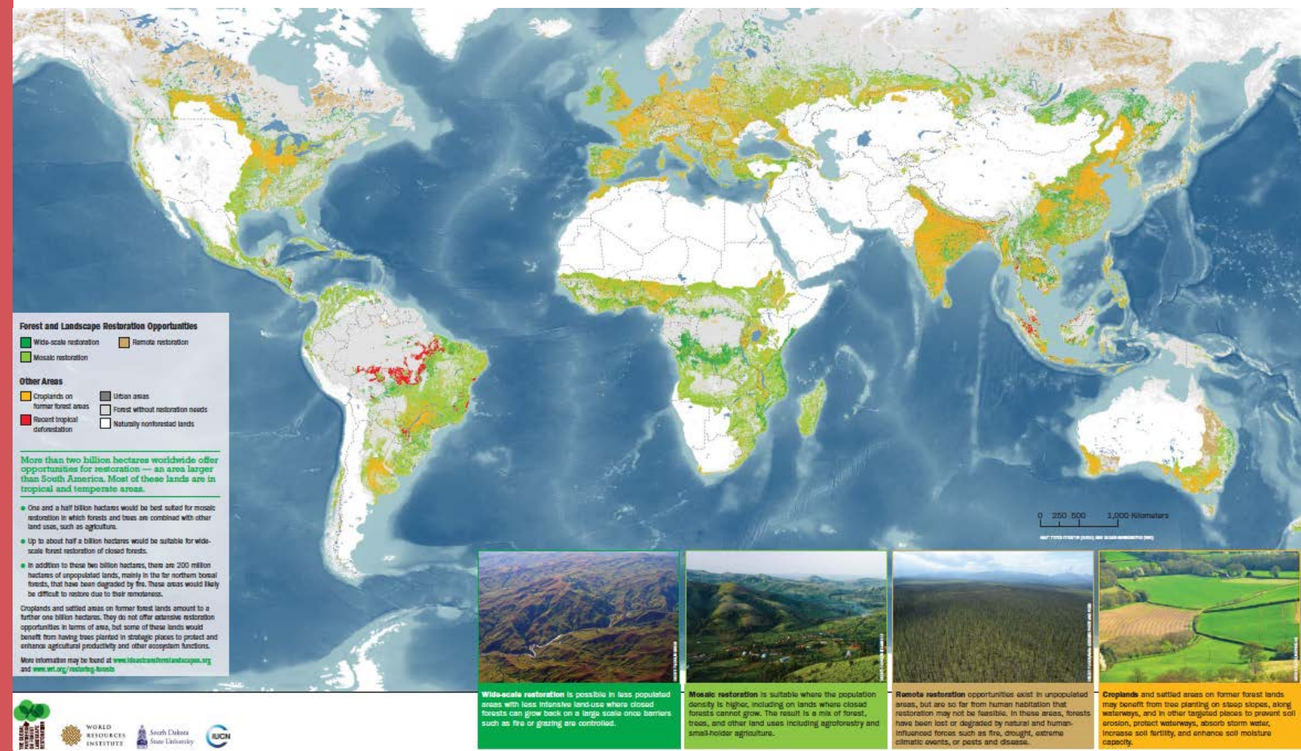
4. The concept of Forest and Landscape Restoration

4. The concept of Forest and Landscape Restoration

Forest and Landscape Restoration (FLR) is defined as a planned process to restore ecological integrity and enhance human well-being in degraded forest landscapes so that their ecological and social resilience is strengthened and their ecosystem services are enhanced to support the societal needs.

Deforested land and degraded natural and seminatural ecosystems can be brought back to a healthy state by means of forest and landscape restoration, regaining their ecological functions and enhancing human well-being. An assessment by the Global Partnership on Forest and Landscape Restoration (GPFLR) identified approximately 2 billion hectares of the world's deforested and degraded forest lands where opportunities for restoration may be found – an area larger than South America. This represents a vast opportunity to reduce poverty, improve food security, mitigate climate change impact, and conserve biodiversity. The assessment classifies forested and degraded forest lands into four categories, among which is "Mosaic restoration", which applies to land experiencing moderate human pressure (between 10 and 100 people/ km2) and offers a potential to restore a mix of forests and other land uses including agroforestry systems, pastures and small-holder agriculture land.

Worldwide Forest and Landscape Restoration Opportunities



Most degraded areas in Lebanon and the Mediterranean region are suitable for "mosaic restoration", mainly in mountain areas. This may consist of a combination of active and passive interventions to regain a diverse landscape pattern with a mix of land uses including high forests, open wooded areas, agroforestry systems, pastureland, and small-holder agriculture land, such as agriculture terraces in mountain slopes. Maintaining and restoring Mediterranean mosaic-like landscapes with a high diversity of land uses, habitat types, and wild and locally-adapted cultivated species and varieties, is also critical to increase resilience against climate change. In general terms, mosaic landscapes with high diversity of habitats and land uses are more resilient to climate risks, while offering a wider range of economic opportunities to rural societies habitat types, land use options and ecosystem services.

A considerable amount of information on forest landscape restoration is available to practitioners, through global networks set up by national and international institutions in the past decades, which capture the approaches, methodologies, and best practices developed and successfully applied in many regions. The following is a non-comprehensive list of well-known and reputed networks:

The Global Partnership on Forest and Landscape Restoration (GPFLR)
(http://www.forestlandscaperestoration.org)

The Forest and Landscape Restoration Mechanism
(http://www.fao.org/in-action/forest-landscape-restoration-mechanism/en/)

Global Guidelines for the restoration of degraded forests and landscapes in drylands
(http://www.fao.org/dryland-forestry/dryland-restoration-initiative/en/)

Restoration of Natural Capital Alliance (RNC)
(http://www.rncalliance.org)

The Ecosystem Services Partnership (ESP)
(https://www.es-partnership.org/)

[7]: *https://infoflr.org/what-flr (IUCN).*
[8]: Minnemeyer, S. et al. (2011) A World of Opportunity: Bonn Challenge on forest, climate change and biodiversity 2011. The Global Partnership on Forest Landscape Restoration (More information may be found at *www.ideastransformlandscapes.org* (the page domain is for sale, it will be stopped soon) and *www.wri.org/restoring-forests* (the website is not available)

The FLR initiative in the SBR landscape followed the FLR planning methodology proposed by the Global Guidelines for the Restoration of Degraded Forests and Landscapes in Drylands, is part of the FAO Forest and Landscape Restoration Mechanism, and builds on innovative science and technologies developed and successfully tested in Mediterranean-wide regional projects.

(http://www.forestlandscaperestoration.org)

(http://www.fao.org/in-action/forest-landscape-restoration-mechanism/en/)

(http://www.fao.org/dryland-forestry/dryland-restoration-initiative/en/)

(http://www.rncalliance.org)

(https://www.es-partnership.org/)

5. FLR in the Lebanese Agenda: the policy framework

5. FLR in the Lebanese Agenda: the policy framework

Forest restoration is considered by the Lebanese government as a critical action to meet the national commitments on biodiversity conservation and climate change, and to combat desertification. During the past decade, Lebanon has initiated a number of programs/initiatives to restore forested lands: (i) the development of the National Afforestation/Reforestation Plan (NARP) by the MoE in 2001; (ii) the development of the National Action Plan to Combat Desertification by the MoA in 2003, (iii) the development of the project "Safeguarding and Restoring Lebanon's Woodland Resources" to complement what was started under the NRP in 2009, (iv) the launch of the Lebanon Reforestation Initiative (LRI) in 2012 with the support of the International Program of the US Forest Service, (v) the launching of the "40 Million Forest Trees Programme" by the MoA in 2012; and (vi) the implementation of forest restoration initiatives by the civil society, with the financial and technical support of international organizations such as MAVA Foundation, IUCN, WWF, FAO, UNDP, EU-ENPI Programme and The GEF since 2009.

The 40 Million Forest Trees Programme and the Intended Nationally Determined Contribution (INDC) launched by the Ministry of Agriculture in partnership with the FAO in 2012 and under the umbrella of UNFCCC, aim to increase forests from 13% of Lebanon's total area to 20% over a period of 20 years, and to develop and implement adaptation plans to reduce the vulnerability of natural and agriculture ecosystems and the rural society to climate change. These programs aim at both increasing the resilience of forests to the impacts of climate change and reducing national GHG emissions by creating additional carbon sinks.

Under the CBD, Lebanon's revised National Biodiversity Strategy and Action Plan-NBSAP (2016-2030) mentions the sustainable management and use of natural ecosystems and resources and ecosystem restoration as priority strategies for the achievement of the biodiversity conservation objectives set by the Lebanese government. Biodiversity protection within the CBD framework is specifically referred to in the LRI, particularly in restricting the forest tree species used in reforestation to native species only and in banning the use of any restoration method that could harm the existing biodiversity.

The Final National Report on Land Degradation Neutrality Target Setting produced by Lebanon under the Global Mechanism of the UNCCD (2018) includes among its targets the need to: (i) avoid further decline of forest through law amendments; (ii) provide economic

incentives for improving forests showing declining productivity; and (iii) adopt sustainable land management practices to avoid overgrazing, frequent fires, and soil erosion. It also suggests to maintain current management practices on land showing increasing productivity while avoiding fire hazards especially on forest and grassland areas and requires the adoption of sustainable forest management practices (e.g. reduce fire frequency and severity, undertake forest management and harvesting plans, etc.).

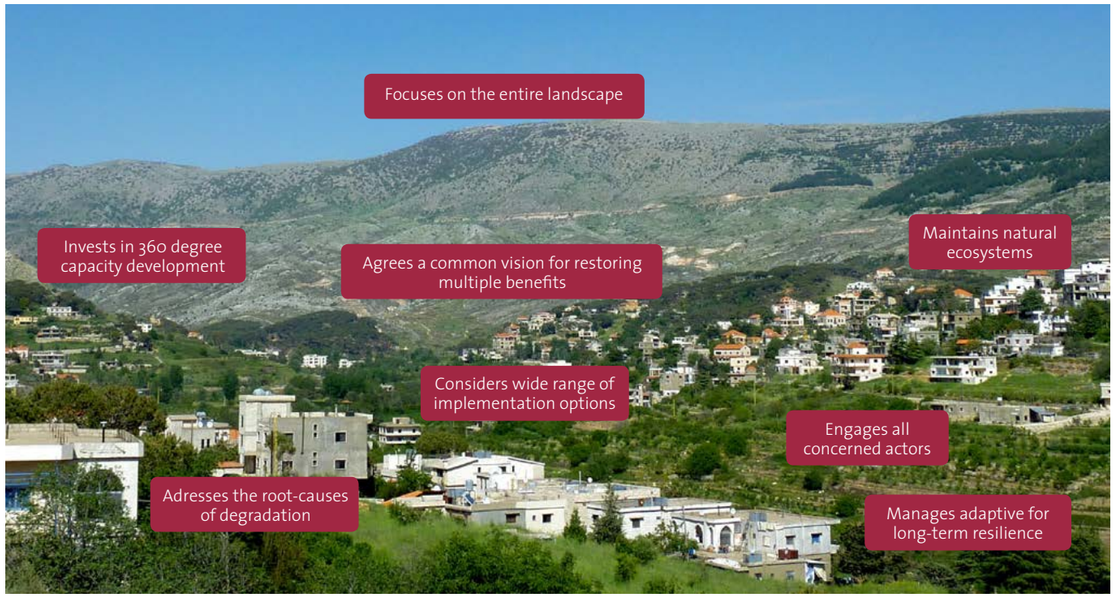
Other policy documents that are relevant to FLR practices in Lebanon include the Desertification National Action Plan (2003), the National Master Plan for Land Management (2009), the National Strategy for Forest Fires (2009), the "National Master Plan for Quarries" (2009) and the "National Plan for Integrated Solid Waste Management in Lebanon" (2010).

6. The FLR Guiding Principles

6. The FLR Guiding Principles

Forest landscape restoration is the ongoing process of regaining ecological functionality and enhancing human well-being across deforested or degraded forest landscapes. It is more than just planting trees – it is restoring a whole landscape to meet present and future needs and to offer multiple benefits and land uses over time.

The FLR initiative in the Shouf-West Beqaa Landscape was shaped along a set of guiding principles of forest landscape restoration, proposed and adopted by the founders and members of the Global Partnership on Forest Landscape Restoration (GPFLR). The project has interpreted the concepts that underlie these principles, resulting in the eight FLR principles defined in the following pages. These principles were applied in an integrated way, and translated into practice taking into consideration the local context of the Shouf-West Beqaa landscape.



I. FOCUSES ON THE ENTIRE LANDSCAPE

It entails balancing a mosaic of interdependent sustainable land uses and management practices, and ensures the maintenance of functional ecosystems and viable species populations over a large territory - in this case the 50,000 ha of the Shouf Biosphere Reserve mountain range.

II. ADDRESSES THE ROOT-CAUSES OF LANDSCAPE DEGRADATION

Effective restoration interventions in the long-term require a good understanding of the anthropogenic and climate change drivers of degradation and the implementation of reduction measures.

III. AGREES A COMMON VISION FOR RESTORING MULTIPLE FUNCTIONS FOR MULTIPLE BENEFITS

FLR interventions aim to restore multiple ecological, social and economic functions across the landscape, generate a range of ecosystem goods and services that benefit multiple stakeholder groups, and help conciliate the different actors' interests, including biodiversity conservation needs.

IV. MAINTAINS AND ENHANCES NATURAL ECOSYSTEMS WITHIN THE LANDSCAPE

FLR enhances the conservation, recovery, and sustainable management of natural ecosystems and traditional management practices that are linked to the cultural identity of the landscape, following the "ecological restoration principles" - an intentional activity that initiates or accelerates the recovery of ecosystems with respect to their functions, structure, species composition and resilience to environmental risks.

V. CONSIDERS A WIDE RANGE OF IMPLEMENTATION OPTIONS WITH A COST-BENEFIT VIEW

FLR uses a variety of approaches that are adapted to the local social, cultural, economic and ecological context, and ensure short- to mid-term economic benefits: (i) policy improvement; (ii) protection, measures; (iii) sustainable management of natural resources; and (iv) active restoration interventions.

VI. ENGAGES ALL CONCERNED ACTORS AND SUPPORTS PARTICIPATORY GOVERNANCE

FLR actively engages stakeholders at different scales, including vulnerable groups, in planning, decision making, and direct involvement in the implementation, monitoring and benefit sharing from restoration actions.

VII. INVESTS IN 360 DEGREE CAPACITY BUILDING AND KNOWLEDGE GENERATION

FLR supports knowledge generation incorporating scientific innovation and local know-how to adapt restoration to the local context, and continuous training for transferring cutting edge FLR knowledge to national and local learning platforms.

VIII. MANAGES ADAPTIVELY FOR LONG-TERM RESILIENCE

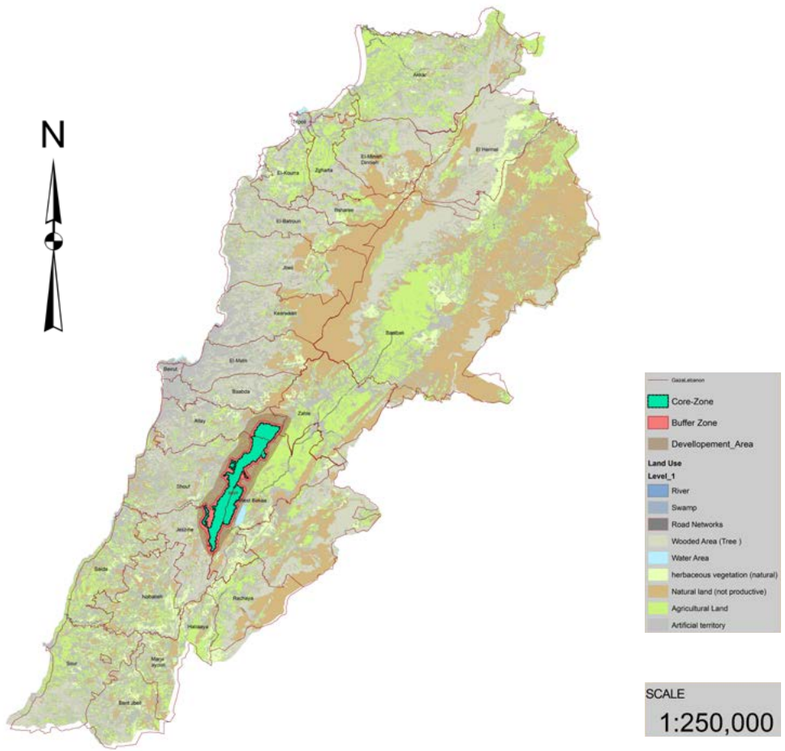
FLR seeks to enhance the resilience of the landscape and its stakeholders over the long-term. Restoration approaches should be adjusted over time, being flexible and responsive to social, economic and environmental changes. As restoration progresses, information from monitoring activities, should be integrated into management plans and transferred into learning process.

FLR Principle I: Focuses on the Entire Landscape

According to the first principle of FLR, large territorial units or landscapes are required to maintain a mosaic of interdependent sustainable land uses and management practices, and ensure the maintenance of functional ecosystems and viable species populations over a large territory - in this case the 53,900 ha of the Shouf Biosphere Reserve mountain range.

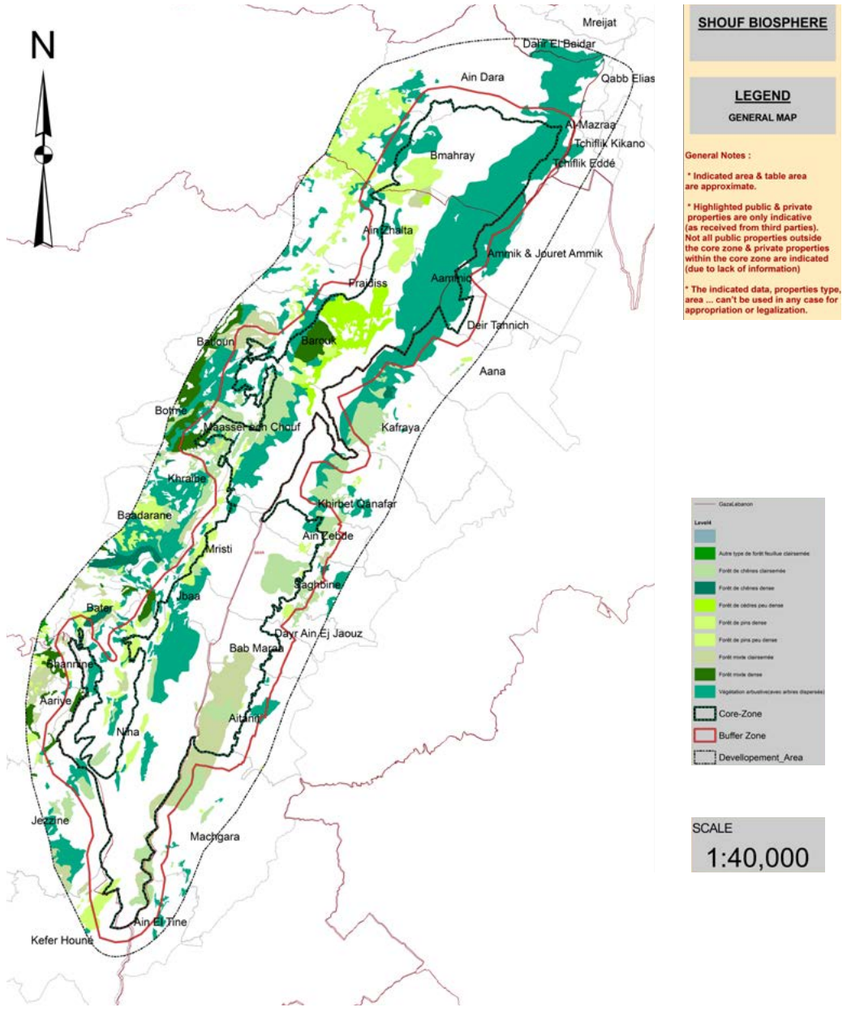
The Al-Shouf Cedar Nature Reserve was established by the Lebanese Government in 1996 under the authority of the Lebanese Ministry of Environment (MoE), which manages it through the Appointed Protected Area Committee (APAC) that includes among its members the Al-Shouf Cedar Society (ACS), the Mayors of the larger villages, and independent environment experts. With the declaration of the Shouf Biosphere Reserve (SBR) by UNESCO in 2005, the protected landscape was enlarged covering approximately 539 km equal to 5% of the total area of Lebanon, which constitutes the largest protected area in the Mediterranean area of the Middle East.

Land use map of Lebanon, representing the boundaries of the Shouf Biosphere Reserve zones



The SBR extends along a north-south axis, with the western slopes facing the Mediterranean Sea and the eastern slopes facing the Anti-Lebanon range and connecting with the Beqaa valley. From north to south: the western slopes belong to the districts of Aley and the Shouf (Mount Lebanon Governorate), and Jezzine (South Governorate); the eastern slopes belong to the districts of Zahle and West Beqaa (Beqaa Governorate). Most of the territory of the biosphere reserve occupies the adjoining areas of the neighbouring districts of the Shouf and West Beqaa, so from now on in the publication the landscape will be mentioned as “Shouf-West Beqaa Landscape”.

Forest cover of major forest types in the Shouf Biosphere Reserve



For management purposes the SBR is divided into:

- **Core zone:** the core zone covers an area of about 115.5 km. and its main objectives are the protection and rehabilitation of the SBR's natural and cultural values. It includes all the area designated as Nature Reserve.
- **Buffer Zone:** the buffer zone covers an area of about 64.5 km. surrounding the core zone and where activities compatible with the conservation objectives can take place (such as ecotourism or agriculture).
- **Transition zone:** the transition zone covers an area of about 359 km. and includes all the villages surrounding the SBR where sustainable resource management practices are promoted.

According to the first principle of FLR, large territorial units or landscapes are required to maintain the functionality and sustainability of agro-silvo-pastoral systems in ecological and socio-economic terms. The Shouf-West Beqaa landscape is a good example of this.

The mosaic-like mountainous landscape supports a wide range of habitats, species and rural populations which have interacted throughout millennia. Traditional cultural practices linked to agricultural, pastoral and forestry systems helped shape the landscape, as a result of the efforts made by rural communities. Agriculture is the main land use in the SBR landscape, covering 30% of the territory, of which 19.4% is currently abandoned. Forests cover 16.1% of the landscape, and pastureland occupies 14% of the SBR, from which 61.5% are high mountain grasslands located in the core zone, and 38.5% are low mountain pastures where livestock grazing is allowed.

The Shouf-West Beqaa landscape is a provider of critical ecosystem services to the surrounding areas and to the densely populated coastal regions of the country, including the capital Beirut. The forests and the terraced landscapes of the mountain areas play an important role in regulating the flow of water and soil nutrients, allowing agriculture development at lower altitudes and contributing to soil water infiltration and underground water recharge. About 200 springs supply the 28 towns and villages that surround the massif and feed the perennial rivers Litani, Damour and Awali. An assessment of the SBR ecosystem services carried out in 2015, which took into consideration carbon sequestration, water, the provision of edible, aromatic and fuelwood (briquettes production) products, tourism, cultural services and patrimonial value, reached the conclusion that the economic benefits generated by the landscape every year are in the range of 16.8 to 21.4 million US dollars.

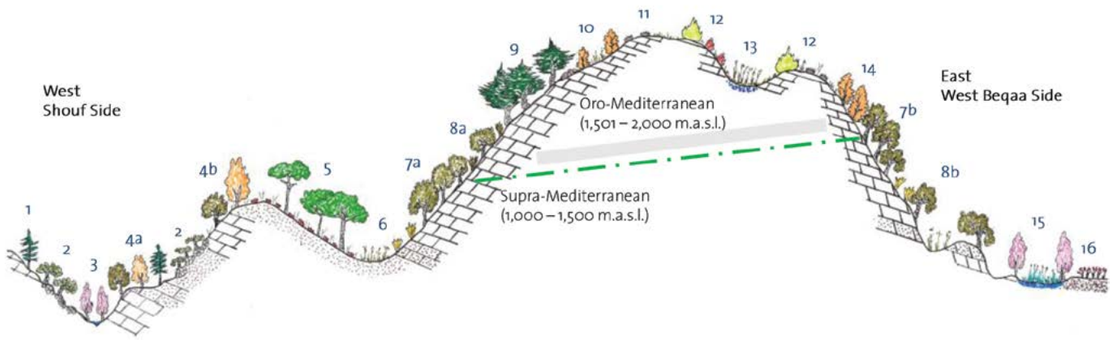
	Ecosystem Service	Value (USD/Yr)
Regulating services	C Sequestration	860,000
	Ecological benefits Ammiq	600,000
Provisioning services	Nursery production	200,000
	Biomass for bioenergy & compost	200,000 – 1 M
	Grid water	9.2 – 12.3 M
	Water bottling	2.6 – 3.4 M
	Hydropower	1.3 M
	Rangeland for livestock	600,000
	SBR labelled native plants' products	130,000
	Honey production	450,000
Cultural services	Entrance fees	186,000
	Guesthouse B&L	79,000
	Conventional restaurants	247,500
	Tawlet Ammiq Eco-restaurant	200,000
Total		16.8 – 21.4 M

The climate of SBR is characterized by a bio-climatic gradient from the Supra-Mediterranean type at the lower altitudes, with fresh to cold temperatures and sub-humid conditions (annual rainfall between 600 and 1,300 mm), to the Oro-Mediterranean type at higher altitudes, with sub-humid to humid conditions (annual rainfall between 1,000 and 1,600 mm) and cold to very cold temperatures. The eastern slopes have drier conditions with annual rainfall lower than 600 mm. Climate change has become evident in recent years: lower annual rainfall, higher temperature and longer drought periods have become a major challenge for the survival of the planted seeds and seedlings in the FLR interventions, and need to be considered into the planning and implementation of restoration works.

Cedar tree crown snow load

Fog is common in the western side of the SBR

Bioclimatic zones in the Shouf Biosphere Reserve Landscape



Supra-Mediterranean Bioclimatic Zone

1 - Brutia pine (*Pinus brutia*) forest
2 – Oilve & fruit tree plantation in agricultural terraces
3 - Riparian forest (*Alnus orientalis, Platanus orientalis, Populus alba, Salix spp*)
4a – Mixed forest (*Quercus calliprinos, Q. Infectoria, P. Brutia*)
4b – Mixed oak forest (*Quercus calliprinos & Q. Infectoria*)
5 – Stone pine (*Pinus pinea*) forest
6 – Low mountain pastures and shrubland (*Sarcopoterium spinosum & Calycotome villosa*)
7a – Dense oak (*Quercus calliprinos*) forest in the more humid Shouf side
7b – Dense oak (*Quercus calliprinos*) forest in the more dry and continental Beqaa side
8b – Open oak (*Quercus calliprinos*) forest in the more dry and continental Beqaa side
15 – Ammiq wetland with Fraxinus syriaca and Ulmus minor forest
16 – Vineyards in the flatland area of Beqaa valley

Oro-Mediterranean Bioclimatic Zone

8a – Open oak (*Quercus calliprinos* Woodland and high mountain shrubland (*Spartium junceum, Styrax officinalis, Colutea cilicica*)
9– Cedar (*Cedrus libani*) forest
10 – Open oak (*Quercus brantii* subsp. look) forest and copses of Rosaceae tree species (*Sorbus torminalis, S flavellifolia, Pyrus syriaca, Prunus ursina, Crataegus azarolus*)
11 – Mountain Summit throny cushion shrubland (*Astragalus spp., Onobrychis cornuta, Acantholimon ulicinum, Berberis libanotica, Prunus prostrat*a)
12 – High mountain juniper Woodland (*Juniperus excelsa*)
13 – Doline depression humid pastureland (*Hordeum bulbosum, Blysmus compressus, Alepecurus arundinaceus*)
14 – Dense oak (*Quercus brantii subsp.* look) forest and *Quercus Calliprinos*
7b – Dense oak (*Quercus calliprinos*) forest in the more dry and continental Beqaa side

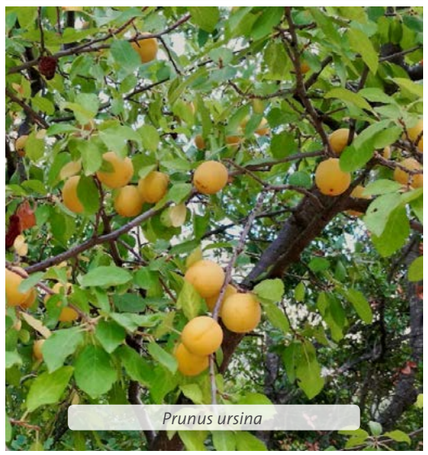
The forests of the Supra-Mediterranean bio-climatic zone are dominated by the evergreen oak *Quercus calliprinos*, the deciduous oak *Quercus infectoria*, the Stone pine *Pinus pinea* and the Calabrian pine *Pinus brutia*. Recently abandoned agriculture terraces in limestone substrates have been colonized by species-rich communities of herbaceous plants, including numerous orchids.

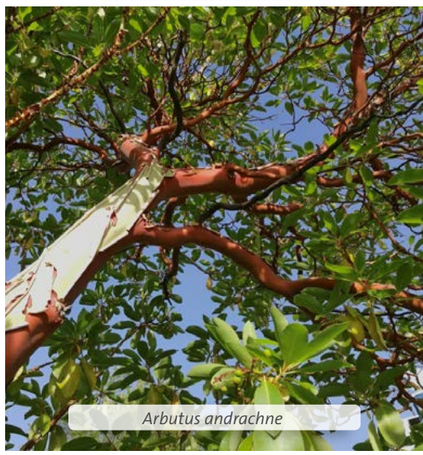

Quercus calliprinos


Pinus brutia


Quercus infectoria


Acer obtusifolium


Prunus ursina


Arbutus andrachne


Pistacia palaestina


Crataegus monogyna

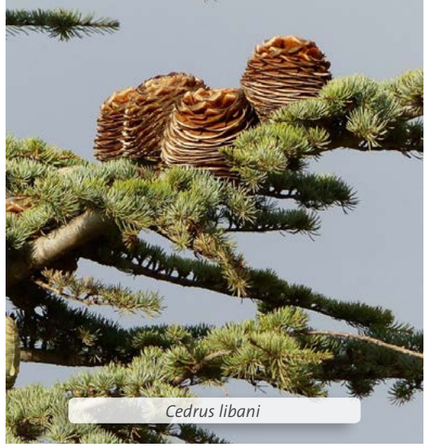

Pyrus syriaca

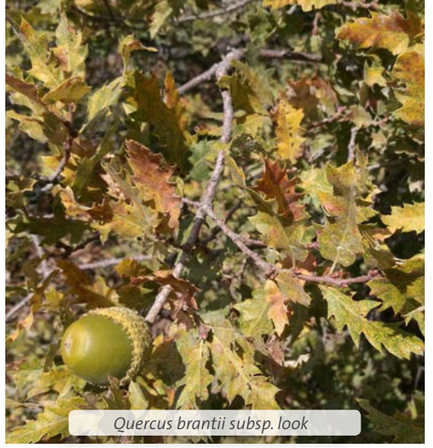

Neotinea tridentata

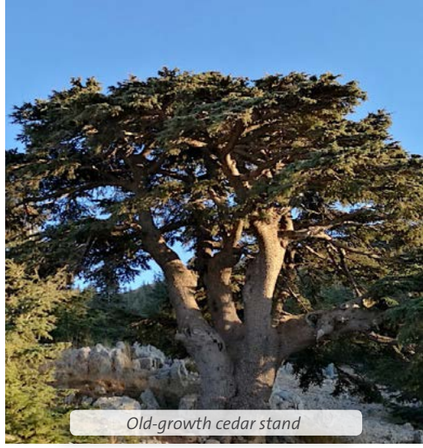

Ophrys fusca

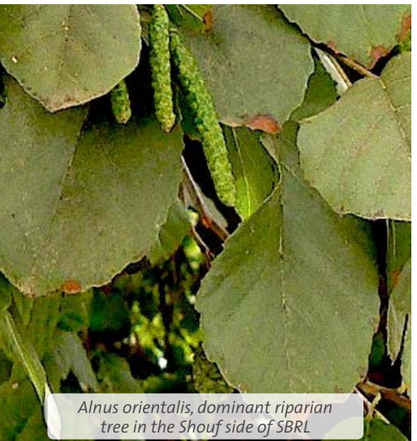

Orchis gallilaea

The rivers in the western side of the landscape are characterized by Oriental alder (*Alnus orientalis*), Oriental plane tree (*Platanus orientalis*), the White poplar (*Populus alba*), and several willow species (*Salix libani, Salix alba*). The Ammiq lake at the foot of the mountain in the Beqaa plain, is characterized by the Syrian ash (*Fraxinus syriaca*). Freshwater ecosystems are a refuge of a number of Tertiary relics, such as *Rhododendron ponticum*.


Cedrus libani


Quercus brantii subsp. look


Old-growth cedar stand


Alnus orientalis, dominant riparian tree in the Shouf side of SBRL


Rhododendron ponticum, relic species that grows in riverine zones in the Shouf side


Fraxinus syriaca, common tree in Ammiq wetland

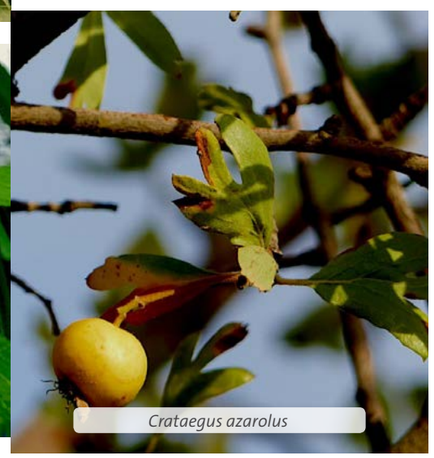

Cedar plantation


Sorbus flabellifolia


Sorbus torminalis


Ammiq wetland (West Beqaa valley)


Iris pseudacorus


Crataegus azarolus

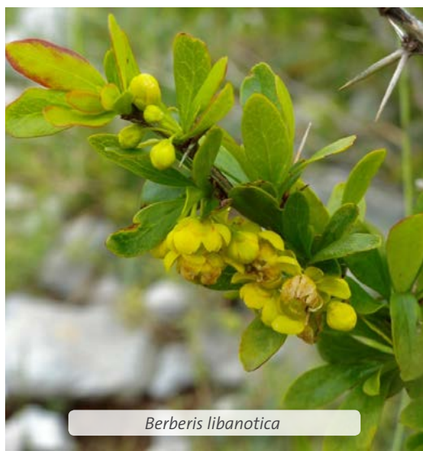

Lonicera nummulariifolia

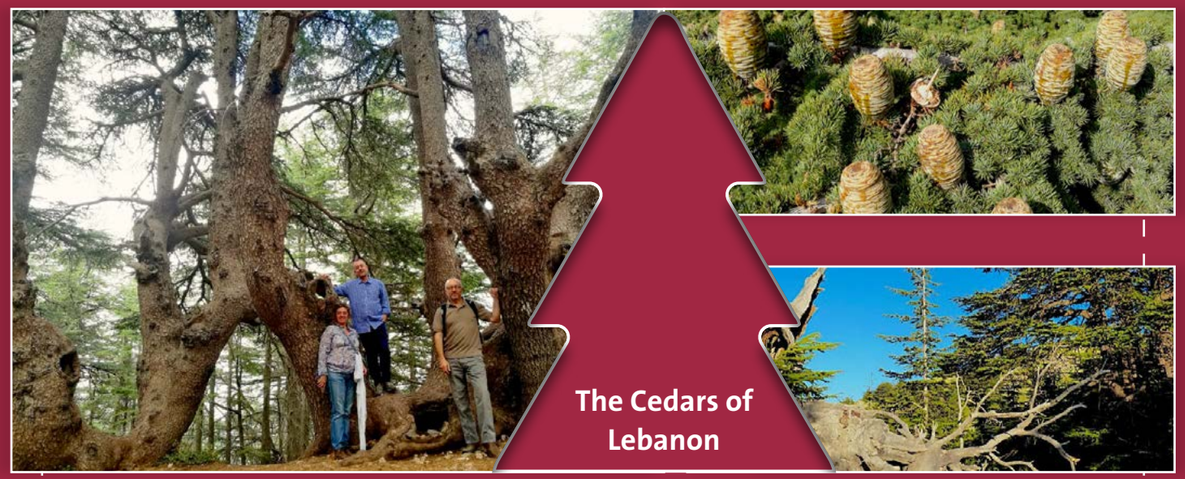

Styrax officinalis

The Oro-Mediterranean bio-climatic zone is characterized by forest habitats in which the dominant tree species are the Lebanese cedar tree (Cedrus libani) on the western sea-facing slopes, and the oak species Quercus brantii on both mountain sides. The mountain summits at about 1,900 m are exposed to extreme weather conditions, with strong cold winds in winter and abundant snowfall. Under these conditions, the few trees that occur show very limited growth in height, with a characteristic flag-shape, scattered and distributed in small troughs and slopes protected from the dominant winds.


Colutea cilicica


Geranium libanoticum


Berberis libanotica



The Cedars of Lebanon

The Lebanese cedar (*Cedrus libani*) is a conifer tree distributed in mountain areas of Turkey, Cyprus, Syria and Lebanon. The iconic and world-famous cedar forests of Lebanon enjoy the unique distinction as the oldest documented forests in history, with written records of the Sumerian civilization dating from the third millennium BCE. The species is considered as "Vulnerable" in the IUCN Red List of Threatened Species. Cedar forests are severely fragmented: as a result of centuries of over-exploitation, the tree now covers only 5% of its estimated ancient range in Lebanon, with an actual size of about 22 km2, scattered in fifteen fragmented relic stands. Six of these stands are located in the SBR landscape, with the largest ones in Bmohrai- Ain Zhalta, Barouk, and Maasser el Shouf, that combined are home to about 32 % of the remaining cedar forests in Lebanon. This makes the SBR a critically important site for the long-term conservation and natural propagation of the cedar tree.

So far, about 1,100 vascular plant species are known in the SBR landscape. The landscape is rich in medicinal, edible and aromatic plants that are harvested by local inhabitants. It is also home to 25 internationally and nationally threatened species, and 48 species endemic to Lebanon or to the wider region. The SBR has a high diversity of vegetation types due both to the ecological diversity, and the historical interactions between people and nature.


Salvia multicaulis


Cyclamen persicum


Helichrysum sanguineum


Michauxia campanuloides


Tulipa montana


Ophrys holosericea


Thymbra spicata


Sternbergia clusiana


Astragalus cruentiflorus


Onobrychis cornuta


Atraphaxis billardieri

The SBR landscape is home to 32 species of mammals, with stable populations of Wolf, Striped hyena, Wild boar, Golden jackal, Indian porcupine, Beech marten, Wild cat, European badger, and many others. An abundant stable population of Cape hyrax (*Procavia capensis*) is located in the southwestern part of the Reserve. Over 275 bird species have been recorded in the Shouf Biosphere Reserve and the Ammiq Wetland including rare or threatened species such as the Syrian serin, Eagle owl, Chukar partridge, Long-legged buzzard, among others. The whole area, strategically placed between Europe, Africa, and West Asia is very important for bird migration. Each year countless White storks, birds of prey, and other migrants pass over the Reserve and use it as a resting, feeding and roosting site. The SBR also includes 31 species of reptiles and amphibians including chameleon, tortoise, and several species of snakes, lizards, frogs, and toads.


Empusa pennata


Libelloides macaronius


Aporia crataegi


Bird migration

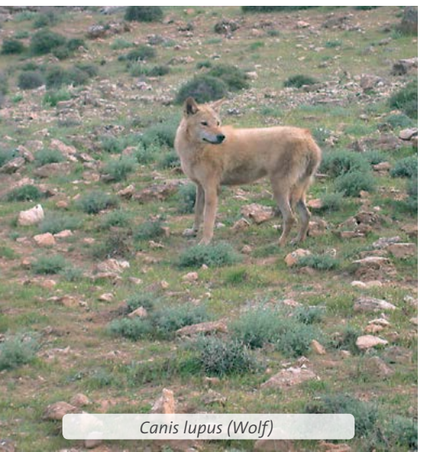

Meles meles (Eurasian badger)

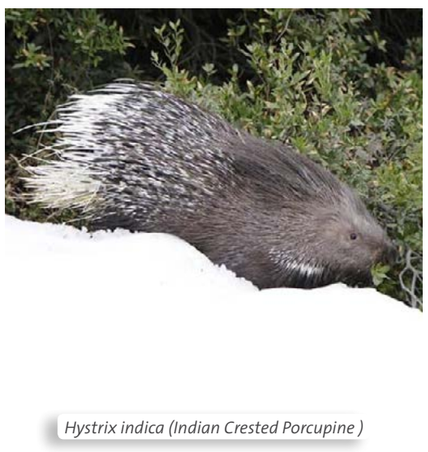

Procabia capensis (Rock hyrax)


Mauremys cf. rivulata (Western Caspian turtle)


Hyla savignyi (Common tree frog)


Testudo graeca (Greek tortoise)


Canis lupus (Wolf)


Hystrix indica (Indian Crested Porcupine)


Hyaena hyaena (striped hyena)


Stellagama stellio (Starred agama)


Serinus syriacus (Syrian serin)


Upupa epops (Common hoopoe)

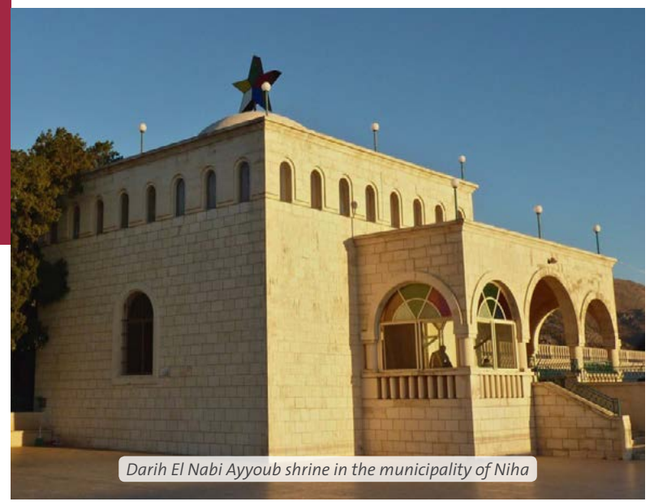
The Nubian Ibex

The Nubian ibex (*Capra nubiana*) is a species of wild goat that occurs in rocky, steep mountains in Africa and the Middle East originally. Nowadays, the Nubian ibex is extinct along most of its original range and is listed by the IUCN Red List as "Vulnerable". In 2015, the SBR started a process for the reintroduction of the Nubian ibex in the Shouf-West Beqaa Landscape, in partnership with Istituto Oikos, an Italian NGO with a solid track record of work on ibex reintroduction. This was the first operation of its kind in the history of Lebanon, a country from which the Ibex had disappeared at the beginning of the 20th century. After a field assessment of the conditions for the reintroduction, a small founding herd of Nubian ibex was translocated from Wadi Rum Protected Area in Jordan to a fenced acclimation area in the eastern part of the SBR in October 2017. The herd is now slowly growing in size, and the first reintroduction in a suitable habitat of the Reserve is foreseen sometimes in the next couple of years.

Land use/land cover in the SBR is the result of past and present changes in the application, abandonment or intensification of traditional economic and cultural practices. The part of the landscape most modified by human intervention corresponds to the mountain foothills at the Supra-Mediterranean level, due to the milder climate conditions and the complex geological features favouring the presence of deeper soils and higher soil water content and freshwater availability. The landscape is characterized by a mosaic of agricultural land, agro-forestry, semi-natural woodlands and pastures. Opencast mines for aggregate extraction (sands and limestone rocks) are scattered throughout the landscape, especially impacting the Pinus pinea forestland, mountain pastures and evergreen oak woodlands.

The SBR is home to more than 170,057 inhabitants, spread over 28 municipalities, which are located in the development zone of the Reserve around the core and buffer areas. Despite the historical feuds between Christian Maronites and Druze, the Shouf district remains one of the most religiously diverse regions in Lebanon. On average 30% of the population are civil servants, 30% are engaged in agriculture activities, 25% in private businesses, and 15% are unemployed. A large number of the population depend on agricultural activities as an additional income to improve their livelihoods. However, an increasing number of people are leaving their villages to become construction workers, government or private sector employees, and small business entrepreneurs. The trend is towards downscaling traditional agricultural activity as a result of an aging population, poor marketing strategies, soil degradation, and high production costs (e.g. excessive use of pesticides and fertilizers). Security issues and political instability have also had a marked impact on the social fabric of the area people. The SBR hosts approx. 58,000 Syrian refugees, mostly in the eastern side (Qeb Elias municipality).

The SBR is a multicultural region with a mosaic of religious communities and is the home of the Druze, settled since the Middle Ages, and to numerous Maronite Christians, Greek Catholics and Sunni Muslims. Rich in history, having being the centre of the Emirate of Mount Lebanon, the area hosts a wide choice of heritage sites, from archaeological places, to historical palaces, to religious sites, all adding to the charm and attractiveness of this unique region.



Darih El Nabi Ayyoub shrine in the municipality of Niha

Miracolous old strawberry tree (Arbutus andrachne) at Darih El Nabi Ayyoub shrine

Roman grape press in Barouk municipality

Niha fortress

Beekeepers

Oak honey and other local products

Preservation of Ambarees in the Beqaa

Production of pine nuts in Ain Zhalta

Gundelia tournefortii

Scorzonera cf. mollis

Eryngium falcatum

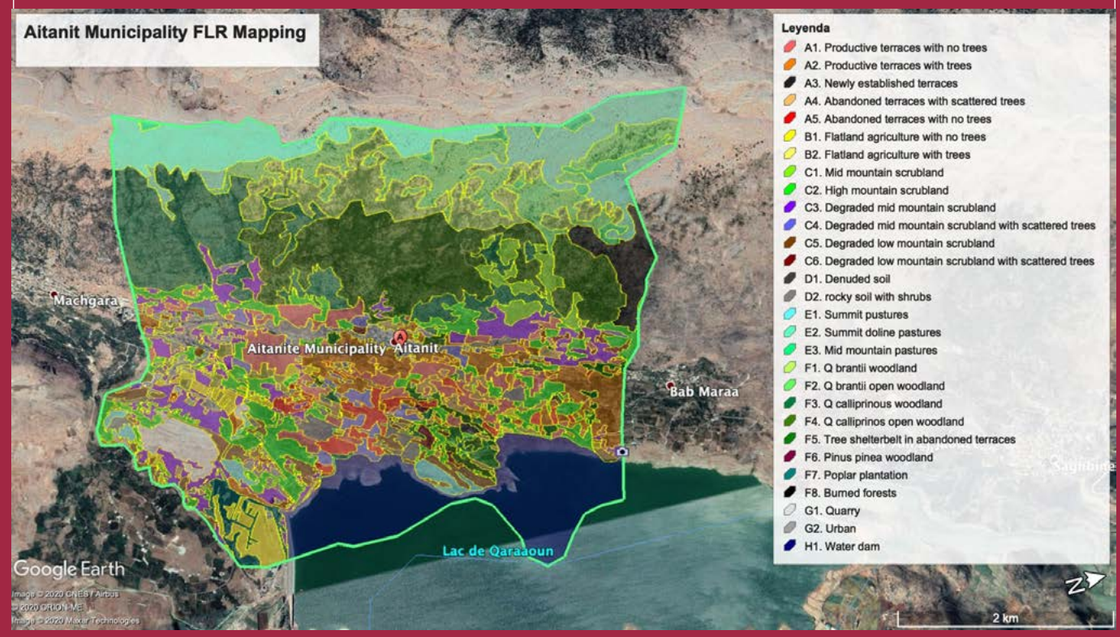
Centaurea cf. iberica

GIS mapping of FLR restoration priority areas in the Shouf-West Beqaa landscape

The ACS FLR team has supported the Municipal Forest Management Committees (FMCs, see FLR principle VI) in the identification of priority areas for FLR interventions at the municipality level. The project has supported the FMC members in the effective use of the FLR Planning & Monitoring Tool, produced by FAO, as part of **the Global guidelines for the restoration of degraded forests and landscapes in drylands (FAO Drylands Initiative)**. The mapping exercise consisted in:

1) Identification, classification and description of the different land uses in the Shouf-West Beqaa landscape, with the definition of their favorable conservation status and their different stages of degradation that exist in the landscape. This was based on very extensive field work and large consultation with the different stakeholders.
2) Digital mapping through Google Earth of the landscape polygons corresponding to the different land uses and degradation stages.
3) Field verification of the mapped polygons to check their correspondence with the established typologies and amend possible misinterpretations.
4) Ranking of the landscape polygons based on their conservation status and restoration needs.
5) Participatory process with FMC members for the selection of priority polygons for FLR interventions, using ecological, social and economic criteria.
6) Analysis of the land tenure conditions in the priority intervention areas and development of consultations to negotiate with the land owners and the municipality the win-win conditions that allow the implementation of restoration actions. In some cases, the swap between public and private properties is proposed to reduce risks of uses not compatible with the conservation and sustainable management of forests in buffer zones of the biosphere reserve, and thus be able to undertake restoration actions avoiding conflicts
7) Agreements between interested parties to undertake restoration actions and selection of the most suitable type of action for each area.

Example of FLR mapping in the Municipality of Aitanit (West Beqaa side of the landscape)



The project team has organized meetings involving the different FMCs to discuss about the FLR mapping results at the municipality level, harmonize the FLR priorities among neighboring municipalities, and agree on a common FLR vision for the whole Shouf-West Beqaa Landscape.

FLR Principle II: Addresses the Root-causes of Landscape Degradation

This principle highlights the need to understand and remove the underlying socio-economic and political causes that truly drive the degradation of natural resources, which means "scaling up" the restoration objectives and actions and strengthening the sustainability of restoration actions in the field through macro-level measures such as policy reforms, market incentives and regulations and socio-economic dynamics. Only by exploring, understanding and addressing the root causes of natural resources degradation and loss at the local, regional, national and international levels can FLR create conditions for success and sustainability.

The FLR process in the SBR carried out a thorough multidisciplinary, participatory analysis of the causes of land degradation to determine: (i) the underlying policies, institutional dynamics, market forces and human actions driving the direct causes which lead to landscape degradation; (ii) the interlink between direct and root causes; and (iii) the priority interventions at various levels to address them.

Participatory workshop with the landscape stakeholders

Conceptual model for assessing root causes of landscape degradation in the SBR Landscape

Ultimate causes	Intermediate causes	Proximate causes	Threats to Landscape values
Lack of incentives (awareness, capacity & resources) for value chains around the SBR ecosystem services	Rapid and precarious agriculture intensification in response to volatile market demand for apples	Maladaptive agricultural practices (over-use of agro-chemicals; burning of waste	Pollution
Political instability in the region	Abrupt population dynamics out-migration/refugees	Abandonment of traditional agricultural practices (terraces)	Soil erosion
Poor links with commercial markets around green growth opportunities	Investing remittances in house construction	Uncontrolled urbanization	Forest fires
Inadequate policies, laws & regulations, and lack of enforcement mechanisms	Lack of land use planning	Uncontrolled quarries	Water shortage
	Unclear land tenure	Limited water storage during summer	Habitat degradation & loss
	Abandonment of customary governance systems	Mismanagement of forest & pasture resources	Species (genotypes) population decline
		Uncontrolled hunting	
		Over-collection of plants	
		Climate change	

The causes of landscape degradation in the SBR are grouped under three categories:

Proximate causes of landscape degradation:

Both the excessive exploitation of natural resources and the abandonment of cultural practices are the cause of degradation and loss of habitats and species, rendering the mosaic of natural- and agro-ecosystems of the landscape unable to provide many ecosystem services. The loss of the traditional cultural practices that allowed an efficient use of the natural resources adapted to the environmental constraints of the SBR landscape have resulted in the mismanagement and overexploitation of forests, pastures and wildlife. The abandonment of the traditional terraced farming systems and the introduction of intensive farming (i.e. apple production) have caused significant soil erosion and water pollution problems. Uncontrolled land uses, such as the opening of quarries and building houses have reduced the aesthetic value of the landscape and are creating serious problems of air, water and soil pollution, soil erosion, habitat fragmentation and higher fire risk. There is a positive feedback between land degradation and climate change: on the one hand carbon emissions from fires and soil degradation increase the concentration of green-house gasses in the atmosphere; on the other hand, the higher temperatures and drought events derived from climate change negatively affect the landscape uses, with a higher risk of agricultural production losses, and decrease in the quality and availability of pastures, forest products and water.

Intermediate causes:

The unclear delimitation of land tenure, together with the absence of land use planning are behind uncontrolled urbanization and mining activities in the buffer and core zones of the SBR. The abandonment of the customary governance systems that regulated the management of natural resources in communal and public lands has led to conflicts among land users and the overexploitation of the natural ecosystems. Abrupt population dynamics like the migration of a large part of the population during and after the war are also behind the degradation of the landscape. On the other hand, the recent war in Syria led to major population displacements and the settlement of refugees in the region, which has increased the pressure on the SBR landscape. The lack of planning for the agricultural sector makes it difficult to understand the region's agricultural potential and access to markets. As a consequence, local farmers respond to ephemeral booms, such as the cultivation of apples, which are subject to a very volatile market and a strong environmental impact because of the excessive use of agrochemicals and water.

Ultimate causes:

Political instability represents a major cause preventing sustainable development in the region and in Lebanon as a whole. Current policies, legislation and regulations are in some cases weak and require improvements to support sustainable management practices and land uses. The lack of sufficient enforcement mechanisms prevents the effective control of illegal actions. There are limited governmental resources to undertake spatial planning processes and cadastral survey and mapping, an issue that is especially relevant in the case of protected areas. The absence of governmental incentives to support land users in the adoption of sustainable production systems makes it difficult for the revitalization and improvement of the economic sectors that depend on the natural resources of the landscape. To this, we must add the lack of local knowledge and external support to develop value chains for high value products, such as organic food, medicinal and aromatic plants.

Soil erosion, hydrological disruption and fires in abandoned agriculture terraces

Uncontrolled house building throughout the territory

Opening of quarries for stone and sand extraction without impact evaluation, planning or post-extraction restoration plan

Higher occurrence of large scale fires due to the combined effect of maladaptive agricultural practices (burning of waste) and climate change

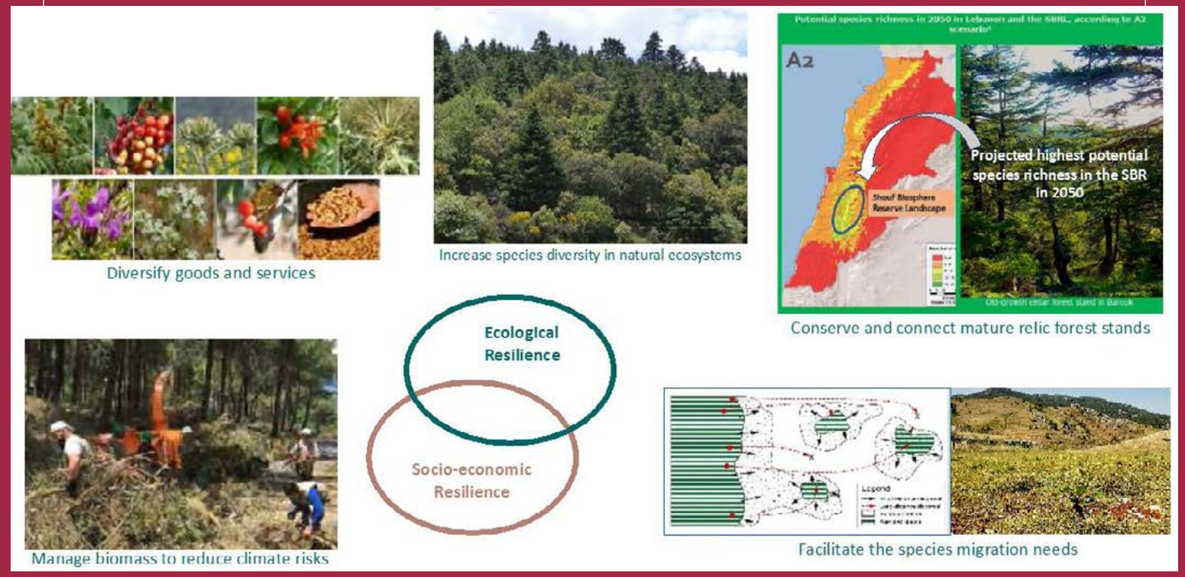
Climate change in the Shouf-West Beqaa Landscape: Mainstreaming the adaptation of forest ecosystems in the SBR to climate change

In recent years, climate change has become evident in the SBR landscape, with the exacerbation of land degradation problems negatively affecting the ecosystem services on which society depends. Since 2013 an increase of 0.7 °C of the average annual temperature has been observed, a slight reduction in the annual precipitation more concentrated in winter, and a longer summer drought period extending from end of April/early May towards the end of October/beginning of November. Snow, a critical water resource in Mount Lebanon, will decrease by 40% with a warming of 2 °C, shifting the lower limit of snowfall from 1,500 m to 1,700 m by 2050 and 1,900 m by 2090[9], which means that it will hardly snow in Shouf massif. A longer summer period with less water reserves, lower rainfall and greater evapotranspiration causes higher stress on the vegetation, increasing the risk of dieback events, and reducing crop productivity. Likewise, the greater drought and higher temperatures of autumn - a period in which farmers burn stubble and pruning remains - increases the risk of forest fires that spread more easily as the natural vegetation is more dehydrated. The delay in precipitation in autumn has a negative impact on forest planting activities, as it leaves little room between the first rains and the significant drop in temperatures to ensure the proper installation of seedlings in the field. The same occurs in the spring planting period, which should be anticipated to coincide with the rains of April, exposing the seedlings to a long period of drought until well into autumn.

The FLR programme in the SBR has prioritised the adaptation of forest ecosystems to climate change. The assumption is that climate change compounded by maladaptive anthropogenic processes such as land-use changes, rural abandonment and overexploitation of land resources are likely to increase the frequency and intensity of disturbances, leading to: (i) the replacement of healthy forest by fire-prone shrub communities; (ii) Increasing landscape fragmentation and extinction of species at risk, and (iii) decreasing annual tree growth increments and the subsequent income from forests.

FLR in the Shouf-West Beqaa Landscape has addressed climate change impacts to the natural ecosystems in the landscape, with the aim of increasing ecological and social resilience through:

- the facilitation of in situ persistence of habitats and species through the conservation of old-growth mature forest stands as genetic reserves with high genetic diversity that can better tolerate changes in the environment.
- the planting of seeds and seedlings from a selected number of tree species that characterize the lower bioclimatic level in deforested areas of the transition zone with the upper level, as a way of creating seed dispersion islets that will facilitate the future migration needs at higher altitude areas.
- The species diversification through planting and managed natural regeneration with the double objective (i) to increase the number of life forms (e.g. resprouting species, species attractive seed dispersal fauna, nitrogen fixing species) in the natural ecosystems and consequently their resilience to climate risks, and (ii) to support the reorganization of plant species and changes in tree species dominance in the landscape as a response to the changes in climate conditions.
- The restoration of productive dry stone-wall terrace systems with diversified crops, including high value local crop species and varieties and native edible, medicinal and aromatic plant species (EMAP), as part of green value chains that enhance social and economic resilience.
- The adaptive, integrated management of forest and agriculture biomass and livestock with the multipurpose objective to: (i) reduce climate risks (e.g. fire risk, pests and dieback events linked to the accumulation of dry biomass and the burning of agriculture waste); (ii) enhance local livelihoods through the creation of new jobs and small green local businesses, and the reduction of the cost of energy; (iii) reduce pollution and carbon emissions from diesel combustion, fires and agricultural waste.



The A2 scenario with the Potential Species Richness in Lebanon by 2050, comes from the publication: Navarrete Poyatos, M.A. et al (2014) Climate change impacts on native tree species distribution in Lebanon: Potentiality projections to 2050. IDAF

Based on a study lead by IDAF[10] that forecasted the projected changes by 2050 under B1 and A2 IPCC scenarios in the distribution range of 20 forest tree species native of Lebanon, the team selected 15 common tree species in the different bio-climatic zones of the landscape, analysed their current and future potential distribution ranges, extracted conclusions on the climate change modelling and field observations, and formulated a strategy for the management and use of each species in the development of the FLR plan. The FLR implications of this exercise may be summarized as follows:

a) The FLR approach in the buffer zone of the SBR should match sustainable, adaptive management measures – e.g. biomass management and fire prevention - to reduce anthropogenic drivers of biodiversity loss, and increase resilience against climate risks.
b) Seedlings and seeds from species whose distribution is projected to shift upwards should be planted in areas about 200 m above the current distribution area, mixed with other species whose current distribution coincides with the plantation site. In this way, the future need for species migration at high altitudes is accelerated, without drastically altering the floristic composition of the current ecosystem in the intervention site.
c) Perform seedling/seed planting from species whose distribution range is projected to shift upwards in pasture areas without woody vegetation, by creating small scattered patches, temporarily fenced, that will become seed dispersion islets that will facilitate the future migration needs at higher altitude areas.
d) In the case of species that inhabit the upper altitudinal limit and that cannot migrate at higher elevations, – as is the case of cedars and junipers– it is advisable to plant seedlings in those sites that offer the best environmental conditions (e.g. to avoid sites with very poor soils, and exposures to strong winds) for the future survival of the plants.

Current and Future (2050) Potential Distribution of Selected Tree Species in the Shouf-West Beqaa Landscape

Species	Current & future potential distribution range						CC Impact and FLR recommendation
	Shouf side (SS)			W. Beqaa (WB)			
	MM	SM	OM	MM	SM	OM	
Acer obtusatum	↓	↑		↓	↑		• Upwards migration • Seedling planting (current distribution range & above)
Acer tauricolum			■			↓	• SBRL: area with highest future potentiality in Lebanon • Narrowing distribution range in WB • Seedling planting (current distribution range)
Arbutus andrachne	↓	↑↑		■	↑		• Upwards species migration •Seedling planting (current distribution range & above)
Cedrus libani		⊘	↓				• SBRL: area with highest future potentiality in Lebanon • Narrowing distribution range • Seedling planting (current distribution range), avoiding sites affected by strong wind

Species	Current & future potential distribution range						CC Impact and FLR recommendation
	Shouf side (SS)			W. Beqaa (WB)			
	MM	SM	OM[45]	MM	SM	OM	
Crataegus spp.	⊘	↓↓	↑↑	⊘	↓	↓	• SBRL: area with highest future potentiality in Lebanon • Upwards species migration • Narrowing distribution range in WB •Seedling planting (current distribution range & above)
Juniperus drupacea		⊘	↓		⊘	↓	• SBRL: area with highest future potentiality in Lebanon • Narrowing distribution range • Seedling planting (current O. distribution)
Juniperus excelsa			■			■	• Narrowing distribution range in WB • Seedling planting (current distribution range)
Juniperus oxycedrus	■	↓	↑	⊘	↓	↓	• SBRL: area with highest future potentiality in Lebanon • Upwards species migration • Narrowing distribution range in WB •Seedling planting (current distribution range & above)
Pinus brutia	↓	↓	↑	(S) ↓	(S)	↑	• Upwards species migration • Northwards species migration in the WB •Seedling planting (current distribution range & above)
Pistacia spp.	↓	↓	↑	(S) ↓	(S)	↑	• Upwards species migration • Northwards species migration in the WB •Seedling planting (current distribution range & above)
Prunus ursina		↓↓	↓		(S) ↓↓	(S) ↓	• SBRL: area with highest future potentiality in Lebanon • Upwards species migration • Narrowing distribution range in WB •Seedling planting (current distribution range & above)
Pyrus syriaca	↓↓	↓↓	↑	(S) ⊘	(S) ⊘	↑	• SBRL: area with highest future potentiality in Lebanon • Upwards species migration • Narrowing distribution range in WB •Seedling planting (current distribution range & above)
Quercus calliprinos	↓	↓	↑		↓	↑	• Upwards species migration • Narrowing distribution range in WB •Seedling planting (current distribution range & above)
Quercus infectoria		↓↓	↑	⊘	↓↓	↑	• SBRL: area with highest future potentiality in Lebanon • Upwards species migration • Narrowing distribution range in WB •Seedling planting (current distribution range & above)
Styrax officinalis	↓↓	↓↓	↑	↓↓	↓↓	↑	• Upwards species migration • Narrowing distribution range in WB •Seedling planting (current distribution range & above)

Symbols:

- ■ Current high potentiality
- ■ Future high potentiality
- ■ Current medium to low potentiality
- ■ Future medium to low potentiality
- ↑ Future low to mid potentiality increase
- ↑↑ Future high potentiality increase
- ↓ Future low to mid potentiality decrease
- ↓↓ Future high potentiality decrease
- ⊘ No future potentiality

FLR in the Shouf-West Beqaa Landscape has addressed the root causes of landscape degradation through the selection and implementation of priority actions at various levels:

Level	
Proximate causes behind direct threats	• Ecological restoration to increase the extension and improve the quality of habitats and the populations of rare and/or threatened flora and fauna. • Development of production protocols and availability of plant material in local nurseries from a wide range of native plant species and genotypes of local crops and wild relatives. • Reduction of fire risk through the management of forest biomass and agriculture waste. • Reduction of water shortage through water harvesting structures, the reduction of soil water evaporation in forest planting and agriculture production, and the increase in the availability of water in the soil through water capture and storage systems. • Reduction of soil erosion through the restoration of agriculture terraces and the improvement of soil cover in agriculture production. • Reduction of pollution through the promotion of organic agriculture, the management of solid waste for briquettes production and compost, and municipal plans to prevent and regulate polluting uses in the landscape. • Incorporation of climate change adaptation measures in the methods and technologies for the restoration of agriculture land and natural ecosystems, and the management of natural resources.
Intermediate causes	• Revitalization of traditional customary governance systems, mainly linked to short-distance transhumance grazing systems. • Establishment of local governance mechanisms to facilitate FLR planning and implementation. • Clarification and cadastral mapping of land tenure and promotion of participatory planning processes to regulate land uses and prohibit urbanization, mining, hunting and unsustainable activities. • Support farmers to convert their lands into organic farming of high value local crops and wild edible plants. • Support unemployed locals and refugees to develop professional skills and find jobs linked to the management of natural resources.
Ultimate causes	• Demonstrate best practices through pilot interventions on spatial planning, effective governance systems, and sustainable management of forests, pastures and agriculture to influence policy making and legislation/regulations improvement. • Build the institutional and technical capacity of all actors on FLR. • Raise awareness and education of local stakeholders and visitors, with special attention to the new generations. • Enhance green growth in the SBR landscape through the promotion of small local business that respond to climate change, and value chain development around goods and services from the landscape ecosystems.

[9]: bid
[10]: Navarrete Poyatos, M.A. et al (2014) Climate change impacts on native tree species distribution in Lebanon : Potentiality projections to 2050. IDAF.

FLR Principle III: A Shared Vision for Restoring Multiple Functions for Multiple Benefits

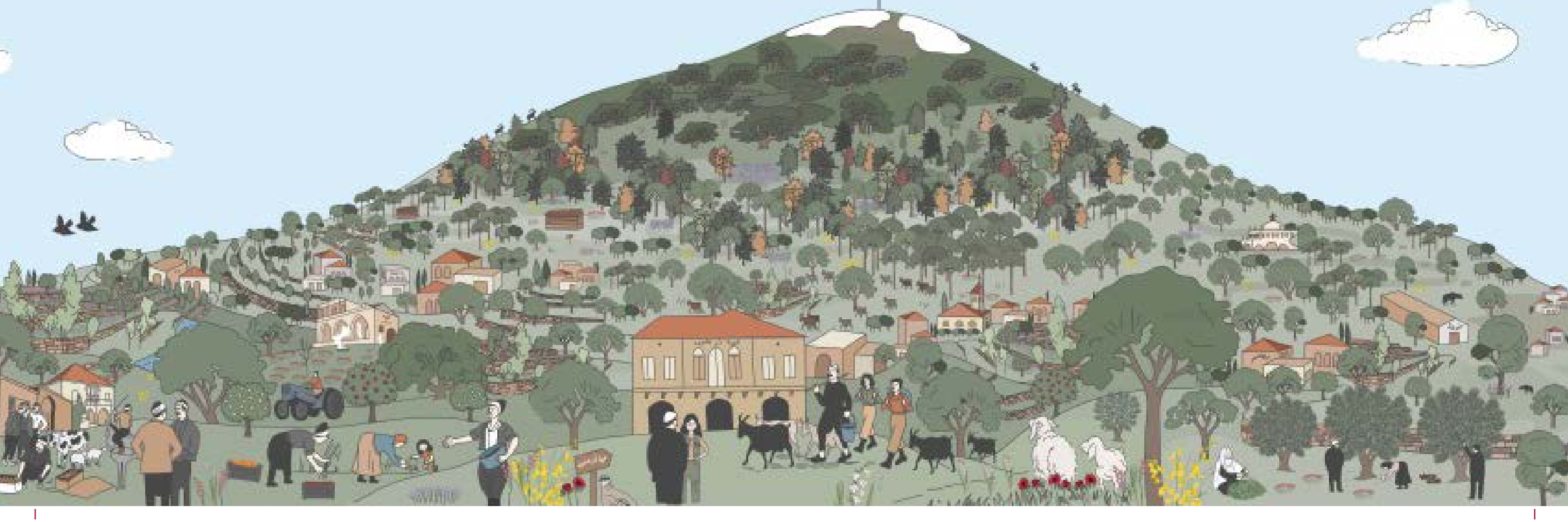
FLR interventions aim to restore multiple ecological, social and economic functions across the landscape, generate a range of ecosystem goods and services that benefit multiple stakeholder groups, and help conciliate the different actors' interests, including biodiversity conservation needs.

A shared vision describes the desired state or ultimate condition that will result from long-term restoration actions, in terms of the natural capital (NC) and ecosystem services (ES) that deliver the desired socio-economic benefits in the landscape. Defining a vision enables the landscape stakeholders to discuss about the importance of different landscape ecosystem services for each, account for factors that may produce trade-offs between different interests with an understanding of why (and what) trade-offs result, discuss about the variety of positive and negative effects associated with both conservation and development needs, and agree on restoration goals and outcomes that help create synergies between stakeholders acting at different scales and provide a natural link between local, regional and global scales (e.g. local communities within the immediate vicinity of the ES of interest; users of the ES of interest living outside the landscape). The vision statement and mapping exercise becomes the starting point for discussion about developing FLR goals for the landscape, and turning them into more specific and tangible outcomes that can drive activities and result in accomplishments.

The landscape vision

Together with all stakeholders, the team formulated a FLR vision for a climate resilient SBR Landscape:

"A highly diverse and functional SBR landscape that is internationally recognized as the repository of a rich cultural heritage linked to its natural resources and emblematic species - especially the national symbol Cedrus libani, that sustains healthy ecosystems and viable populations of biological species resilient to environmental risks, and whose restored ecosystem services support the economic, cultural, and spiritual needs of local communities"



1- Supporting effective governance & participation

2- Restoring ecosystem services

3- Adaptive management for climate-risk reduction

4- Improving water conservation & harvesting

5- Transforming waste into a good & reduce pollution

6- Managing human-wildlife interactions

7- Enhancing biodiversity & cultural values

8- Green Growth & economic diversification based on local identity

Multi-purpose FLR Goal to Build the Ecological, Socio-economic, and Cultural Resilience of the SBR Landscape

Building landscape resilience to climate and anthropogenic disturbances involves interventions at different levels that are interdependent with the multi-purpose goal of increasing ecological, social and cultural resilience and promoting sustainable development. The programme team has agreed on a set of FLR objectives contributing to the ecological, socio-economic, and cultural resilience of the landscape against climate change impacts:

Overall Landscape:

• Restore the connectivity, functionality and diversity of the natural ecosystems in the SBR mountainous landscape, to facilitate the species adaptation needs – in situ conservation and upwards migration – enhance the availability of ecosystem services, and create a more resilient mosaic-like landscape pattern against climate risks.

• Produce and use climate-resilient seedlings from a wide range of native plant species and locally-adapted crop varieties to recover in an integrated way the natural ecosystems and the agricultural terraces with high diversity of high value organic crops, contributing to the ecological, social and economic resilience of the landscape.

• Mainstream water regulation, harvesting and storage in FLR interventions, involving the construction of green infrastructures and restoration of agriculture terraces to regulate water flow and enhance groundwater recharge, and the use of drought-resistant species and soil protection techniques such as mulching in forest restoration and agriculture production to reduce soil water evaporation.

Upper Natural Landscape Area:

• Restore the large herbivore population of the SBR landscape, resulting in a balanced predator/prey food web, which has a profound positive effect on the health of the ecosystems of the core zone of the reserve.

• Restore the species diversity and connectivity of fragmented mountain forest stands – especially the small relic cedar populations - through the active planting of climate-adapted framework species from the reference ecosystem, and making use of positive species interactions, such as the nursery effect of oaks and shrubs facilitating the growth of the established seeds and seedlings.

Lower Cultural Landscape Area:

• Diversify simplified, degraded woodlands and scrublands by planting and/or supporting the natural regeneration of multipurpose native species with high ecological, socio-economic and cultural values, that help reduce trade-offs between the economic development demands of the local population and the recovery of ecosystem services.

• Create suitable conditions for the effective governance of short-distance transhumance in the buffer and development zones of the SBR landscape, making use of effective rotation-resting livestock management, and recovering diversified woody pastures - sowing legumes, and establishing scattered fenced plots for seeds and seedling planting, predominantly oaks - which ensure permanent food and shelter under climate change conditions, and higher quality and quantity of dairy products.

• Apply an integrated climate change adaptation and mitigation through joint management of oak/pine forest biomass and agriculture waste to be converted into bioenergy (briquettes) for household heating and cooking, and compost for agriculture, with a positive effect on: (i) the reduction of climate risks such as forest fires and dieback events; (ii) the improvement of forest growth and carbon storage; (iii) the reduction of carbon emissions by replacing fuel with briquettes; (iv) the improvement of livelihoods through the creation of employment, the creation of small businesses and the reduction of energy costs and indoors pollution problems from the burning of fuel.

• Restore the productivity, biodiversity and cultural values of traditional agriculture terraces systems and related semi-natural habitats, supporting critical ecosystem services, and producing diversified high value crops of wild plants and local fruit varieties with a tree-crop-livestock integrated management approach.

• Enhance the climate resilience of a gender- and youth-sensitive local economy through a green growth approach based on the integrated development of green value chains of a diversified set of forest, agriculture, livestock and tourism-related products resulting from FLR interventions, and targeting the local, national and international markets.

Resilience in the SBR Landscape

Resilience can be defined as “the capacity of a social and/or ecological system to absorb disturbances and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks”[41]. Social resilience is an important component of the circumstances under which individuals and social groups adapt to environmental change. Ecological and social resilience may be linked through the dependence on ecosystems of communities and their economic activities, and the dependence on sustainable cultural practices of long-ago modified ecosystems.

Socio-Economic Resilience

Highly diverse traditional production systems:
- Terraced crops for olive and fruit trees, vineyards, cereals and vegetables
- Transhumant livestock management for milk products, leather and meat
- Harvesting of firewood, honey, edible plants, pine nuts and fruits.

Shouf Landscape Resilience

Ecological Resilience

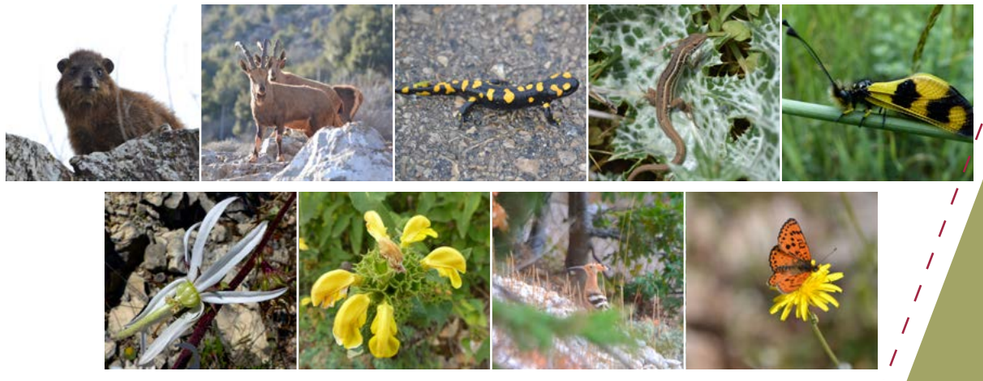
Highly diverse agro-silvo-pastoral mosaic landscape:
- Spring-summer mountain pastures
- High mountain cedar and oak forests
- Semi-domesticated low mountain oak and pine woodlands
- Highly diverse habitats and crop species & varieties linked to the agriculture terraces

Cultural Resilience

Strong regional Identity around the production of high value products (e.g. olive oil, wine, labneh, oak & cedar honey and pine nuts), and strong historical cultural influences directing farmers towards their production.

More resilient social-ecological systems are able to respond to shocks without changing in fundamental ways. In other words, they can cope, adapt, or reorganize without sacrificing the provision of ecosystem services[42]. Resilience is often associated with diversity at different levels: ecological diversity in terms of habitats, species and gens; socio-cultural diversity in terms of the use of large number of crop and animal species and genetic varieties, and diversification of cultural practices, production and market opportunities.

Building social-ecological resilience requires understanding the complex connections between people and nature, incorporating the knowledge of local users, and creating opportunities for technological innovations and supportive economic incentives and policies.



Ecological Diversity

The capacity of species to adapt to new circumstances, - e.g. resource scarcity, a changing environment - depends on its genetic diversity: the greater the variation in genes, the more likely is that individuals in a population will possess the genes which are needed to adapt to changes in their natural environment.

Plant diversity increases the stability of predator species richness, possibly as a result of higher habitat structure and herbivore diversity. It provides a key ecosystem service by reducing insect outbreak potential over time. Thus conserving and and restoring diversified plant communities contribute to the maintenance of biodiversity, ecological processes, and the stability of entire food-webs.

Biodiversity plays an essential role for the functioning of extensive natural landscapes, that consist of different ecosystem types such as forests, pastures, scrubland and agriculture land. Landscapes with a greater biodiversity are more productive and their productivity shows lower year-to-year variation under climate-driven environmental changes.

SBR

Landscape Resilience

Socio-economic Diversity

Cultivating different varieties of the same crop species and different crop types in the same plot increases resilience:
Each variety and each crop species tolerates different environmental constraints (e.g. drought, frost, heat, pests) and all together reduce the risk of loosing the entire harvest.
Each variety and/or species may fructify in a different period, which lengthens the production season and increases market opportunities.
Different species and products helps diversify market opportunities.

The diversity of crop species and varieties increases the aesthetic and cultural value, as well as the tourist potential of the landscape.

The diversity of habitats linked to farming systems increases the ecosystem services (e.g. Pollination, presence of insects that fight pests, soil fertilization, wáter conservation, edible species).

FLR Principle IV: Maintains and Enhances Natural Ecosystem integrity and functionality within the Landscape

FLR enhances the conservation, recovery, and sustainable management of natural ecosystems and traditional management practices that are linked to the cultural identity of the landscape, following the "ecological restoration principles" - an intentional activity that initiates or accelerates the recovery of ecosystems with respect to their functions, structure, species composition and resilience to environmental risks.

The Production of High-Quality Plant Material

The main criterion when selecting plant material for a FLR operation will be the multipurpose character of the selected species. Priority should be given to those native species that provide a number of critical environmental, social, economic and cultural benefits jointly identified by researchers, land owners and users, municipal forest committees, forest, livestock and agriculture agents, etc. In the case of the Shouf-West Beqaa Landscape, the main criteria taken into consideration in the plant selection process in the SBR were: environmental (increase landscape resilience to climate impacts; be part of the reference ecosystem; attraction of seed-dispersal fauna; re-sprouting after disturbances such as fire, cutting and browse; provide soil protection/ improvement benefits; drought resistance; biodiversity conservation); and economic, social and cultural (economic production; pollination and pest control services; social preference; cultural keystone species).

Plant reproductive material for ecological restoration activities includes seeds, whole plants, and cuttings for vegetative propagation. Plant reproductive material is gathered in the field preferably in areas near the site to be restored and with similar ecological conditions. In the Shouf Biosphere Reserve seeds from about 45 native species were gathered in areas with similar ecological conditions to the areas being restored. The action required: (1) a good knowledge of the target species through the consultation of literature, web, specialists, and interviews with people living in the areas where the species occur; (2) the delineation of a mapping of the exact region of provenance of each seed species; (3) the establishment of criteria for the selection of high-quality seeds; (4) a research on the best timing for the collection of each species in the field.

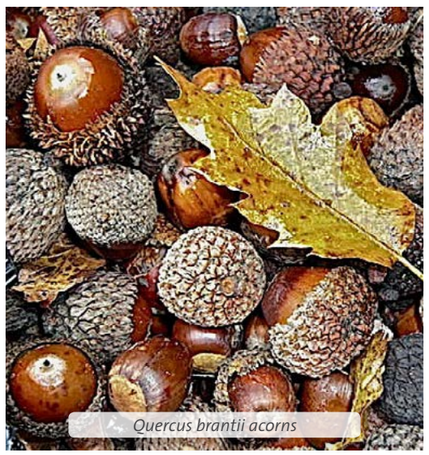
State-of-the-art management of collected reproductive material is required from the collection site prior to its use in the tree nursery or to its direct use in the restoration sites. Protocols for each species should be developed, in terms of collection tools, duration and conditions of transport from the field to nursery, storing, packaging, temperature, humidity, shadow conditions and stratification. In the FLR program of SBR, the protocols for the management of seedlings was entrusted to an international expert, who worked closely with the Lebanese nurseries that had been selected as suppliers. The protocol established criteria for the cleaning-extraction-processing protocols specific of the seeds from the fruits of each species; testing procedures for seed viability, selection and calibration, and strict short- and long-term conservation measures.

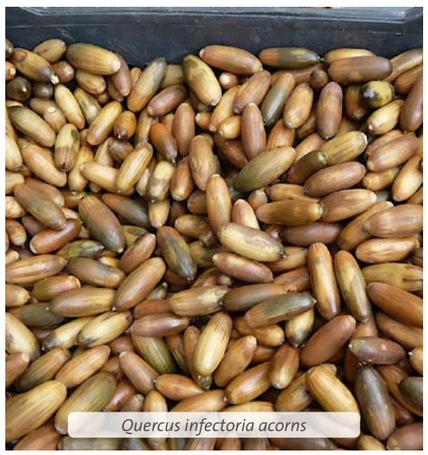
The program applied seed treatment technologies developed to facilitate uniform germination and improved plant production, including treatments for breaking internal and external dormancy (warm and cold stratification, use of acids, choice of the right substrate etc), and pre-germination techniques to accelerate germination right after seed sowing.


Collecting fruits in the wild


Juniperus drupacea seeds


Sorbus torminalis fruit collection

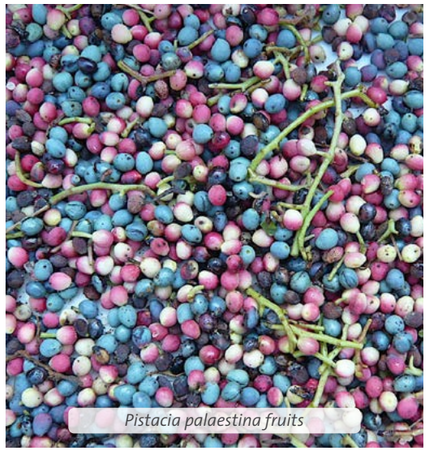

Quercus brantii acorns


Quercus infectoria acorns


Crataegus azarolus fruits


Cedrus libani seeds


Laurus nobilis fruits


Pistacia palaestina fruits


Stratified seeds

Germination of Acer obtusatum seeds


Germination of Acer obtusatum seeds

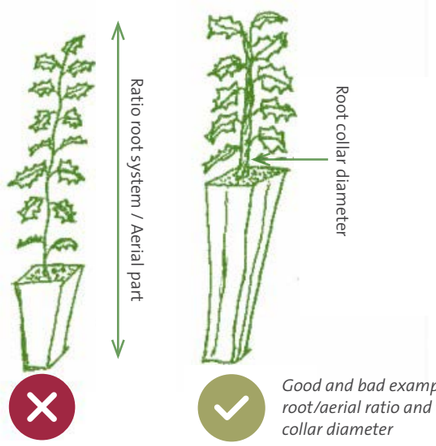
The technologies and protocols used in the tree-nursery determine the quality of the plant material and are critical for a better performance in the field. The FLR program fine-tuned the cultural practices in the nursery to improve the quality of the produced plants so they would be highly adapted to limiting climate conditions. Optimizing the seedling potential for establishment in harsh field conditions depend on the following factors[11]:

• Working with tree nurseries that have a good experience of the local flora and ecosystems. The FLR program of SBR established a collaboration with Native Nurseries, an enterprise located in Ramlieh, one of the municipalities of Alay region.
• The programme promoted the use of adequate containers that prevent root spiralling and are adequate to the morpho-functional characteristics of the plant species, its development patterns

and the environmental conditions where it will be planted. Under Mediterranean climate conditions with strong water restrictions during summer drought period a poorly developed seedling root system will lead to high mortality. In this sense, the local nursery produced seedlings with an appropriate biomass distribution, and an optimum root/shoot ratio with a robust root system longer than the aerial part, capable of reaching quickly the deeper and moister soil during the summer drought period.
• The local nursery used soil substrates that allowed optimum oxygenation of the plant root system[12], presented good water holding capacity to help reduce the post-transplant shock, and reduced water stress conditions during the first months after out-planting.
• Water quality was a primary consideration as this is a critical factor for plant production. Good water management required an efficient use of water, reliable sources of water, high uniformity of water distribution, and a flexible approach to the changing needs of species grown during germination and early growth. Hand-watering required simple and inexpensive equipment as the most practical irrigation strategy for small/medium native plant nurseries like the one in Ramlieh. After the specific watering requirements for each plant species were understood the nursery owner established automated micro-pressurized irrigation systems to meet the plant's needs.
• The programme set up a pilot composting unit in the village of Maasser to supply the restored agricultural terraces, producing aerobic compost with shredded material from the pruning of trees, and cow and chicken manure. The initiative also involved: (ii) training landowners to develop a composting unit on their farms, following the model in Maaser, with learning-by-doing workshops; (iii) the development of educational materials to outreach other farmers beyond the programme framework.
• The FLR initiative in the SBR supported biological phytosanitary treatments that are more environmentally-sound and prevent water/soil pollution and workers' health problems.
• The use of inorganic herbicides was not supported due to the negative health and environmental effects. Moreover, the repeated use of one herbicide, or herbicides with a similar mode of action will gradually produce a shift in the weed population to those that are tolerant, or it could lead to the development of an herbicide resistant biotype.
• The plant material used in the FLR was obtained in two ways: (1) Propagation from seeds, a system that enhances genetic diversity, improving the capacity of the seedlings and restored habitats to cope with climate variability and change, and (2) Cuttings, the most popular method of vegetative propagation. Seedlings from cuttings have identical genetic makeup which reduces the diversity of the plant populations that they produce. This makes them less resistant to pests and diseases, as well as to climate variability. In ecological restoration cutting techniques are only recommended for those species with very difficult germination.
• A key part of the process of seedling production was the hardening treatments, consisting of:
(1) Drought preconditioning: it consists of reducing the watering regime in the tree-nursery by submitting the seedlings to progressive drought conditions to enhance the physiological attributes

that increase the survival and growth of seedlings under field condition. The following hardening measures were applied: When seedlings are transferred to grow outside the greenhouse, after the germination phase, watering is reduced from 85% to 70-75%. At the end of the production process (1-1.5 months before planting) watering is decreased to 50-60% to guarantee a good hardening. Right before planting, seedlings are heavily irrigated in the nursery and transported to the restoration sites. (2) Nutritional hardening: Nutritional hardening implies the reduction of nitrogen supply to control seedling growing, promote reserve accumulation, and increase K supply to prevent transpiration water loss and to face low temperatures[13].

Cedrus libani high quality seedling



Good and bad example of root/aerial ratio and root collar diameter

[11]: *Most information extracted from: Chirino E. et al (2009). Ecological restoration in degraded drylands: the need to improve seedling quality and site conditions in the field. Chapter 4 in: S.P. Grossberg Ed. Forest management. Nova Science Publishers, Inc.*
[12]: *Tsakaldimi, M. (2006). Kenaf (Hibiscus cannabinus L.) core and rice hulls as components of container media for growing Pinus halepensis M. seedlings. Bioresource Technology, 97, 1631-1639.*
[13]: *Chirino, E., A. Vilagrosa, J. Cortina, A. Valdecantos, D. Fuentes, R. Trubat, V.C. Luis, J. Puertolas, S. Bautista, M.J. Baeza, J.L. Peñuelas & V.R. Vallejo (2009) Ecological restoration in degraded drylands: the need to improve the seedling quality and site conditions in the field. In: Forest Management, Steven P. Grossberg Ed. Nova Science Publishers, Inc.*

Quercus infectoria seedlings

Cedrus libani seedlings

Abies cilicica seedlings

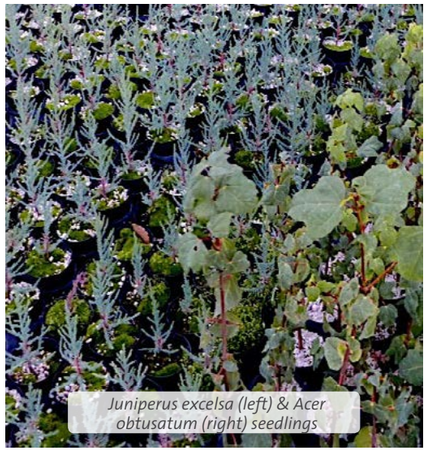
Pinus brutia seedlings

Celtis australis seedlings

Crataegus sp. seedlings

Pyrus syriaca seedlings

Arbutus andrachne seedlings

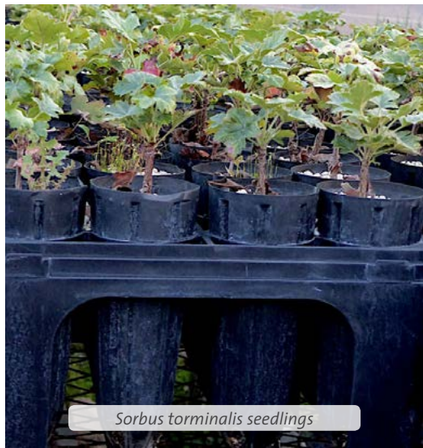


Juniperus excelsa (left) & Acer obtusatum (right) seedlings

Rhus coriaria seedlings

Lonicera nummulariifolia seedlings

Prunus dulcis seedlings



Sorbus torminalis seedlings

Effective Field Forest Restoration Interventions to Increase Water Availability and Seedling Survival

Landscape restoration in Mediterranean areas with summer drought conditions will require addressing the question of how to establish efficient arrangements for water supply and water use to ensure both ecological and socio-economic sustainability. The main complementary approaches applied to improve the water availability for seedlings, especially in the first years after plantation are: (i) the selection of drought-tolerant species and ecotypes which may be better adapted to face summer drought; (ii) the use of water and nutrient hardening treatments to the seedlings produced in the tree nursery to induce mechanisms for drought resistance; (iii) the increase of water availability in the field through proper location of the planting hole and soil preparation techniques; (iv) The reduction of water losses (e.g. location of the hole in micro-relief areas with higher protection from the sun; the use of mulching, shelters and nurse-plants as facilitators).

The main challenge faced when planting seedlings, cuttings and sowing seeds in the field restoration interventions was to overcome water stress after planting, especially during the summer drought period of the first year after planting which has extended well beyond autumn (late October/early November) due to climate change trends. Innovative soil and water conservation technologies, as well as planting techniques that mimics ecological interactions to foster seedling establishment, have significantly improved plantation success in line with results from other experiences in the Mediterranean region[14]. These included: increasing the planting hole depth, applying soil mulching, and constructing micro-catchments for runoff harvesting. In the SBR the combined use of micro-catchments and the setting of stones covering the hole around the planted seedlings for soil mulching have provided very satisfactory results promoting runoff harvesting, reducing soil water evaporation, and preventing the growth of weeds.

Irrigation has seldom been used in large forestation projects in the Mediterranean region. Assisted watering should not be necessary, or at least it should be limited to exceptional times of water stress in the first two years after planting if the following three premises are met:

- Use of high-quality seeds, seedlings and cuttings, well hardened to face the field conditions;
- Adequate preparation of soil conditions to help store the maximum quantity of water;
- Selection of the right time for planting at the beginning of the rainy season.

Many irrigation systems are available to deliver water to planted seedlings in an efficient way, but scientific literature and innovation on this topic is scarce. The FLR initiative in the SBR considered the following systems: (1) Small water inputs applied by drip irrigation or hand hose; (2) Fog water collection. The FLR planting interventions were designed with the exclusion of assisted watering. However, the programme undertook assisted watering in a number of sites when summer drought was more intense. Interestingly the survival rate of irrigated seedlings did not increase in comparison with the rest.

Forest Landscape Restoration planting interventions in the SBR Landscape aimed to enhance habitat functionality and species diversity. The programme has supported the planting of seeds and seedlings from about 45 native species representing the "reference ecosystems" of the different habitat types under restoration. Generally speaking, between 9 to 12 different species where planted in the same site, including dominant tree species (representing the majority of seedlings) and companion tree and shrub species.

Post-planting interventions include:

- Replacing dead seedlings. In the SBR, 2,000 seedlings were replanted in 2015 to replace dead seedlings planted in 2014. Seedlings from coniferous species and oaks were the most sensitive and affected by the severe drought conditions in 2015. In the case of oaks, predation of a large number of sown acorns caused high mortality in a number of sites. In order to overcome this problem, the acorns were planted with protectors the following year which increased their survival significantly.
- Supplemental irrigation in the restored sites. Because of climate change and exacerbated summer drought conditions, one or two supporting summer irrigations in years were applied after planting in few areas, although the survival rate of irrigated seedlings did not increase in comparison with the non-irrigated ones.

The nursery effect of thorny cushion legumes (*Onobrychis cornuta*) facilitating the growth of Prunus ursina seedling

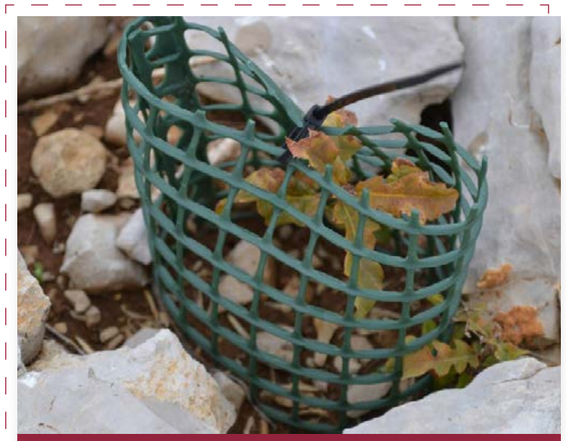
The nursery effect of *Quercus brantii* facilitating the growth of cedars

Applied research projects in the Mediterranean region have demonstrated a much higher seedling survival when planted under/nearby individuals of pioneer shrubs acting as nurse plants, when compared to seedlings planted in open areas where the vegetation cover had been previously cleared[15.16.17]. The rationale for this is that the pre-existing vegetation buffers summer drought stress, ameliorates the water status of seedlings and thus usually increases seedling survival. The SBR FLR planting interventions maintained the vegetation cover in the restored sites, and made use of the positive nursery role played by oaks and legume thorny shrubs that provide shelter and favourable micro-climate conditions for the planted seeds and seedlings. The use of nurse-plants in restoration work was tested in two ways: (1) Increasing the population of facilitator species through seed sowing or seedling planting (e.g. the sowing of oak acorns) that locally ameliorate abiotic conditions and biotic conditions; (2) Testing the "nursery effect" of thorny shrubs to demonstrate an effective facilitation role supporting the survival and growth of seedlings and seeds planted in the adjacent part above the nurse plants.

The best period for planting is the one in which the soil has the necessary water for the establishment of the seedlings to meet their water needs during the first months on the ground. In the SBR landscape this basically corresponds with October/November. However, inter-annual climate variability and climate change trends are significantly affecting both the total amount of annual rainfall and the starting of the rainy period. This makes it necessary to monitor the rains to ensure that the soil is sufficiently wet to start planting.

An important adaptive measure is adjusting the planting density and seedlings' distribution. In the Mediterranean climate the main factor influencing the planting density is the seedlings' competition for the scarce water resources. Planting densities should be adjusted to the carrying capacity of the habitat in terms of soil conditions and water availability and to the species used. It is a common mistake to use planting densities substantially higher than the maximum density attainable by these species in natural landscapes. The FLR work in the SBR applied planting densities between 500-800 seedlings of trees/ha, and between 1500-1750 seedlings of shrubs/ha, depending on the landform units.

[14]: *Chirino, E., A. Vilagrosa, J. Cortina, A. Valdecantos, D. Fuentes, R. Trubat, V.C. Luis, J. Puertolas, S. Bautista, M.J. Baeza, J.L. Peñuelas & V.R. Vallejo (2009) Ecological restoration in degraded drylands: the need to improve the seedling quality and site conditions in the field. In: Forest Management, Steven P. Grossberg Ed. Nova Science Publishers, Inc.*
[15]: *Castro, J.; Zamora, R.; Hódar, J.A.; Gómez, J.M., 2002. The use of shrubs as nurse plants: a new technique for reforestation in Mediterranean mountains. Restoration Ecology, 10, 297-305.*
[16]: *Castro, J., R. Zamora, J. Hódar, J.M. Gómez, L. Gómez-Aparicio (2004) Benefits of Using Shrubs as Nurse Plants for Reforestation in Mediterranean Mountains: A 4-Year Study. Res- toration Ecology Vol. 12 No. 3*
[17]: *Ouahmane, L., R. Duponnois, M. Hafidi, M. Kisa, A. Boumezouch, J. Thioulouse and C. Plenchette (2006) Some Mediterranean plant species (Lavandula spp. and Thymus satureioides) act as potential 'plant nurses' for the early growth of Cupressus atlantica. Plant Ecology (2006). Springer*



Sowing of Branti oak acorns with protector to prevent rodent predation

Rodent activity in the soil of restoration sites

Seed sowing under the snow

Cedar seeds

Cedar regeneration

field restoration information panel

Workers digging holes with auger

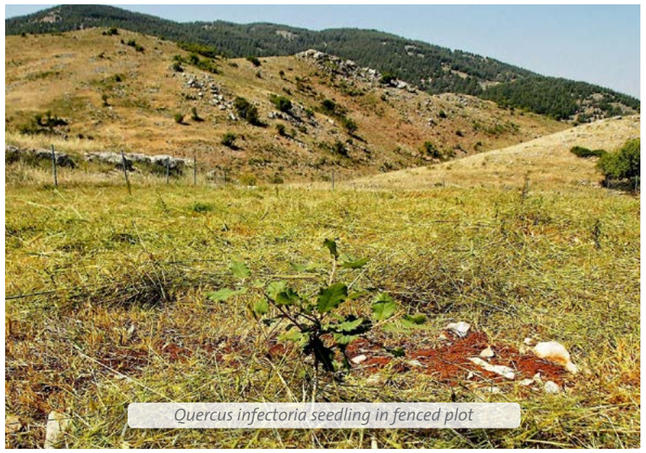
Restoration site in Maasser municipality

Stone mulching

Sorbus torminalis seedling

Cedrus libani seedling

Establishing small 2 m height fenced plots in pasture land to restore "woodland islets"



Quercus infectoria seedling in fenced plot

Quercus calliprinos seedlings in fenced area

Seedling planting in the talus debris inside the quarry in Mrusti

Seedling planting and seed sowing in the talus debris of the abandoned quarry in Mrusti.

Rapid growth of Rhus coriaria seedlings in the slope debris

FLR Principle V: Considers a Wide Range of Implementation Options with a Cost-benefit View

FLR uses a variety of combined approaches that are adapted to the local social, cultural, economic and ecological context, and ensure short- to mid-term economic benefits: (i) policy and governance improvement; (ii) protection measures; (iii) sustainable management of natural resources; and (iv) active field restoration interventions. Convincing and comprehensive cost-benefit justification of the selected approaches in your landscape is a powerful tool to raise the interest and create demand for FLR among policy makers and private investors. The diverse set of environmental, social and economic benefits generated by FLR interventions – from restoring traditional agriculture terraces for high quality diversified products, to local job creation, to global climate change mitigation, to improved ecosystem services – is an important reason to raise the landscape stakeholders' interest in FLR. The challenge lies in estimating a value for the different multi-purpose benefits that are relevant to the different stakeholders that are involved in FLR planning and decision-making.

Select the Type of Restoration Interventions

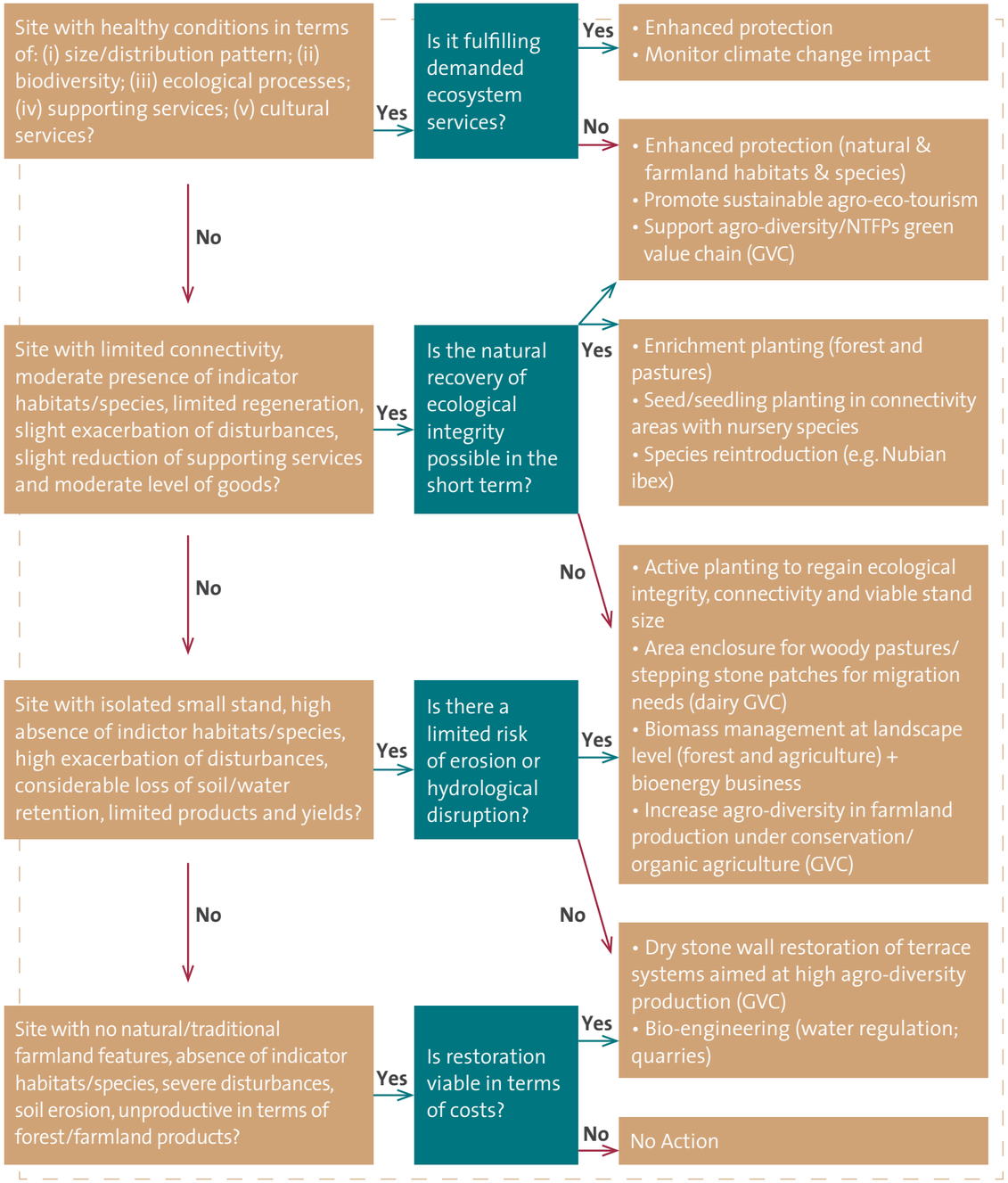
In most cases forest landscape restoration consists of a combination of protection, management and active planting measures. Protection and management interventions may be very effective in the early stages of landscape degradation and very often are very affordable actions in terms of costs. Active restoration interventions "described in FLR Principle IV" may be required when natural ecosystems need support to enhance regeneration and species diversification. A cost-benefit analysis must precede the decision to adopt each measure. In fact, the need for active restoration should be carefully assessed and, if land degradation risks do not require urgent seeding/plantation actions, it may be desirable to first monitor the results of protection/management interventions before deciding what will be needed. It may result that protection, adaptive management and/or enriching planting activities may be all that is required. This will result in a substantial reduction of costs and site alteration.

Decision-making was based on a cost-benefit analysis that estimate pros and cons for restoration intervention options depending on the conditions of the site and the landscape matrix in which the site is embedded. The analysis went beyond monetary costs and benefits, looking at:

- environmental benefits, such as whether the action will: enhance biodiversity, ecological processes, ecosystem connectivity; enhance water harvesting, storage and regulation; enhance soil conservation and health conditions; facilitate climate change adaptation and mitigation needs; minimize the impact of extreme whether events such as forest fires and drought; reduce inhouse and outdoors pollution; stop and reverse mines and infrastructures in the buffer area of biodiversity hotspots;
- social benefits, such as whether the action will: create job opportunities for vulnerable population (e.g. young unemployed and refugees); increase the availability of local products derived from restoration actions with lower costs for local communities; prevent health problems at home due to diesel heating; improve water availability and quality for human consumption; improve the availability of health food products; support producers' organizations, especially women cooperatives, as collectively, forest and farm producers have higher chances to achieve sustainable development goals and respond to climate change at landscape scale;
- economic benefits, such as whether the action will produce financial gains, such as: create opportunities for the existing and new local businesses; enhance production of a wide range of high quality forest, agriculture, livestock, and touristic products; open new international and domestic market opportunities linked to the green branding of the restored landscape ecological and cultural values.

The FLR programme in the Shouf-West Beqaa landscape has organized multi-disciplinary and multi-stakeholders' workshops making use of a scoring system to assess the degree of conservation or alteration of the conditions of the site and the landscape matrix in which the site is embedded, and identify the most suitable restoration interventions that provide a balance between environmental, social and economic benefits. The following figure summarizes the decision making exercise to define restoration needs according to the conditions of the site/landscape matrix and the priorities identified in terms of restoration interventions with the consideration of the environmental, social and economic benefits.

Carefully assess the range of combined RR intervention needs and options (e.g. protection, area enclosures, adaptive biomass management, crop diversification, active restoration) with a cost-benefit view



Define FLR Priority Interventions for the SBR Landscape

Based on landscape mapping exercises, field assessments, and consultation with multi-disciplinary experts and programme partners, a strategy for FLR priority interventions was developed. The strategy considered six broad types of land use for restoration interventions: (1) forestland (2) shrubland (3) pastureland (4) agriculture land (5) freshwater areas and (6) barren land. Each of the six area types was further divided according to land use/land cover types: for instance, the "forestland" type was divided into eight sub-groups depending on the dominant species/s (cedar, oak species, pine species, etc) and the management/state of the forest (old-growth, coppice, dense, scattered trees, plantations etc.). Priority interventions were agreed and describes for each sub-type. Again, in the case of forestland, these include: different techniques of enrichment planting (using seeds and seedlings from one or more species); full protection; temporary area enclosures with or without planting of seeds and seedlings; thinning and pruning operations; measures to avoid the burning of the forest understory to prevent soil erosion; controlled grazing; compensation measures for areas where access needs be limited; etc. Finally, a landscape layer was added to the strategy, to make sure that the different FLR interventions would be implemented in synergetic fashion, enhancing biodiversity and ecological process in a more resilient landscape pattern.
This layer considered, for instance, landscape connectivity ("vertical" and "horizontal" planting intervention to connect forest habitat types along the altitudinal gradient, and among relic forest stands) and species migration needs (creation of fenced "woodland islets" to enhance natural seed dispersal). The selected restoration interventions where analyzed in terms of costs and benefits, and when possible, linked to local business development opportunities.

Develop a cost-benefit FLR Plan

A detailed restoration plan identifies the broad steps and list of actions needed to achieve successful restoration results, covering both the selection of specific measures and the approaches and technologies used to implement them, with the specification of the costs and benefits[18].
The development phase should involve all concerned stakeholders, defining their roles and responsibilities in its implementation and monitoring work. The programme has applied the FAO's Monitoring and Reporting Tool for Forest and Landscape Restoration in Drylands[19], which aims to guide project leaders in designing their projects, and implementers in reporting on and tracking the progress of restoration, analysing the elements of success and failure, and compiling the lessons learned and corrective actions.

Forest Landscape Restoration Plan Components[20]	
General information	Users provide a one-stop summary of the restoration initiative's main attributes, such as its location, geographic extent. The involved stakeholders are identified, along with the nature of their contributions.
Area description	Users characterize the restoration area according to 5 criteria: (1) Climatic conditions and climate-related risks (2) Geomorphological, hydrological and pedological properties (3) Ecological properties (4) Socio-economic context (5) Causes of degradation: historic and current; direct and root-causes.
Problem statement	Users explain what is needed and why, ideally with reference to similar projects carried out elsewhere with lessons learned.
Restoration objectives	Users state the multipurpose restoration objectives and related outcomes, outputs, actions and timeframe. The scope of the intervention and its contribution to broader initiatives is described.
Supportive governance framework	Users assess the level of support for restoration provided by the governance framework. Stakeholder involvement should be detailed in a table showing roles and responsibilities. List information on local actors and providers of specific actions in capacity development, research, awareness raising and institutional development.
Restoration strategy adopted	Users justify the selection of the restoration strategy and prioritized interventions with a cost-benefit explanation. They provide details about: planned interventions, proposed implementation measures, plant material, equipment and inputs needed, human resources needed, and costs. Special attention is given to facilitate natural regeneration, soil and water management measures, the selection of adequate plant material, and planting/post-planting maintenance related activities.
Business plan with costs and benefits of planned interventions and linked businesses	Users develop a business plan with projected net income after production costs are compensated, including: • the cost of the proposed restoration interventions (e.g. the cost of nursery production of native species; active planting costs; area fencing costs; biomass management costs; dry stone wall restoration costs; the cost of green bio-engineering infrastructures; nature trail construction and equipment; construction costs of biodiversity information centre) • the cost of businesses linked to restoration interventions (e.g. bioenergy production; compost production; high value diversified agriculture production and marketing; high value dairy production and marketing; eco-tourism services; non-timber forest products NTFP production and marketing). • The projected net income after production costs are compensated and beyond. • The employment that the intervention will create (temporal and permanent) disaggregated by gender and vulnerable groups. • The local services that the intervention will mobilize in the short and long term (e.g. local providers of inputs, equipment and other services).
Awareness raising and knowledge management	Users describe the planned awareness raising activities to get the buying, consult, inform and disseminate results. Develop a specific plan to share know-how from the FLR intervention with practitioners from the programme area, the national and international arena.
Monitoring	Users specify the proposed monitoring plan, including timeframe, baseline, performance & impact indicators, means of verification, measurement methods, stakeholders' roles and responsibilities, costs, etc.
Results and sustainability	Users provide an indication of the degree of success of the initiative, based on the measurement of processes and activities, with a focus on the following points: (1) Restoration objectives and outcomes; (2) Capacity development; (3) Field restoration ecological results and impacts: survival rate; plant growth; increase in vegetation cover; changes in degradation drivers, cost/ha, etc., (4) contribution to human well-being; (5) Impacts on policies; (6) Environmental impact of restoration interventions; (7) Sustainability; (8) Identification of problems and measures to overcome them in future interventions

Adaptive Management Interventions to Increase Resilience Against Climate Risks

Climate change is exacerbating the landscape vulnerability to unsustainable fire regimes and forest dieback, especially when maladaptive human practices or land abandonment promote the accumulation of dry biomass and the burning of agriculture waste. This is especially evident in the case of the SBR landscape, where forest fires occur mainly in autumn - outside the period of greatest risk in summer - due to the burning of pruning remains and stubble by farmers.

The FLR initiative in the Shouf-West Beqaa Landscape has incorporated management and economic development objectives for climate change adaptation through the collection and economic use of forest and agriculture waste. This has helped transform dense forest stands into a more resilient forest structures that positively contribute to the ecological resilience of the SBR landscape, while supporting new economic development and employment opportunities.

In abandoned coppiced forests and too dense secondary pine/oak forests thinning and pruning operations helped speed up the growth of the best selected stems, increased carbon storage, reduced water stress and competition, and increased the ecosystem services provided by forests (e.g. higher diversity and abundance of non-timber forest products). The collection of pruned branches from fruit trees and other residues also helped reduce the risk of fire while creating economic opportunities through bioenergy and compost production. Forest management interventions consisted in the thinning and pruning of dense oak coppice stands, mainly along the roads, with the aim of keeping about 1-3 stems per individual. This intervention provided excellent results in terms of: (i) improved growth and health conditions of the thinned oaks and pines; (ii) positive effect in raising the awareness of all concerned stakeholders about the climate-risk reduction and socio-economic opportunities; (iii) upscaling effect wherein the MoA forest administration became more willing to support thinning and pruning operations that were previously very limited, or even banned in the case of pine forests; (iv) significant decrease of the risk of fire, especially after agreeing with farmers the collection of pruning remains instead of burning.

The FLR initiative in the SBR has supported livestock grazing as a complementary activity of the thinning and pruning management interventions in forest land. Local shepherds were involved in goat grazing interventions in the years following thinning operations as a way to prevent the regrowth of the cut stems and control the growth of the forest understory in high fire-risk areas, such as along the road network.

[18]: *Keenleyside, K., N. Dudley, S. Cairns, C. Hall & S. Stolton (2012) Ecological restoration for Protected Areas: principles, guidelines and best practices. IUCN.*
[19]: *The Global guidelines for the restoration of degraded forests and landscapes in drylands, developed in the framework of the FAO Dryland Restoration Initiative: http://www.fao.org/dryland-forestry/dryland-restoration-initiative/en/*
[20]: *Based on the FAO's Monitoring and Reporting Tool for Forest and Landscape Restoration in Drylands: FAO. 2015. Global guidelines for the restoration of degraded forests and landscapes in drylands: building resilience and benefiting livelihoods, by Berrahmouni, N., Regato, P. & Parfondry, M . Forestry Paper No. 175. Rome, Food and Agriculture Organization of the United Nations.*

The adaptive management of large grazing areas in the buffer and development zones of the SBR landscape has sought to reduce the pressure of livestock in the upper part of the mountain with integral protection, thus avoiding the degradation of very valuable ecosystems with high species diversity and endemicity, as well as future conflicts between cattle and wild herbivores. The programme mapped the areas assigned to each shepherd to move his flock throughout the annual seasons, and analysed the existing constraints in terms of water and fodder availability, whose scarcity pushes some farmers to illegally cross the boundaries of the integral reserve. The restoration intervention established temporary fences over large areas of herbaceous pastures, for the planting of woody species considered by farmers of high forage value - especially oaks and other native fruit trees for acorn, fruits and leaves - which represent a critical source of food during the summer, and also provides shelter during the days of extreme heat. Enrichment planting of degraded pastures mainly with selected native legume species also improves the quality and quantity of goat milk for dairy products. In addition, the program built water reservoirs in critical areas to supply, among others, water troughs for livestock.


Transporting the charcoal kiln

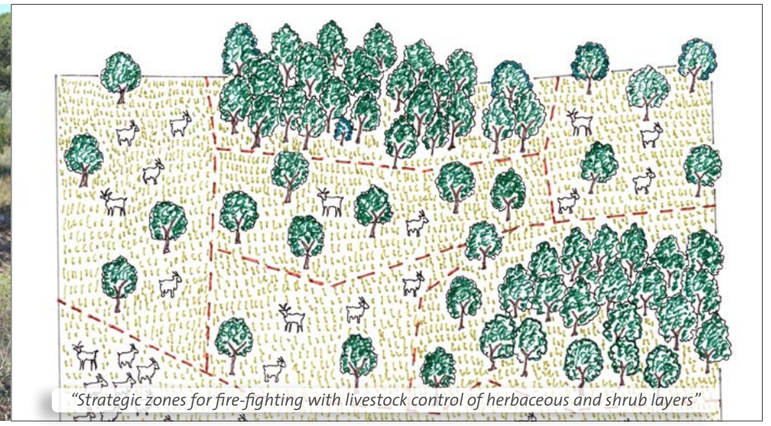

Charcoal production


Thinned forest site maintained with goat grazing


Goats controlling the growth of new shootings in thinned forest sites

Oak forest thinning site


Oak forest thinning operations


"Strategic zones for fire-fighting with livestock control of herbaceous and shrub layers"


Oak thinning


Brutia pine pruning and shredding machine


F ire-break are managed by hired shepherds implementing controlled livestock grazing

Restoring Dry Stone Walls and Soil Conditions in Abandoned Agriculture Terraces for Productive High-value Multi-crop Systems, Using Native Edible and Aromatic Species and Local Varieties of Fruit Trees.

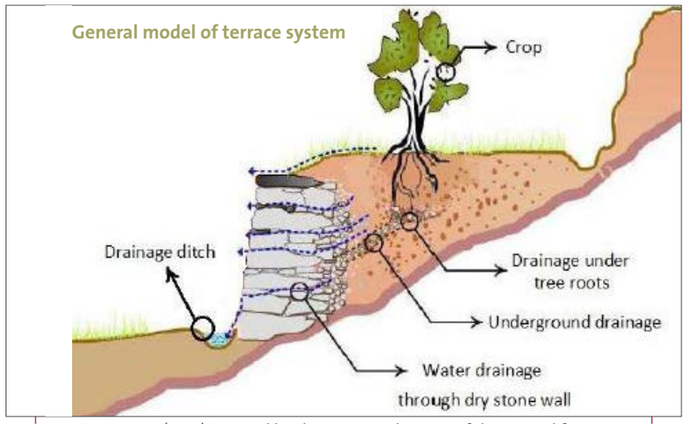
The restoration of abandoned terraces plays a critical role in terms of enhancing ecosystem services to sustain both biodiversity and human livelihoods. The programme demonstrated best practices in terms of: (i) restoring the ecological functionality of the terrace systems to avoid environmental risks, regain biodiversity values and enhance their integration in the eco-cultural landscape; (ii) supporting green economic opportunities to enhance people's livelihoods, jobs generation and market links between producers and consumers, through the production and marketing of aromatic/medicinal/edible plants positively impacting the socio-economic situation in the region.

The restoration of dry-stone wall terraces in the SBR also included interventions for the maintenance and recovery of marginal habitats linked to the agriculture terraces, such as hedges, tree and shrub shelters, isolated trees, ruderal vegetation along roads, the stone walls, etc. Installation and preservation usually require low-cost techniques and minimal labour. Preserving and restoring small strips of land left unploughed have demonstrated major environmental benefits:

- Species diversity in marginal agricultural habitats is significantly high including insects that play a major role in crop pollination and pest control.
- Marginal habitats act as barriers to slow runoff water, improve water infiltration, prevent wind desiccation and erosion, prevent loss of soil nutrients, and create microclimate conditions in croplands.
- Natural vegetation strips (NVS) have little competition with crops for space and can play an important role for fodder provision.
- Economically valuable wild trees or shrubs can be planted in the border of stone walls, providing additional source of income, as for instance oak honey or edible fruits and nuts.
- Restoring dry stone walls, seeds, rhizomes and bulbs of wild plants, such as species from the genus Cyclamen, Capparis spinosa, Sedum spp, ferns, can be incorporated in the crevices between the stones to enrich the habitat type.

The SBR FLR has restored about 150 ha of degraded dry-stone walls according to the following process: (i) removal of unconsolidated/loosened stones from damaged/fallen area of the wall (stones in good condition will be used again); (ii) digging a trench for the base course, with a depth between 20 and 30 cm, and ensuring an efficient drainage system at the base of the wall; (iii) arranging stones by size: starting with larger ones at the bottom and the smaller ones on top, and ensuring that overlaying stones cover the joint in the row below; (iv) placing rubble and gravel behind each layer of the stonewall; (v) inserting longer stones every three to four rows, with the long edge into the wall to increase wall stability; (vi) and selecting flat stones for the last row to have a smooth upper layer. The soil of the cultivation area of the terraces has been improved with compost produced by the programme, and the planting of seedlings from the cultivated species has been carried out with the minimum disturbance of the natural habitats inside and around the terraces.

Restoring abandoned terraces



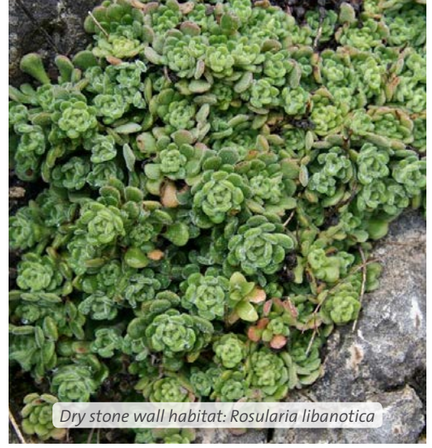
Contessa V. (2014) Terraced landscapes in Italy: state of the art and future challenges. Corso di laurea magistrale in Scienze Forestali e Ambientali. U.S.Padova. Dip. Territorio E Sistemi Agro-Forestali

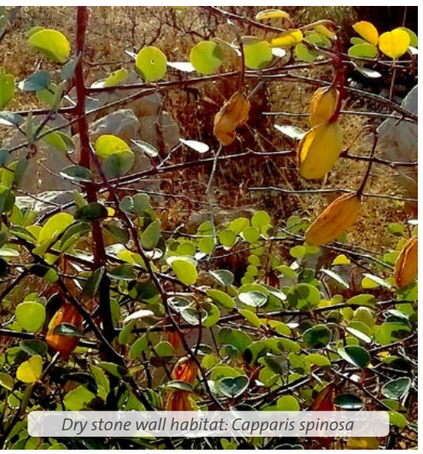
Water pond in abandoned agriculture terrace, fed by underground water from an excavated tunnel in the mountain slope

Restored agriculture terraces under production with oregano, lavender, olives and wild fruit trees (Maasser Al Shouf)


Dry stone wall habitat: Dryopteris pallida


Dry stone wall habitat: Ceterach officinarum (right) and Umbilicus cf. intermedius (left)


Dry stone wall habitat: Rosularia libanotica


Dry stone wall habitat: Capparis spinosa


Dry stone wall habitat: Cyclamen persicum


Dry stone wall habitat Aristolochia sempervirens


Centhrantus ruber


Parietaria judaica


Ceterach officinarum

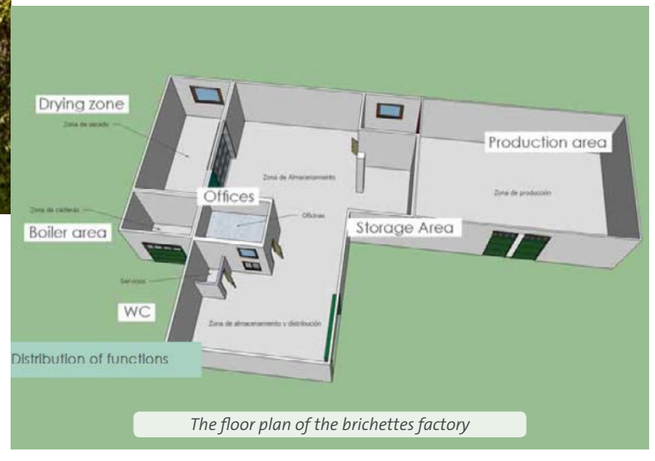
Investments in local businesses linked to FLR interventions in the Shouf-West Beqaa Landscape

Forest Landscape Restoration requires major investments that usually exceed the budgets of local and national public and private sectors. Despite the fact that sustainable finance for major FLR needs requires help from the private and financial sector, FLR planning at landscape scale must incorporate business development plans that allow the long-term sustainability of the restoration needs, and their incorporation into the socio-economic landscape development plans. FLR in the

Shouf-West Beqaa Landscape has developed restoration interventions associated with high interest consumer commodities like briquettes to make ecological/social sound and economically viable the heating system of local homes, compost, organic food and aromatic essences, eco-tourism packages, that were very effective at making the connection with FLR and developing business cases to promote productive restoration models. These productive models had the advantage of providing a wide range of returns on investment, from direct economic and social return, to environmentally positive changes in terms of ecosystem services.

Since its inception, the FLR initiative in the SBR was conceived to become an engine for local economic development. This approach was considered indispensable in order to gain the buy in and collaboration of local stakeholders, and to ensure the sustainability and replicability of all the actions undertaken. Economic development was sought mainly through the following:

• **Creation of local businesses for briquettes production.** The programme has supported the establishment of a local bioenergy plant in the village of Kfarfakoud for the production of briquettes for cooking and heating from local waste materials – the olive pomace that result from olive oil pressing, and the wood waste from the pruning of olives and fruit trees, and from the thinning and pruning of oak and pine forests. Around 100 daily-paid workers are involved in the gathering of biomass from October to April. Five workers (2 permanent, 3 seasonal) manage the factory. The factory produces about 6,000 briquettes per day with the plan to increase production from 1 million briquettes in 2013 up to 5.6 million in 2021. The net profit is 25% of sales (USD 50/t of briquettes, with a sale price of USD 200/t), part of which reverts to the improvement of the management of the SBR and FLR implementation.



The floor plan of the brichettes factory


Briquettes factory


Mixture of wood chips and olive pomace


Briquettes production machines


Baled cardboard stacked outside

Compost production


Cutting the briquettes


The drying of the briquettes


The packaging of the briquettes

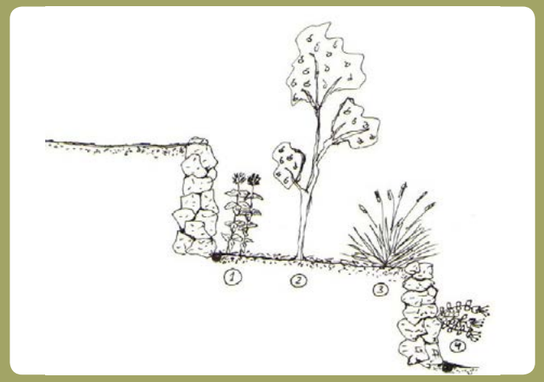
Briquettes box

• **Establishment of a solid waste treatment and composting unit**. SBR participated in the setup of a waste treatment and composting factory in the village of Baadarane. The unit produces recyclable materials and compost, and discards inert material. The factory is managed by 18 permanent staff plus 9 workers (6 permanent and 3 seasonal) whose task is to collect the waste from the villages. Part of the waste gathered is turned into organic compost, that is eventually improved with shreds from forest thinning and pruning. In 2018, 400 t of high-quality compost were produced to be used in the restored agriculture lands.

• **Sustainable agriculture production in restored terraces.** The landscape of the lower areas of the Reserve is dotted with abandoned terraces that used to grow olives, different fruit trees, vineyards and cereals. The abandonment process resulted in their collapse and subsequent washing downslope of the terraced soil. The restoration of abandoned terraces plays a critical role in terms of enhancing ecosystem services to sustain both biodiversity and human well-being. In recent years ACS and its partners engaged in terrace restoration projects: (i) restore the ecological functionality of the terrace systems to avoid environmental risks, regain biodiversity values and enhance their integration in the eco-cultural landscape; (ii) support green economic opportunities to enhance people's livelihoods, jobs generation and market links between producers and consumers, through the production and marketing of aromatic/medicinal/edible plant products and services, positively impacting the socio-economic situation in the region. The FLR initiative is also supporting the maintenance and recovery of marginal habitats linked to the agriculture terraces, such as hedges, tree and shrub shelters, isolated trees, ruderal vegetation along roads, the rocky plants in the stone walls, etc.


The use of forest biomass for compost production

Diversified production scheme in the restored terraces




Morus nigra


Rosmarinus officinalis


Rhus coriaria


Lavandula officinalis


Origanum syriacum


Cyclamen persicum

1) Main cropping area:

- 3 to 4 staggered lines of small shrubs and/or herbaceous plants, or 1 line of large shrubs

- **Potential species:** *Oryganum syriacum, Thymbra spicata, Gundelia tournefortii, Tragopogon longirostris, Allium ampeloprasum, Hypericum perforatum, Matricaria chamomilla.*

2) External line of plants on the upper edge of the terrace wall:

- 1 line with medium-size aromatic shrubs

- **Potential species:** *Lavandula officinalis, Salvia urticifolia, Salvia fruticosa, Rosmarinus officinalis*

4) Plant species to increase the biodiversity value of the dry stone wall habitat.

- **Potential species:** *Capparis spinosa, Cyclamen persicum, Putoria calabrica, Rosularia libanotica, Centranthus ruber.*


Restored agriculture terraces for the production of lavender, oregano, and fruit trees in Maasser Al Shouf


Organic lavender and oregano

Wild herbs produced by women cooperatives and marketed in the Shouf Biosphere Reserve


Selling food

Enhanced local income and farmer's resilience through product diversification from restored terraces

• **Enhanced tourism-related natural infrastructure.** ACS has established more than 480 km of hiking trails throughout the SBR landscape, connecting sites of high ecological value, in which the different ecosystems and natural values of the landscape are represented, and sites of high cultural value, where historical monuments and traditional cultural practices are maintained. The creation of the trail network has been part of the capacity building and employment generation activities of the FLR program. ACS has also produced many publications and videos to facilitate the fruition of these infrastructures to the visitors **(see *www.shoufcedar.org*)**. Awareness raising and communication about the trail network is part of AGSBR's tasks to bring municipalities together and facilitate coordinated actions and cooperation among them on FLR-related activities.

Nature trail conditioned for disable visitors

Workers opening a nature trail

Visitors walking in a nature trail

Night walk on the forest trail

Upscaling FLR best practices into a conducive policy framework

The work on Policy and Legal Frameworks within the FLR program was tackled through the following actions:

(1) Increase land users' knowledge about forest-related legislation and promote the use of existing public incentives. The FLR initiative in the SBR has assessed gaps and opportunities within the existing Lebanese policies regulating natural resources management. User-friendly materials were produced and disseminated among land owners and users through information events and learning workshops to increase their knowledge about existing legislation, rules and regulations about forest conservation, management and restoration and to facilitate the access to the existing public financial aid for landowners.

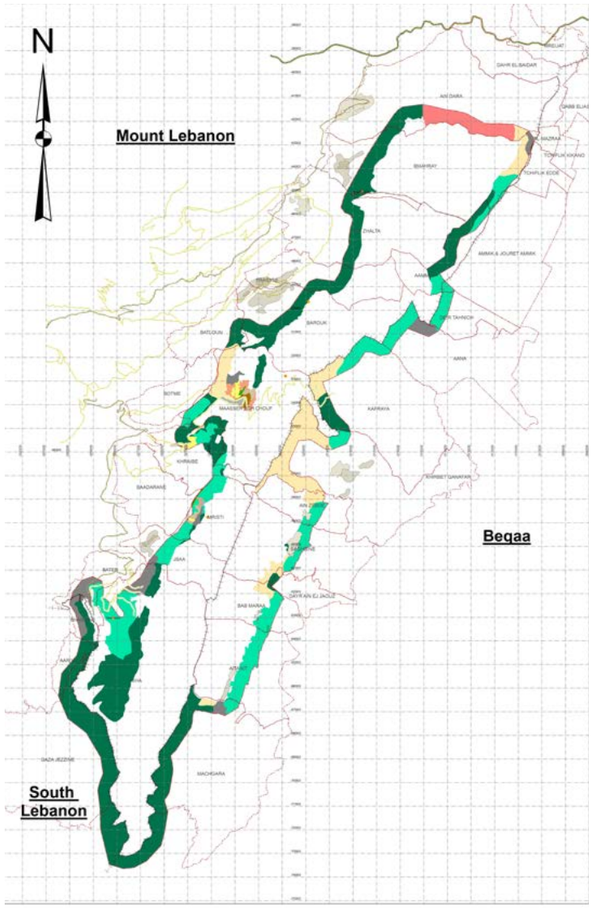
(2) Advocacy for policy improvement through mainstreaming climate change adaptation into forest restoration and management. Pilot interventions were used to influence national policies on forest management and environmental risk reduction. These included: (i) governmental guidelines and criteria for innovative nursery techniques for the production of high quality seedlings of about 45 native species; (ii) governmental guidelines and criteria effective forest planting techniques to improve soil water harvesting and storage in the planting sites to help compensate the trend of summer water deficit and increase the survival rate of seedlings; (iii) governmental regulations on sustainable options for the management of forest and agriculture biomass with the multiple objective to reduce climate-related risks (e.g. forest fires and forest dieback events) while creating economic opportunities (e.g. professionalization of young unemployed, women and Syrian refugees in jobs related to FLR; small local businesses on briquettes production for house heating and composting for agriculture). All the pilot interventions were implemented in close cooperation with the MoA and MoE, who reviewed forest restoration and management regulations based on the positive results of the programme and upscaled them. These successful results have also inspired other forest restoration and management interventions such as the "Lebanon Reforestation Initiative" (LRI) under the USAID and USFS Partnership, the Lebanese component of the FAO "Forest and Landscape Mechanism", and the "Cash for food e-cards" WFP programme.

(3) Delineation of the boundaries and clarification of tenure rights and land use restrictions in the different zones of the landscape. Delineation is now mandatory for the establishment of protected areas in Lebanon and refers to the definition of protected areas' boundaries that includes the geo-referencing of borders. A pending issue after the designation of the Shouf Biosphere Reserve in 2005 was the clear delineation between publicly owned lands and privately- owned lands, and the regulation of land uses in the different zones of the reserve. The delineation process of the SBR was commissioned to five experts (land-use, topography, environmental, GIS, and legal) who worked for two years and delivered the delineation of the boundaries of the SBR zones. The experts reported back to all concerned stakeholders on the findings as well as the course and the decisions followed in the delineation process. The process to develop maps and guidelines for permissible land-uses followed a participatory process, involving: (i) negotiations and conflict resolution, supported by the

the identification of suitable compensation and appropriation modalities for the private lands annexed to the core zone; (ii) economic valuation of opportunities for sustainable uses to convince land owners to adopt them; (iii) proposal of incentives such as taxes reduction and other tactics, to push land owners towards sustainable uses in the buffer zone; (iv) improvements in the existing Detailed Urban Plans; (v) development of Strategic Environmental Assessment (SEA) for the guidelines proposed for the buffer zone.

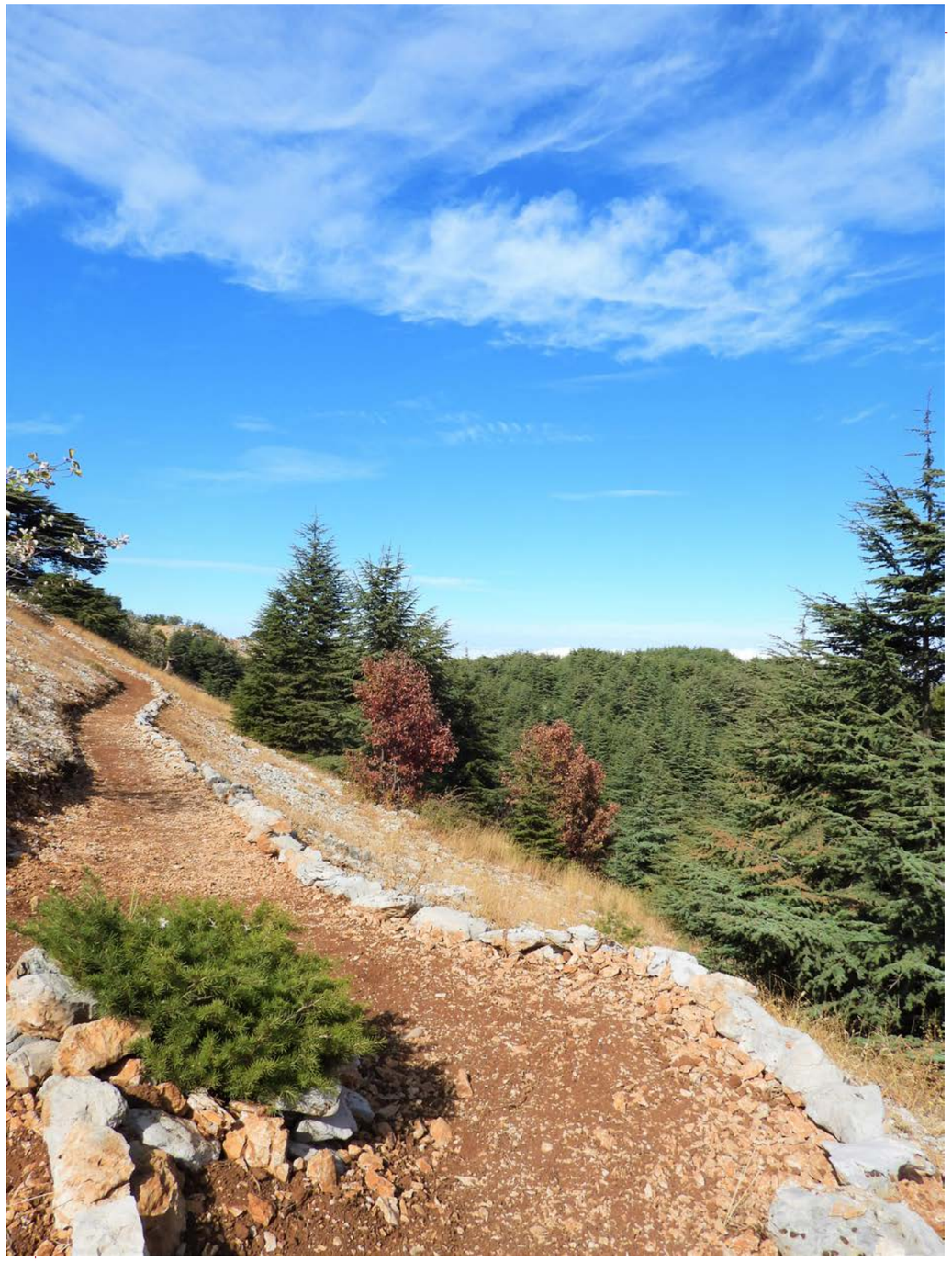
The maps and guidelines were submitted through MoE to Directorate General of Urban Planning. Awaiting final approval, any development proposal in the core and buffer zones of the SBR should undergo a detailed assessment of potential impacts. This represents a major step to improve the governance of the SBR, and to prevent land degradation problems from unsustainable land uses in the landscape.

Land tenure delineation and land-use regulation in the SBR



Legend:

- The Old Center (A)
- Dense residential areas and trade (B)
- Medium residential and Trading Areas (C)
- Natural Area (N)
- Residential Zone for villas (V)
- PA0 (Construction allowed in 1% of land property)
- PA1(Construction allowed in 2% of land property)
- PA2 (Construction allowed in 5% of land property)
- PA3 (Construction allowed in 10% of land property if bigger than2500 m2)
- PA3-1 (Construction allowed in 5% of land property if bigger than2500 m2)



FLR Principle VI: Engages All Concerned Actors and Supports Participatory Governance

Lessons learnt globally show that ecosystem degradation trend can be reversed by: (i) establishing and enforcing policy and legal frameworks that regulate the sustainable use of resources and prevent conflicts between competing development sectors, and (ii) involving local communities through legitimate decentralized institutional arrangements.

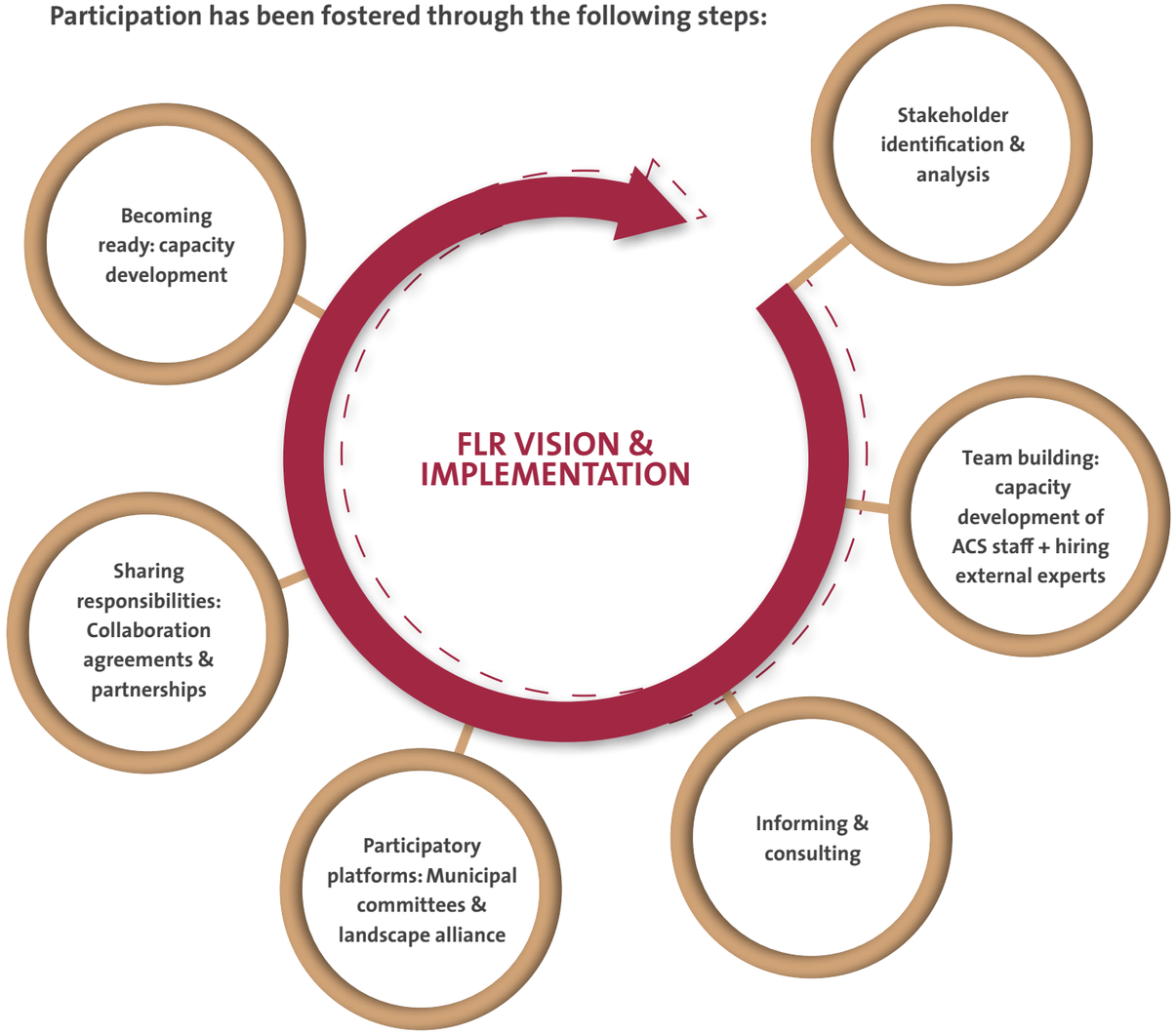
Engagement of all concerned actors in FLR planning, implementation and monitoring

FLR actively engages stakeholders at different scales, including vulnerable groups, in planning, decision making, and direct involvement in the implementation, monitoring and benefit sharing from restoration actions. The Stakeholders' assessment and mapping stage involved the identification of people, groups, and institutions that have interest in FLR or will be affected by FLR interventions. A stakeholder table was produced to: (i) visualize the influence and level of interest of each stakeholders group; (ii) understand which stakeholders share similar goals or have similar interests; (iii) identify potential alliances between groups that may join efforts to advocate for actions supporting FLR.

Stakeholders' participation was fostered through the following steps:

A) Team building: ACS established an internal FLR team and hired international assistance to provide advice, scientific guidance, training and technical support on FLR programme development and implementation. Training for the programme staff on different FLR-related subjects was provided, and two national organizations were hired to assess water resources and climate change impact in the SBR landscape and the restoration needs.
B) Information and consultation: ACS introduced the FLR rationale, objectives, and methodologies to all the identified stakeholders. Consultation followed a gender- and age-sensitive approach, targeting separately women and men, and understanding the different realities of young and older population.
C) Engagement: ACS fostered personal relationships with key stakeholders, organizing participatory processes for the planning, implementation and monitoring of FLR interventions, and securing commitments for FLR implementation through informal agreements, MoUs and contracts.
D) Partnerships and networking: the FLR program was developed in the framework of the Global Partnership on Forest and Landscape Restoration (GPFLR). It followed the FLR principles and FAO guidelines for FLR in Drylands, and became one of the pilot sites of the Mediterranean Initiative under the FAO Forest and Landscape Restoration Mechanism FLRM). In the framework of Mediterranean Mosaics, ACS established partnerships with the Italian organizations Lipu (BirdLife-Italy) and Ilex (Italian Landscapes Exploration), to exchange of know-how and experiences on FLR under a climate change scenario.
E) Empowerment: the programme invested significant efforts in capacity development actions, addressing all concerned actors, from local unemployed young people, to land users, extension agents, NGO staff, researchers, civil servants, local entrepreneurs, and school teachers. Poverty alleviation and gender balance have been major criteria for the selection of candidates, so as to increase their chances to find jobs linked to the FLR program.

Participation has been fostered through the following steps:



Establishing decentralized participatory governance mechanisms for FLR planning, implementation and monitoring

FLR in the Shouf-West Beqaa Landscape has addressed governance problems to improve natural resources management and restore natural and semi-natural ecosystem health and services. Decentralised governance arrangements included the creation of the following, new bodies:

(1) Alliance for the Green Shouf Biosphere Reserve (AGSBR), an informal network aimed at gathering all the main partners and stakeholders around a common FLR vision, with the multiple objective of empowering on FLR planning and implementation, reducing trade-offs to maximize environmental and socio-economic benefits, and leveraging resources for the FLR goals.

(2) Municipal Forest Management Committees (FMCs) were established in sixteen municipalities with the aim to have credible grass-root structures with legitimacy and recognition from local stakeholders and respect from the communities. FMCs are small bodies formed by 7 to 12 members representing the municipal council, community organizations, women groups, NGOs and local schools. FMCs facilitated the development of action plans for FLR interventions at the municipality level, and catalysed the participation of the population of the municipality in the planning and implementation of different FLR interventions. The programme implemented a capacity development plan to empower the FMCs with field training sessions following a "learning-by-doing" approach to acquire knowledge on native species plant production protocols, field restoration techniques, the sustainable management of forest biomass, and FLR monitoring among other issues.

(3) Pilot Municipalities: A specific collaboration protocol was signed between the ACS and the four municipalities of Barouk, Maasser, Mrusti and Aitanit for the development of municipal forest restoration plans (MFRPs) and the implementation of concrete pilot FLR interventions.

The AGSBR and FMCs proved to be very useful decentralized governance arrangements to convey the FLR objectives and generate positive impact for the development of the primary beneficiaries – the rural communities of the SBR municipalities. ACS is currently helping both bodies to achieve operational independence and plan/develop a long-term action plan beyond the completion of the current FLR program.

Stakeholders involved in FLR planning and implementation in the SBR landscape			
Level	Interest in FLR	Level of support/ opposition to FLR	Strategy for getting support or reducing obstacles
Local	24 municipalities of the SBR; Federation of Municipalities of the Higher Shouf (Moukhtara)		
	• Improved conditions in municipal and private lands, mainly for human benefits	• Variable: mainly in favour (fear of land use restrictions may generate little interest or initial rejection)	• Awareness raising, visits to successful pilot experiences • Setup of FMC for FLR planning and implementation • Capacity development (CD)
	Deir el Kamar Forestry branch-offices, Ministry of Agriculture		
	• Best practices on forest management issues	• In favour	• Awareness raising, CD, and best practices
	Al-Shouf Cedar Society (ACS)		
	• In charge of the management of the SBR, leading FLR	• In favour (leader organization)	• Internal CD of staff (technical, participation, gender)
	The SBR Appointed Protected Area Committee (APAC)		
	• Same as previous	• Same as previous	• Strong focus on awareness raising of committee members
	Local NGOs: Green Orient, Friends of Green Environment, and Lebanese Home for Environment		
	• Improved conditions for biodiversity conservation, NRM and livelihoods	• In favour	• Identification of synergies and collaboration for FLR implementation
	Land users: beekeepers, farmers, shepherds, and plant collectors		
	• Improved conditions for higher quantity and quality of natural resources	• Variable, depending on whether they sense risk to their interests or support for their activities	• Support green value chain development through grants • Agreements on NRM regulations and effective governance
	FLR-related enterprises: "Native Nurseries"; AFDC tree nursery; Kfarfakoud briquettes plant; women cooperatives		
	• Emerged from FLR actions, and fundamental for the sustainability of FLR in the SBR landscape	• In favour	• Support green value chain development through grants • Strong efforts on CD • Leading role in FLR implementation
	Tourism operators, restaurants, guesthouses, hotel and hostel, local guides, and shops		
	• Improvement of SBRL values to attract investment and visitors	• In favour	• Marketing SBRL values & identity • Support sust. tourism businesses
	Large agriculture-related enterprises, such as the Kefraya winery		
	• Improved ecosystem services from SBR landscape, with high interest for CC adaptation	• In favour or neutral	• FLR as an opportunity for CC adaptation (e.g. moving vineyards at higher altitude) • Potential for upscaling pilot interventions (e.g. bio-energy)
	Land owners and citizens		
	• Improvement of SBR landscape values to attract investment and visitors	• Variable, depending on whether they sense risk to their interests (e.g. house building) or support for their activities	• Spatial planning/cadastral to define tenure rights and regulate land uses • Marketing of landscape values and identity • Support green growth through job creation and grants

Stakeholders involved in FLR planning and implementation in the SBR landscape			
Level	Interest in FLR	Level of support/ opposition to FLR	Strategy for getting support or reducing obstacles
Local	Syrian refugees		
	• FLR as an opportunity for social integration within SBR hosting communities	• "Hidden stakeholder" with no role in decision-making	• Social integration through capacity development and green jobs around FLR implementation
	Public and private schools and education associations		
	• FLR as an opportunity to introduce environmental issues to new generations	• In favour	• Strong focus on awareness raising and education on FLR implementation
National	Ministry of Environment; Ministry of Agriculture		
	• FLR best practices in the SBR to guide the national response to commitments to Rio conventions	• In favour: support FLR implementation at the national level	• FLR in the SBRL: pilot for replication and upscaling at national level • Fundraising opportunities • Advocacy for policy improvement
	Ministry of Finance; M. Interior & Municipalities; M. Energy & Water; M. Public Works & Transport		
	• Improvement of SBRL values for development opportunities	• Variable, depending on FLR alignment with cross-sectoral policies	• Spatial planning/cadastral to define tenure rights and regulate land uses • FLR mainstreaming in policy dev.
	Souk El Tayeb		
	• Improvement of SBRL values to attract investment and visitors	• In favour	• Support green growth through FLR • Active involvement in green value chain development
	American University of Beirut; Lebanese University		
	• Improvement of SBRL values & biodiversity conservation	• In favour	• Active involvement in biodiversity monitoring and research on ecosystem management
	NGOs: SPNL, AFDC, A Rocha Lebanon, Arcenciel, the Lebanon Mountain Trail Association		
	• Improvement of SBR biodiversity and socio-economic values	• In favour	• Identification of synergies and collaboration for FLR implementation
	MORES s.a.r.l. consultancy firm		
	• Improvement of SBR biodiversity and socio-economic values	• In favour	•Collaboration for FLR implementation
	Eco-tour operators Responsible Mobilities, Lebanese Adventure, Esprit Nomade, Liban Trek		
	• Improvement of SBRL values to attract investment and visitors	• In favour	• Marketing of SBRL values & identity • Support sustainable tourism businesses
	Visitors to the SBR		
	• Improvement of SBR ecological, and socio-cultural values	• In favour	• Strong focus on awareness and education
	Lebanese Media (TV, radio, press)		
	• Improvement of SBRL values	• In favour	• Strong focus on awareness raising

Stakeholders involved in FLR planning and implementation in the SBR landscape			
Level	Interest in FLR	Level of support/ opposition to FLR	Strategy for getting support or reducing obstacles
International	IUCN Regional Office for West Asia; IUCN Centre for Mediterranean Cooperation		
	• Improvement of SBRL values	• In favour: leader on FLR worldwide	• Best practices to be shared and transferred worldwide
	Private foundations MAVA Foundation pour la Nature, Ford Foundation, and Rotary Club		
	• Mediterranean-wide interest on cultural landscapes and biodiversity conservation	• In favour: FLR funders in the SBR landscape	• Positioning SBR as a best-practice landscape to be shared with other Mediterranean biodiversity and cultural hotspots • Fundraising opportunities
	Italian NGOs: LIPU/BirdLife Italy and the Istituto OIKOS; Italian company ILEX		
	• Improvement of SBRL values	• In favour: FLR partners	• Sharing know-how and experiences on FLR in the Mediterranean region
	The Royal Society for the Conservation of Nature of Jordan		
	• Regional cooperation on Biodiversity conservation	• In favour or Neutral	• Cooperation on Nubian ibex reintroduction
	Mediterranean Centre for Environmental Studies (CEAM, Spain)		
	• Cooperation on FLR-related issues	• In favour	• Replication of best practices on FLR in other Mediterranean countries
	International experts on FLR, mainly from Spain		
	• Sharing knowledge on FLR-related issues	• In favour: direct contributors	• Provide technical support and guidance on FLR
	UN organizations: FAO, UNDP and UNESCO		
	• Improvement of SBRL values	• In favour: FAO is leading FLR worldwide	• Best practices to be shared and transferred worldwide
	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		
	• Improvement of SBRL values	• In favour: FLR funders	• Fundraising opportunities
	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		
	• Improvement of SBRL ecological and socio-cultural values	• In favour: FLR funders	• Contribute to the environmental & social corporate responsibility • Potential for PES schemes
	Visitors to the SBR		
	• Improvement of SBR ecological, and socio-cultural values	• In favour	• Strong focus on awareness and education

FLR Principle VII: Invests in 360º Capacity Development and Knowledge Generation

Forest Landscape Restoration supports knowledge generation incorporating scientific innovation and local know-how to adapt restoration to the local context, and continuous training for transferring cutting edge FLR knowledge to national and local learning platforms.

Capacity Development

Modern approaches in forest and landscape restoration are very recent and much work is needed to build the capacity of all practitioners to acquire the skills needed for its sound implementation. The FLR program adopted a "continuous" training strategy integrating knowhow on FLR components from other Mediterranean landscapes (e.g. the CEAM[21] forest restoration programme in Valencia Autonomous Region in Spain; the GLOCHAMORE and other forest restoration programmes of the university of Granada in Spain[22]), with comparable ecological and socio-economic contexts and degradation problems, as well as best practices developed in the SBR:

Capacity development and employment opportunities for vulnerable population: The programme has invested significant resources to create employment opportunities. Farmers, unemployed young and Syrian refugees – both women and men – were professionally trained on forest thinning, forest restoration planting techniques, dry stone wall construction, compost production, charcoal production, rehabilitation of water reservoirs, and the construction and conditioning of nature trails and other ecotourism-related infrastructures. The SBR FLR initiative has contributed to the successful results of the WFP "cash for food e-cards[23]" program which for the first time formed skilled workers among vulnerable population groups – Syrian refugees and local families receiving food assistance – in areas of employment related to the FLR climate-resilient priorities: 376 trainees, of whom 67.5% Syrian refugees and 23.4% women, attended learning-by-doing training cycles with periodic sessions over several months, and got a certificate in the specified professions.

Strengthening the capacity of the SBR managers through regional networking: The FLR team of SBR benefited from training opportunities linked to several regional networking initiatives, including the Mediterranean Mosaics project. The courses had a very practical approach and were held by a variety of experts including: protected areas managers; agricultural entrepreneurs with experience in the development of innovative green value chains and economic diversification; (iii) Business companies and NGOs involved in fair trade and the marketing of goods and services oriented to an international market; (iv) researchers and scientists with experience in integrated natural resources management, the modelling of climate change impacts and identification of adaptive ecosystem management.


Training on forest biomass management


Training on forest biomass management


Training on apiculture

Training on aromatic plant processing


Syrian refugee woman trained on forest restoration


Training on dry stone wall terraces restoration


Training on sustainable agriculture production


Training on aromatic plant cultivation

Knowledge Generation

The FLR programme has produced a variety of printed materials and videos providing guidelines for the planning, implementation and monitoring of several-FLR related issues, including natural resources management and restoration plans, water conservation, climate change and economic assessments, technical documents, and marketing and business plans. Short tutorial videos were produced to guide practitioners in the implementation of FLR-related actions. The results of the FLR initiative have been published, and presented in several international fora and featured in a paper published in the international journal Plant Sociology[24]. Information on FLR in the SBR has also been included in the FAO publications The State of Mediterranean Forest 2018 and Unasylva Vol 66 (2015). All materials are available at ***www.shoufcedar.org***.

This publication, which is also translated into Arabic, is part of a set of knowledge generation materials and actions jointly developed by Al-Shouf Cedar Society (ACS) and its partners the Medforval Network and Istituto Oikos, to share best practices on FLR with forest landscape restoration practitioners and networks from the Mediterranean region and elsewhere. Materials include: (i) booklet with best practices on FLR in Mediterranean landscapes; (ii) MOOCs (Massive Online Open Courses) in English on the principles of FLR to ensure landscape resilience that will be hosted on existing reputable platforms, or uploaded onto an open-source learning platform; (iii) Press and social media campaigns to promote FLR among practitioners; (iv) and e-learning tuition on FLR for students of upper education institutions.

[21]: *CEAM: Centro de Estudios Ambientales del Mediterráneo (Centre for Environmental Studies in the Mediterranean Region).*
[22]: *Global Change in Mountain Regions.*
[23]: *The United Nations World Food Programme (WFP) is rolling out an innovative electronic voucher programme in Lebanon to allow hundreds of thousands of Syrian refugees and vulnerable local population to meet their food needs and help boost the local economy. The e-card collaboration is part of a larger, multi-year partnership with MasterCard, launched in September 2012. It twins MasterCard's prowess in electronic payments systems with WFP's vast experience assisting the planet's hungriest and most vulnerable people.*
[24]: *Hani, N. Et al (2017) Adaptive forest landscape restoration as a contribution to more resilient ecosystems in the Shouf Biosphere Reserve (Lebanon). Plant Sociology, Vol 54. Suppl 1.*

Environmental Education

Education and youth engagement are essential for the long-term sustainability of FLR work. Environmental education activities with children generate interest in their parents, who indirectly participate and become proud of their children's work. This has a catalytic effect, making adults aware and more active. ACS is engaged in many education activities, such as the "Rallying for Nature" and "Green Passport Environmental Journey" campaigns in partnership with the USAID-funded Lebanon Reforestation Initiative (LRI) and involving teachers and students from schools in the SBR municipalities. The education activities provided training to school teachers on key environmental issues related to the SBR and the FLR-related initiatives, and supported them in the organization of classes and field visits to the SBR to learn about different environmental issues.

Raising awareness on endangered species (caracal)


Learning about native plant species

Rally for Nature event in the Shouf cedar forest


Children planting oak seedling

FLR Principle VIII: Manages Adaptively for Long Term Resilience

Effective monitoring is an essential element of adaptive management because it provides a reliable feedback on the effects of programme actions. Monitoring involves the repeated measurement of variables over time to determine if actions have caused changes or trends, either expected or unexpected. As opposed to casual observation monitoring is designed to help us identify what changes are occurring in the system and whether or not these changes are due to our actions. The programme team managing the FLR pilot restoration interventions in the SBR has developed different field monitor protocols to be used in the pilot restored sites depending on the site features and type of restoration interventions:

- Planting and adaptively managed forest sites: monitoring of at least 10% of the surface of each restoration site, defining representative and permanent monitoring plots of 1,250 m2 (18 m x 70 m), with a total of 100 seedlings each.
- Area enclosures in pastureland: monitoring of at least 50% of the fenced plots, counting all seedlings per each species inside the selected enclosures.
- Restored agriculture terraces: monitoring of at least 32 agriculture terraces, including restored sites and control sites representing abandoned terraces, low-intensity cultivated traditional terraces, and high-intensity cultivated terraces. Monitoring protocols include data collection of the applied agriculture practices and their impact on farmland biodiversity indicators (farmland habitats, flora and fauna).
- Abandoned quarries: monitoring 100% of the planting areas in the 2 restored quarries.

The monitoring exercise was carried out twice every year: (i) In May, to assess winter mortality due to bad seedling quality, poor planting or harsh winter conditions; (ii) In October to evaluate the effect of summer drought on the survival rate of the seedlings.

Adaptive Management Approach for FLR Monitoring & Evaluation

Adaptive management is the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn[25].

- Testing assumptions is about thinking about the situation at your project site, developing a specific set of assumptions about what is occurring and what actions you might be able to use to affect these events, systematically trying different actions to achieve a desired outcome, and develop an understanding of not only which actions work and why.
- Adaptation is about acting to improve your project based on the results of your monitoring, and, if needed, changing your assumptions and your interventions to respond to the new information obtained through monitoring efforts.
- Learning is about systematically documenting the process and the results achieved to enable other people in the broader conservation community to benefit from your experiences, including information about successes or lessons learned, as well as about the difficulties you have encountered and the adopted measures to overcome them.

Monitoring goals have determined: (i) whether the FLR programme has helped achieve its stated desired future ecological condition in the programme area; and (ii) whether it has helped achieve its stated social and economic goals or social and economic conditions necessary to the programme. Once the FLR implementation team identified the goals that it wanted to monitor it selected several indicators to measure change in that goal. The programme developed indicators around changes in the natural, social, cultural and economic values of the landscape derived from the FLR interventions:

Landscape values		Indicator themes	Metrix[26]
Ecological value (including agro-biodiversity)	Restored Forestland	Native species planted per site	N°
		Survival rate (disaggregated per each species)	%
		Growth rate of pruned/thinned trees	Cm
		Indicator plant species in pruned/thinned site	N°
	Restored Forestland	Native woody species in enclosure area	N°
		Survival rate (disaggregated per species)	%
		Indicator herbaceous species cover in enclosure area (disaggregated per each species)	BBI
	Restored Agriculture land	Native & local crop species/varieties planted (disaggregated per each species/variety)	N°
		Survival rate (disaggregated per each species)	%
		Soil moisture during drought period	%
		Soil mulching	Sm
		Farmland habitats in/around the site	N°
		Indicator pollinator groups (disaggregated per species)	N°
		Indicator plant species cover (disaggregated per species)	BBI
	Quarries	Native species planted per site	N°
		Survival rate (disaggregated per each species)	%
	Landscape-wide	Changes in forest cover (disaggregated per forest type)	Ha
		Adaptively managed forest (disaggregated per forest type)	Ha
		Changes in open grasslands with scattered woody vegetation cover	Ha
		Changes in land cover with drystone wall terraces under sustainable production	Ha
		Changes in quarry area restored	Ha

[25]: *Salafsky, N., R. Margoluis, and K. Redford. 2001. Adaptive management: A tool for conservation practitioners. Washington, D.C.: Biodiversity Support Program.*
[26]: *BBI: Braun-Blanquet plant dominance/abundance Index; Cm: Cubic meters; Ha: hectares; LBP: Lebanese Pounds; Sm: Square meters.*

Landscape values		Indicator themes	Metrix[26]
Ecological value (including agro-biodiversity)	Landscape-wide	Nature trails constructed & equipped	Km
		Water infrastructures	N°
		Forest fires in the landscape	N°
		Landscape area affected by forest fires	Ha
		Biological corridors	Ha
Social value	Landscape-wide	Preservation of cultural infrastructure (dry stone walls)	Sm
		Preservation of cultural sites	N°
		People participating in FLR interventions (disaggregated by gender and age)	N°
		Improved/new regulations supporting FLR interventions	N°
		Awareness materials produced and disseminated	N°
		Cooperative members participating in FLR Green Value Chains (disaggregated by gender)	N°
		New jobs (disaggregated by permanent/temporary)	N°
		Skilled vulnerable people (disaggregated by profession and local/ refugees)	N°
Economic value	Landscape-wide	Increase in agriculture yields from high quality products (disaggregated by commodity)	Ton
		Increase in dairy from high quality production	Ton
		Increase in bioenergy products	Ton
		Replacement of local use of diesel by briquettes	%
		New funding for FLR in the SBR	LBP
		New markets where FLR commodities are present	N°
		Income changes from targeted commodities between FLR beneficiaries and control group	LBP
		Increased income of vulnerable people participating in FLR activities	LBP

The FLR programme has developed simple monitoring protocols to facilitate the involvement of land practitioners in the monitoring activities, with an adaptive management focus: enable land users to draw lessons from the data collected, understand the impact of their management practices on biodiversity through the exchange of experiences among peers and with the program experts, and make the necessary adjustments to balance the management techniques supporting cultural practices with the preservation and improvement of ecosystem services.

FLR Monitoring requires working with several goals and multiple indicators that feed into complex reporting processes. The SBR FLR programme is in the process of creating a "landscape resilience index," which will be a composite measure that aggregates the several different ecological, social and economic indicators. This will make monitoring more conducive towards a quick snapshot of the landscape restoration programme, and simple and effective communication of the progress and impact of restoration to policymakers, donors, and the general public.

Monitoring results from the field active restoration interventions

Even in locations where forest and landscape restoration are likely to be cost-effective and provide medium and long term socio-economic benefits, shorter-term financial incentives may be needed as support measures to gain support from a wider array of stakeholders. The cost of active restoration interventions can be substantial varying widely among different countries and depending on various factors. An FAO assessment of restoration costs in 22 dryland regions worldwide provided an estimate of costs ranging between USD 200/ha up to USD 17,000/ha, with maintenance costs ranging between no cost up to USD 300/ha/yr.

The active planting restoration costs in the Shouf-West Beqaa Landscape were significantly reduced compared to average costs in Lebanon:

- The Programme managed to decrease the cost from USD10 per each planted seedling to USD 2.5 - USD 3 thanks to : (i) an accurate plant production protocol avoiding the excessive consumption of water and other inputs; (ii) the equipment used for soil preparation (auger machine); (iii) the professionalization of the staff involved in plant production and field planting; (iv) the exclusion of watering in the maintenance of the restored sites.
- The programme has demonstrated the possibility of implementing forest restoration without additional water supply to the planted seedlings, which represents a great success and is a major contribution to the forestation. Supplemental irrigation not only increases the cost of forest restoration but is also socially questionable - water is a much needed and scarce commodity in dry regions.

Generally speaking, survival rates in the SBR FLR initiative are high - especially considering that watering was avoided. The average survival rate of active planting interventions was around 75%, with the exception of the direct sowing of oak acorns (up to 20%) in which case seeds were highly affected by rodent predation. In order to solve this, the programme adopted the use of protection tubes that have demonstrated to be a good option to prevent pre¬dation, with good germination and plant growth. Native fruit tree species (especially Sorbus flabellifolia, Crataegus azarolus Prunus syriaca, and Acer tauricolum) were the most resistant species with almost 100% survival rates, demonstrating a good re-sprouting capacity after summer drought. The survival rate achieved in the temporary fenced plots was very high (about 85%) including fruit tree species with a fundamental role of attracting seed-dispersal fauna and a major socio-economic role of securing the availability of livestock feed during the drought period when grass is dry. The establishment of temporary enclosures where acorns and fruit tree seedlings are planted, had an important awareness-raising function, demonstrating to shepherds an effective way to improve the quality of pastures and diversify the landscape pattern.

The combined seed sowing and seedling planting in unstable soil debris of abandoned quarries has achieved a very high survival rate of about 90%, especially relevant in the case of the sown acorns (95%), with a very positive response in terms of resistance to predation. The pre¬liminary hypothesis is that the instabili¬ty of the slope debris hinders the access of rodents and facilitates seed germination.

Monitoring results from the adaptive management interventions

The adaptive forest and agriculture biomass management and conversion of forest/agriculture biomass into bio-energy has produced the following results:

- For the same heat generation, the cost of energy has been reduced by more than two thirds in comparison with fuel – the main energy source in the local households - with a positive effect on the consumption and savings of the local population, as well as in the reduction of pollution and health problems due to the use of diesel.

- The number of forest fires in the region has significantly reduced due to the decrease in the number of farmers who burn stubble and pruning remains, the main cause of fires in the region, and the control of biomass through livestock grazing in pruned/thinned forest corridors established throughout high fire risk areas in the landscape matrix.

- About 400 tons of high-quality organic compost from the shreds of forest pruning are produced per year supporting sustainable farming practices in the agriculture terraces.

- The restored terraces maintain high levels of indicator farmland habitats/plant species (e.g. high value legume and perennial grass) compared with the controlled low-intensity and high-intensity managed terraces. The supported management practices in the restored farmland areas (e.g. conservation agriculture and crop diversification) have a positive impact in terms of better ecosystem services, and higher yields from a diversified set of products for the domestic and export markets. This has significantly increased not only incomes but also the adaptive capacity of farmers.

- More than 250 km of hiking trails were established and equipped throughout the SBR landscape, connecting sites of high ecological value in which the different natural ecosystems and seminatural agro-silvo-pastoral areas of the landscape are represented, as well as sites of high cultural value where historical monuments are maintained. The creation of the trail network has generated local employment opportunities and increased income opportunities for community members involved in local food and tourism from the villages linked by the network.


Biodiversity monitoring in abandoned agriculture terraces


Monitoring the reintroduced Nubian ibex population


Installing traps to capture and monitor herpetofauna


Observing and counting tarantula nests

Monitoring seedling growth and survival


Monitoring seedling growth and survival

Towards sustainable financing for FLR

Forest Landscape Restoration requires major investments that exceed the budgets of national governments, international donors, and multilateral development banks. To address these investment gaps, help from the private and financial sector is needed, and this is where sustainable finance comes into play. Sustainable finance includes a variety of financial mechanisms, instruments, and products that aim to deliver environmental and social benefits combined with a financial return.

In the SBR landscape, the following initiatives of sustainable financing for FLR were tapped or are currently used:

- **Corporate Social Responsibility.** Private companies are willing to support environmental and social projects in the framework of their corporate social responsibility (CSR) strategies. Since the start of its FLR program, ACS has partnered with national and international private companies such as Middle East Airlines, Byblos Bank, Porches Club Lebanon, Khalil Fatal and Sons, Advanced cars, Lycee National Schools, Four Seasons Hotel, HSBC Bank, and Patchi.

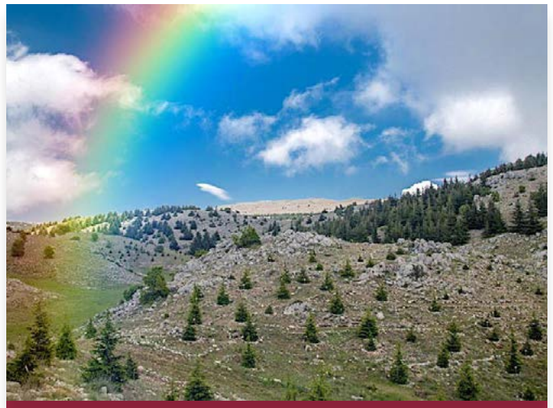
- **Cedars Forever Program.** Cedars Forever is a scheme launched by ACS to support the plantation of cedar seedlings in Lebanon, primarily in the Barouk cedar forest. Individuals and organizations may contribute to the program by adopting a Cedar: for USD150 a cedar seedling will be planted bearing the name of the person who adopted it. So far, 5300 cedars have been adopted through this scheme.

- **Cedar Loan Program.** ACS set up the Cedar Loan Program to facilitate micro-loan access to local villagers and residents, for initiatives that are consistent with the vision of the SBR. Since 2013 ACS has awarded 172 loans worth USD 1000 - 3000 each, for a total value of USD 236,000. Approved applications include projects establishing or expanding plant nurseries, rehabilitating lands and stone terraces, and propagating aromatic/ medicinal plants, as well as ecotourism services.

- **National Afforestation/Reforestation Program.** NARP, also known as the 40 million trees program is an initiative of the MoA that aims at increasing the forest cover in Lebanon from the current 13% to 20% by 2030, adapting the natural ecosystems to the climate change which is already negatively affecting the country. NARP includes planting activities all over the country by the MoA but is designed from the angle of shared responsibilities between stakeholders and the MoA. The programme assists municipalities to form reforestation consortiums (RCs).

The GEF project SALMA, implemented by FAO in the framework of NARP, puts emphasis on the need for the development of large-scale sustainable reforestation activities, as a means to help the Government of Lebanon, including municipalities and RPs, to achieve the goal of NARP.

- **The Forest and Landscape Restoration Mechanism (FLRM) in Lebanon.** The global FLR Mechanism aims to support countries in the planning and implementation of FLR as a contribution to achieving the Bonn Challenge - the restoration of 350 million hectares of deforested and degraded lands by 2030. In Lebanon, FAO's FLRM will promote an integrated approach of landscape management, with the aim to restore a well-balanced package of goods and services provided by the landscapes. In the framework of FLRM, ACS got funding from FAO and the MAVA Foundation for a pilot action to restore the traditional landscape of agriculture terraces in the SBR and the World Heritage site of Qadisha valley in north-western Mount Lebanon. The initiative implemented field restoration work in several pilot terraces and undertook capacity development and awareness raising work targeting local communities about sound restoration methodologies and the socio-economic and environmental values of the traditional terraced landscapes.



"Adopt a cedar" initiative

"Adopt a cedar" initiative

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