HANDBOOK

MedSEVa

Cultivating Sustainable Economies in the Mediterranean through Valorisation of Bushland Ecosystems

Co-funded by the European Union

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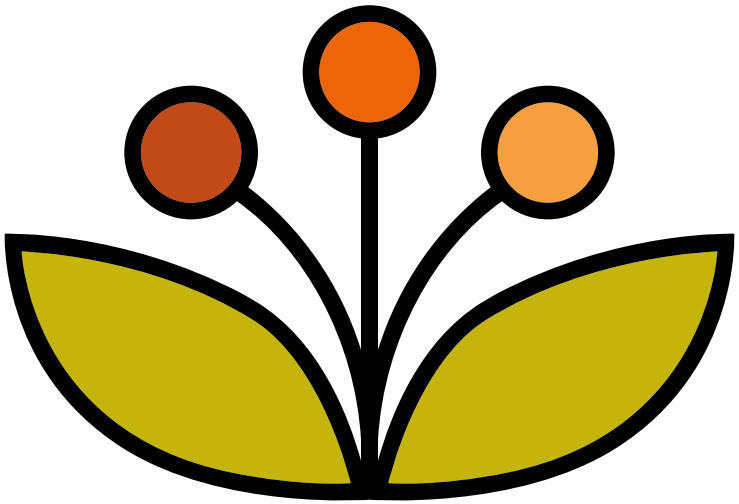

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Cultivating Sustainable Economies in the Mediterranean through Valorization of Bushland Ecosystems

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MedSEVa HANDBOOK

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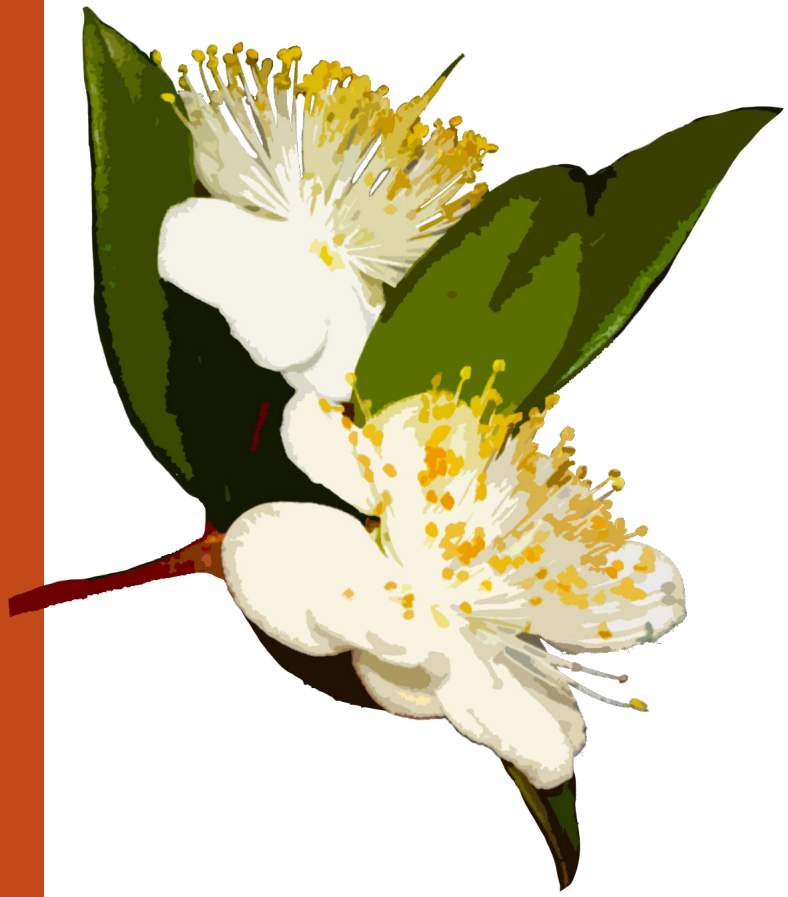

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1. INTRODUCTION

1.1 THE MEDSEVA PROJECT

The MedSEVa project (Cultivating Sustainable Economies in the Mediterranean through Valorization of Bushland Ecosystems) is a strategic partnership funded by the Erasmus+ program, that aims to empower higher education students, professionals, researchers, and local communities with practical strategies to ensure the long-term resilience of Mediterranean bushlands and maquis ecosystems. These ecosystems, including maquis, garrigue, and bushland landscapes, provide vital ecosystem services, such as biodiversity conservation, carbon storage, water regulation, and supporting rural livelihoods. Despite their ecological and socio-cultural value, these ecosystems remain under threat due to land abandonment, climate change, overexploitation, and a general lack of recognition in policy and educational frameworks. By drawing on lessons from multiple Mediterranean contexts, this work contributes to a broader understanding of how complex, multifunctional landscapes can be restored and sustained.

1.2 TARGET AUDIENCE

The MedSEVa Handbook is a comprehensive educational resource designed for higher education students, researchers, professionals, stakeholders, and local communities.

1.3 HANDBOOK OBJECTIVES

The MedSEVa Handbook aims to preserve traditional ecological knowledge (TEK) by documenting and transmitting it to future generations, while integrating it with scientific findings. By connecting theory with real-world applications, the handbook will equip students and professionals with knowledge of sustainable business models, biodiversity conservation, and sustainable use of natural resources in Mediterranean bushlands and maquis. This interdisciplinary guide will support sustainable economic development, highlight the economic value of Mediterranean ecosystems and present strategies for their sustainable use to local communities and enterprises.

1.4 CONCEPT DEFINITIONS – KEY WORDS

Bushlands/Shrublands: Ecosystems dominated by woody shrubs and low-growing vegetation, found in Mediterranean climates. They often occur in dry or semi-arid areas, and include scattered trees, grasses, and herbs.

Garrigue: A specific form of Mediterranean bushland typically grown on calcareous (limestone) soils, forming an open landscape of low-growing bushes, including aromatic plants.

Maquis/Macchia: A specific form of dense, evergreen bushland found in the Mediterranean Basin. It includes aromatic bushes and small trees, taller than garrigue, and is typically found on rocky hillsides and acidic soils.

Fynbos: A unique bushland ecosystem, found only in the Cape Region of South Africa. Part of the Cape Floristic Region, one of the world's six floral kingdoms, it is known for its extraordinary plant diversity and endemism.

Chaparral: Shrub-dominated ecosystem found primarily in California, characterized by dense, drought-resistant shrubs, hot dry summers, and mild wet winters.

Sustainability: The practice of meeting current needs without compromising the ability of future generations to meet their own needs, by protecting ecosystems, conserving resources, and promoting economic and social viability.

Ecosystem services: The benefits that humans receive from ecosystems, including provisioning (e.g., food, water), regulating (e.g., climate regulation, water purification), cultural (e.g., recreation, spiritual value), and supporting services (e.g., soil formation, pollination).

Traditional knowledge: It refers to the accumulated wisdom, practices, and beliefs developed by indigenous and local communities over generations, closely tied to their interaction with the natural environment. It offers locally adapted, sustainable approaches to managing land, water, and biodiversity.

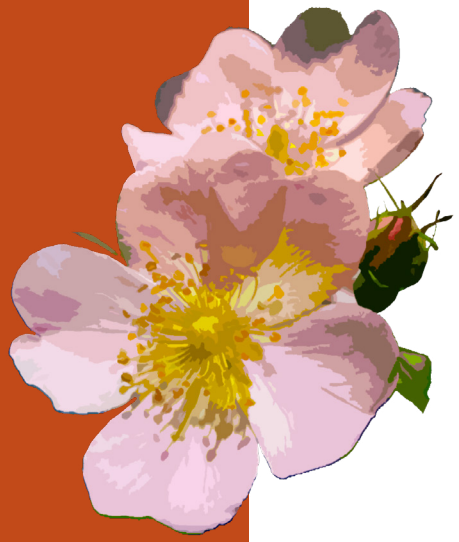
1.5 IMPORTANCE OF SUSTAINABLE PRACTICES AND TRADITIONAL KNOWLEDGE

Achieving a balance between conservation and sustainable use is essential to prevent short-term economic development from resulting in long-term ecological and economic degradation. Sustainable practices, such as bushland restoration, extensive livestock farming, and habitat management, not only support climate change adaptation and ecosystem resilience but also offer significant economic benefits for local communities. To ensure lasting impact, nature-based solutions should be prioritized, and integrated, cross-sectoral strategies must be developed. Sustainable management of bushlands and maquis ecosystems should involve not just the environmental sector, but also agriculture, tourism, forestry, and energy. Equally important is the active involvement of local communities.

Traditional ecological knowledge (TEK), rooted in generations of interaction with the land, can offer valuable insights for conservation and land management. Incorporating this local expertise increases community engagement, enhances social acceptance of conservation efforts, and significantly improves the likelihood of long-term success. By embracing a holistic and inclusive approach, grounded in both modern sustainability principles and traditional ecological knowledge, we can safeguard the ecological integrity and economic value of Mediterranean maquis and bushland ecosystems for future generations.

Figure1. Overview of typical Mediterranean bushlands.
Source: *https://wildfiretaskforce.org/southern-california-regional-profile/healthy-resilient-shrublands/*
https://storymaps.arcgis.com/stories/fb47ff3023e14b4b997338c057b9ce64

2. OVERVIEW OF MEDITERRANEAN BUSHLAND AND MAQUIS ECOSYSTEMS



2A. DESCRIPTION

Mediterranean bushland ecosystems – including maquis, garrigue, chaparral, and fynbos– are among the most ecologically and culturally significant landscapes in the world. They are found not only across the Mediterranean Basin but also in other Mediterranean-climate regions globally. There, the climatic conditions of mild wet winters and hot dry summers foster evergreen low-growing vegetation, including sclerophyllous shrubs and small trees. Plants of these ecosystems are highly adapted to the environmental conditions of the Mediterranean climate and the biotic and abiotic threats that they face.

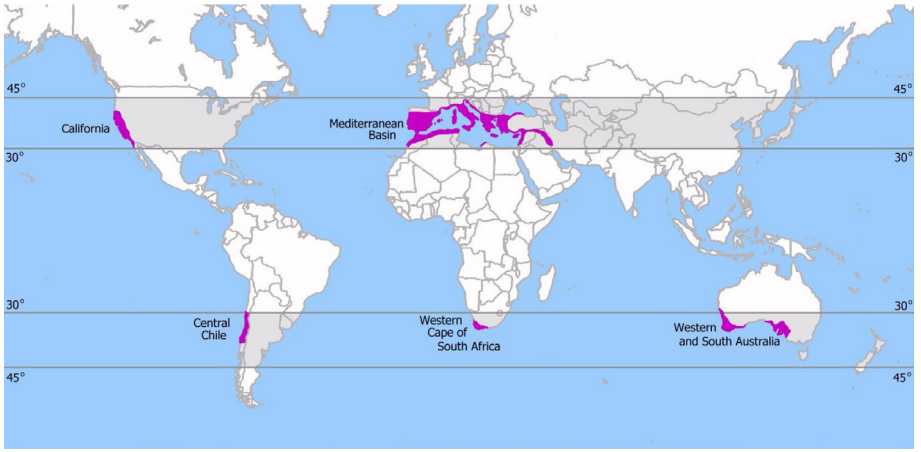


Figure 2. Mediterranean-climate regions, across the world.
Source: *https://gimcw.org/the-mediterranean-climate/*

2B. IMPORTANCE

Mediterranean bushland and maquis ecosystems are characterized by exceptionally high levels of biodiversity, endemism, and intricate socio-ecological histories, and provide ecosystem services. In particular, they are among the most important habitats for wild and domestic herbivores in the Mediterranean biogeography (Rogosic et al., 2011) and are home to a high proportion of endemic plant and animal species. This biodiversity not only creates ecological value but also provides the basis for economic activities such as nature-based tourism (Bernués et al., 2014; Raviv et al., 2020).

In addition to providing a source of fodder for livestock, bushlands provide services such as habitat creation, soil conservation and water regulation, as well as cultural services with aesthetic value (Bernues et al, 2014; de Groot et al., 2022). Their resilience has historically depended on the dynamic interplay between natural disturbance regimes, such as fires and drought, and traditional human land-use practices, including transhumance, rotational grazing, and ethnobotanical harvesting. The habitat-providing function of bushlands is vital, especially for small mammals, birds, reptiles and insects. Maintaining habitat quality supports the maintenance of species diversity and ensures the continuity of ecosystem services (de Groot et. al, 2022; Lasanta et al., 2024; Lecegui et. al., 2022).

Research shows that these ecosystems have a high capacity for carbon sequestration. Shrublands contribute to mitigating the effects of climate change by storing significant amounts of carbon in soil and vegetation (Gratani et al., 2013; Masiero et al., 2016). Additionally, water regulation services emphasize the role of shrublands in supporting the hydrological cycle. Effects such as soil water retention and runoff reduction are critical for the sustainable management of regional water resources (Sánchez-Canales et al., 2012).

2.1 CURRENT CHALLENGES

In recent decades, Mediterranean shrublands have come under growing pressure from threats that have led to widespread habitat degradation, biodiversity loss, and the disruption of ecosystem services. The primary drivers for land use change include the global climate change, the growing demographic pressure, agricultural intensification and urban development, the introduction of invasive alien species, the pollution or over-exploitation of resources such as water and soils and the harvesting of wild plants and animals at unsustainable rates (Schröter et al., 2005; Palahi et al., 2008; Regato, 2008; UNEP/MAPPlan Bleu, 2009; FAO, 2013; Masiero et al., 2016).

Future research, as well as adaptive management strategies need to be developed to address these challenges. Modeling the long-term effects of climate change in bushland ecosystems, more precise spatial analysis of carbon sequestration and water regulation services, increasing community-based valuation studies for ecosystem services, and testing sustainable business models in the field with pilot projects. Also, a clear framework to quantify their economic value is also important to prevent their marginalization in policy decisions. Without a measurable understanding of their actual value, shrublands risk being perceived merely as "unused" or “low-value” lands.

2.1.1 Vegetation disturbance

Vegetation dynamics, i.e., the patterns of change in plant communities over time, are significantly influenced by various disturbances, both natural and anthropogenic. Understanding these dynamics is necessary for effective ecosystem management and conservation. In Mediterranean ecosystems, disturbances such as fire and erosion play pivotal roles in shaping vegetation patterns (Malkisnon et al., 2011; Schaffhauser et al., 2012). Human activities also heavily contribute to vegetation reformation. In particular, land-use changes, especially agriculturalization and urbanization, reduce the area of shrublands and lead to losses in ecosystem services. These losses also negatively affect regional economic activities in the long term (de Groot et al., 2022).

Pastoralism has been a traditional practice in bushland ecosystems and moderate grazing can enhance their conservation. However, its spatial distribution is highly heterogeneous. Overgrazing occurs when stock density exceeds the grazing capacity of rangeland ecosystems. Mid-term it can lead to multiple impacts, such as soil compaction, loss of herbaceous species, and the proliferation of unpalatable or thorny shrubs, ultimately reducing biodiversity and ecosystem resilience (Noy-Meir & Seligman 1979;Thornes 2007; Papanastasis et al., 2009; Herrero-Jáuregui & Oesterheld, 2018). In contrast, undergrazed shrublands exhibit characteristics of land abandonment. Shrubs increase in both biomass and density (encroachment) , alternating the accessible forage (Gomez-Garcia et al., 2023). Additionally, the accumulation of combustible plant material increases substantially, elevating the risk of more intense and destructive wildfires (Moritz et al., 2012).

2.1.2 Fire

In Mediterranean ecosystems, the most prevalent disturbance affecting vegetation is the occurrence of fires, which possess both natural and anthropogenic origins. In the fire-prone landscapes of Mediterranean-climate regions, both the suppression and mismanagement of fire regimes have led to ecological imbalances. While fire remains a necessary ecological driver in some systems, such as the fynbos and Mediterranean maquis, anthropogenic and climate-driven alterations are increasing fire intensity and frequency. Subsequently, necessitating carefully designed restoration techniques that balance ecological requirements with risk mitigation are necessary. Intense fires often reset successional processes, and sustained suppression may lead to overly dense or encroached conditions at higher risk of stand-replacing fire (Huntsinger & Oviedo, 2014).

2.1.3 Climate change

Climate change threatens the carbon sequestration capacity and biodiversity of Mediterranean shrublands with rising temperatures and decreasing rainfall, creating prolonged drought periods that are altering the structure of vegetation and increasing fire risks (Riera et al., 2007; Gratani et al., 2013; Wu et al., 2015; Carrión-Prieto et al., 2017; Masiero et al., 2024;). Rising atmospheric CO_2 concentrations are a major driver of global climate change (IPCC 2021) while it can stimulate photosynthesis and water-use efficiency in many shrub species, often promoting

increased shrub growth and shrub encroachment into grasslands or previously sparsely vegetated areas (Donohue et al. 2013; Myers-Smith & Hik 2018).However, in some Mediterranean territories, elevated CO_2 interacts with warming and altered precipitation patterns to reshape bushland functioning on regional and global scales. Also, in hot and dry areas of the Mediterranean Basin, warming amplifies the flammability of maqui (Morandini et al., 2023). the intensifying aridity increases the mortality of other species and facilitates shrub dominance (Sarmoum et al., 2024).

Figure 3. Examples and visualization of climate change effects.
Sources: *https://era.org.mt/topic/drivers-of-land-degradation/, https://efi.int/news/increased-forest-disturbances-require-better-reporting-and-data-collection-2023-03-07*

2.2 ECOLOGICAL AND SOCIO-ECONOMIC RESTORATION

Despite the challenges, Mediterranean shrublands hold significant potential for ecological restoration and socio-economic revitalization. Scientific research has investigated vegetation responses to nitrogen enrichment, the role of successional stages after natural or anthropogenic disturbances, and the importance of governance and local community involvement (Dias et al., 2013; Bernues et al., 2014; Huntsinger & Oviedo, 2014; Hernández-Rodríguez et al., 2022). Although each region faces distinct environmental challenges – ranging from desertification and fire disturbances to land abandonment and invasive species – they share core principles and shared insights that can inform effective restoration practices.

Bushland ecosystems are not merely ecological entities but are deeply embedded in the cultural and economic fabric of rural communities.

Traditional Ecological Knowledge (TEK) as a key to unlock the restoration

TEK, although increasingly threatened, remains a valuable asset for landscape management, offering context-specific strategies that enhance resilience and sustainability. Revitalizing and integrating this knowledge into modern restoration frameworks is essential for ensuring the relevance and longevity of ecological interventions. The need for restoration to move beyond technocratic, one-size-fits-all models. It is very important to view restoration not merely as a return to "natural" states but as a nuanced process that preserves ecological

heterogeneity and cultural legacies. Successful initiatives are those that adapt to local ecological dynamics, recognize cultural heritage, and involve communities in meaningful, participatory ways. Whether through reintroducing traditional land uses, promoting biodynamic and agroecological systems, or integrating fire-ecology principles, context-sensitive approaches have shown the greatest promise for restoring both ecological function and social value.

Furthermore, restoration in these regions must be viewed through a long-term lens. Shrublands are slow-growing, disturbance-adapted systems that require sustained commitment, adaptive management, and continuous monitoring. Restoration efforts must balance immediate ecological gains with long-term resilience goals, especially in the face of climate change, which continues to alter vegetation dynamics and resource availability across all five studied regions.

Socio-demographic factors have an impact on the sustainable management of ecosystems. The income level, education level and environmental awareness of communities directly affect the value given to ecosystem services. In low-income regions, short-term economic returns may take precedence over long-term ecosystem services (Masiero etl., 2016).

Restoration process and contribution of the state and society

A cross-regional insight is the critical role of governance and community involvement in determining restoration success. While many restoration projects benefit from scientific and technical input, their long-term sustainability often hinges on participatory frameworks, secure land tenure, and locally embedded institutions.

Effective restoration, therefore, is not solely an ecological endeavor but a socio-political one — requiring the alignment of environmental objectives with local aspirations, cultural values, and economic realities. Consequently, the integration of the socio-economic dimension is a fundamental requirement for the sustainable management of Mediterranean shrublands. This integration not only facilitates the achievement of environmental objectives but also promotes long-term social and economic sustainability by improving the well-being of local communities.

3. SCIENTIFIC AND TRADITIONAL KNOWLEDGE RELEVANT TO CONSERVATION

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3.1 TRADITIONAL ECOLOGICAL KNOWLEDGE (TEK)

The concept of ethnobotany, i.e., the study of how people use plants within cultural contexts, was first introduced by American botanist John W. Harshberger in his 1896 article "The Purposes of Ethnobotany." Since then, the field has evolved to encompass diverse plant uses including food, medicine, fuel, ornamentation, and ritual purposes, with a growing focus on preserving this knowledge for future generations (Satil & Selvi, 2024). In Mediterranean regions, ethnobotanical knowledge is deeply rooted in local communities. This body of knowledge, transmitted primarily through oral traditions and experiential learning, includes medicinal, nutritional, and symbolic uses of a wide variety of maquis and bushland plants.

TEK is inherently dynamic, evolving in response to socio-environmental changes. Historically transmitted through oral narratives, seasonal rituals, apprenticeship, and daily practices within families and communities, TEK reflects a deep-rooted relationship between people and nature in the Mediterranean. In rural areas, this knowledge remains relatively resilient, while urbanization, migration, and formal education have contributed to its gradual erosion (Yolcu, 2018; Gorgec, 2019). Despite these challenges, TEK is not static. It is being reshaped into hybrid knowledge systems influenced by ecological movements, sustainable development practices, and agroecology.

Traditional practices in the role of ecological protection mode

Traditional land-use practices in the Mediterranean bushlands represent a sophisticated balance between ecological adaptation and socio-cultural values. Systems such as rotational grazing, coppicing, selective plant harvesting, and the preservation of sacred groves are still used locally by communities, practitioners, and nomadic and semi-nomadic groups. The sustainable use of endemic plant species contributes to biodiversity while supporting rural development through localized economies. These resources are managed using inherited ecological practices, including traditional harvesting, seasonal timing, and low-input cultivation techniques. The continued presence and application of such methods exemplify the integration of TEK with ecological stewardship, economic resilience, and cultural heritage, especially in landscapes dominated by the maquis. When acknowledged and incorporated into contemporary environmental governance, traditional land management systems can offer valuable contributions to sustainable resource use and biodiversity conservation. These systems are not relics of the past but living strategies that embody ecological sensitivity, cultural continuity, and adaptive capacity. Their integration into modern conservation planning is essential for building socially inclusive and ecologically robust governance models.

Sustainability and financial independence by application of traditional methods

TEK plays a pivotal role in the socio-economic structure of rural Mediterranean communities. Plant-based products, including herbal teas, resins (e.g., mastic gum), and traditional foods, support household economies and small-scale trade. On the Aegean and Mediterranean coasts, herbal knowledge has become central to gastronomic tourism and cultural heritage branding. The sustainable use of local biodiversity reduces dependency on external markets, enhancing both resilience and cultural pride (Kok et al., 2020; Agan and Ozer, 2020). The socio-economic implications of TEK are particularly evident in practices such as wild herb collection, traditional cheese-making, and eco-tourism. However, commercialization and the tourism-driven appropriation of ethnobotanical knowledge can distort authentic traditions (Aca, 2022). This raises the need to balance preserving TEK as a cultural asset with its strategic use as a tool for development in environmentally sensitive areas.

By supporting livelihoods through biodiversity-based activities, such as beekeeping, foraging, and nature tourism TEK reinforces biocultural diversity. Nevertheless, market pressures and commodification pose risks such as cultural erosion and knowledge manipulation (Aca, 2022; Yolcu, 2022b). Acknowledging TEK as both a socio-economic driver and a repository of cultural heritage can foster inclusive rural development. In many rural Mediterranean areas, TEK underpins small-scale livelihoods through herbal products, food traditions, animal care, and handicrafts. For instance, the use of carob tree, a characteristic maquis species, for the production of molasses, flour, and traditional remedies offers both nutritional and economic benefits, while sustaining household economies and traditional health practices (Tasligil, 2011; Yildirim & Kargioglu, 2015).

Likewise, the sustainable use of aromatic and medicinal plants supports small-scale economies, particularly through local gastronomy, markets, and ecotourism. The cultural capital embedded in these practices helps sustain rural identities while generating new economic opportunities, especially in regions where wild plant-based culinary traditions attract both tourism and cultural interest (Gok, 2015; Sicak et al., 2013). Lastly, the integration of folk culture with ecological knowledge in rural tourism simultaneously promotes economic development and cultural preservation (Ekici, 2016).

3.2 CASE STUDIES

Several case studies across the Mediterranean region illustrate how scientific tools and traditional knowledge can work together to achieve both conservation and sustainable development goals in bushland ecosystems.

Spain

For instance, in La Rioja, Spain, shrub clearance projects have promoted extensive livestock grazing in shrub-dominated areas to reduce wildfire risk and enhance biodiversity. Through targeted shrub clearing, pasture productivity improved, aligning ecological restoration with economic benefits (Lasanta et al., 2024). Crucially, the active participation of local communities and the use of traditional land management knowledge were key to the program's success. This demonstrates how combining technical interventions with social and cultural knowledge systems can produce resilient outcomes. The *Cistus ladanifer* restoration projects in Spain show how native, fire-adapted species can be used for post-disturbance recovery. Restoration efforts led to enhanced carbon sequestration, biodiversity, and water regulation services (Hernández-Rodríguez et al., 2022). This case highlights the value of species-specific ecological knowledge in restoration planning, particularly in fire-prone Mediterranean landscapes.

Figure 4: Map of Spain
Source: *https://www.guideoftheworld.com/map-of-spain.html*

Italy

Similarly, the Multiscale Mapping of Ecosystem Services (MIMOSE) Model and Optimized Forest Management, developed in Italy, used scenario analysis to evaluate trade-offs and optimize multiple ecosystem services, primarily wood production and carbon storage, while considering nature conservation strategies (Vizzarri et al., 2017). Scientific modeling tools allowed planners to evaluate trade-offs and identify land-use strategies by integrating nature conservation approaches. These results highlight how evidence-based planning can support sustainability goals in Mediterranean shrublands, particularly when integrated with landscape-level ecological knowledge.

Figure 5: Map of Italyl
Source: *https://www.guideoftheworld.com/italy-map.html*

Turkey

The Upper Seyhan Basin case demonstrates how carbon storage and sequestration assessments can support ecological restoration thinking and climate-sensitive land management. Mirici et al. (2024) show that geospatial modelling and economic valuation can be integrated into rural landscape planning to guide more informed and sustainable land-use decisions.

Figure 6: Map of Turkey
Source: *https://www.guideoftheworld.com/map-of-turkey.html*

Science and tradition are aimed at ecological protection

Recent studies also illustrate that integration of TEK with science is not only feasible but also mutually reinforcing. They point toward developing policy-supported, community-involved knowledge platforms where TEK is documented, validated, and integrated with formal science to enhance sustainability, resilience, and innovation. For example, Yolcu et al. (2023) present a model for harmonizing scientific

knowledge with TEK by drawing on extensive field research in rural settlements around the Mount Ida region. They documented villagers' use of ecological calendars, meteorological observations, and traditional flora-fauna classifications, all of which align with empirical scientific methodologies. This suggests potential for co-produced knowledge systems that reinforce ecological monitoring and sustainable resource use.

Furthermore, Faydaoglu and Surucuoglu (2011) emphasize the scientific relevance of traditional uses of medicinal and aromatic plants. Many of these uses have informed phototherapeutic practices and pharmacological research, particularly given Turkey's rich phytogeographical diversity. Their study shows that several plant species traditionally used in rural Anatolia exhibit confirmed biochemical properties, indicating a valuable basis for integrative health approaches. Lastly, Agar et al. (2024) add that plant-based knowledge for treating conditions such as scabies is not only still in use but also provides a promising avenue for new pharmacological compounds, especially as resistance to synthetic treatments grows. This creates a research-practice-policy nexus where TEK can directly inform scientific innovation.

These case studies demonstrate how the integration of scientific modeling, ecological knowledge and traditional practices can lead to effective, context-specific conservation strategies. Strengthening this synergy is essential for the long-term sustainable use and valorization of Mediterranean bushlands and maquis ecosystems.

Also, further case studies on native Mediterranean bushland species can be found through interviews in the link bellow: ***https://medseva.eu***

3.3 BUSHLANDS AND MAQUIS ACROSS COUNTRIES IN MEDITERRANEAN CLIMATE REGIONS

3.3.1 Albania

Albania is a place that hosts unique Mediterranean adapted flora featuring dense evergreen shrubs, aromatic herbs, and drought resistant trees. Plant diversity is abundant, and wildlife plays a vital role in preserving biodiversity. A blend of rugged mountains, pristine beaches, fertile valleys, meadows and forest edges, resembling a living mosaic of biodiversity, a land rich in natural beauty and ecological complexity (Giuliano Fanelli et al, 2015). These diverse habitats are home to several shrubs and aromatic plants, such as oregano (*Origanum vulgare* L.), immortelle (*Helichrysum italicum*), lavender (*Lavandula angustifolia Miller*), thyme (*Thymus vulgaris* L.), rosemary (*Rosmarinus officinalis* L.), Mountain tea (*Sideritis raeseri* Boiss.et Heldr.), bay laurel (*Laurus nobilis L.*), and winter savory (*Satureja montana* L.) (Alban Ibraliu et al, 2025).

Travelling across the coastal zones to continental mountain regions, its variable climate allows both endemic and widely distributed species to thrive across the country. Coastal ecosystems support salt tolerant species, which flourish on sandy and rocky shorelines of dunes. The geological evolution of the landscape has been influenced by long-term climate changes and ongoing ecological adaptation (Giuliano Fanelli et al., 2015). Also, Albania, has a longstanding tradition in ethnobotanical knowledge and the use, collection or even cultivation of wild species, with this agricultural activity playing an important commercial and economic role. Many rural households rely on them

for employment and income (Alban Ibraliu et al, 2025). However, the area faces increasing human pressures. More recently, tourism development threatens coastal ecosystems, exemplified by the near-total loss of dunal vegetation formerly present at Rjolla beach (Backs Rrjolli) (Giuliano Fanelli et al., 2015).

3.3.2 Algeria

In Algeria, bushlands, ranging from sclerophyllous shrub in the north to steppe shrubs in the pre-Saharan zone, undergo rapid transformations under climate change, deforestation, and grazing pressures. Forest cover loss has accelerated the spread of shrub-dominated landscapes, sometimes replacing Atlas cedar standing at lower elevations (Bilel Zerouali et al., 2023; Laala & Adimi, 2024). Historically, sclerophyllous shrubs like Pistacia spp. and Olea spp. formed significant components of vegetation from the post-glacial era into Neolithic expansions (Carrión Marco et al., 2022).

More recent floristic surveys in mountainous zones (Belgacem et al., 2020) demonstrate the presence of drought-resistant shrubs that reflect semi-arid conditions. Farther south, repeated drought events exacerbate overgrazing, leading to bushland degradation in wadis (Daoud & Kadik, 2024; Alliouche & Kouba, 2023) and in steppe rangelands where sedentary pastoralism has contributed to vegetation collapse (Martínez-Valderrama et al., 2018). Nonetheless, local afforestation and reforestation efforts show that targeted interventions can restore some shrublands (Alliouche & Kouba, 2023). Ethnobotanical surveys underscore how these systems remain culturally pivotal, especially among nomadic communities that rely on shrub-based medicinal plants (Miara et al., 2018; Senouci et al., 2019).

3.3.3 Australia | Southwestern and South

Although the term maquis traditionally refers to Mediterranean shrublands in southern Europe and parts of the Middle East and North Africa, Australia hosts analogous ecosystems (Dicastri, 1991; Urdiales-Flores et al., 2024); dense, sclerophyllous shrublands adapted to dry summers, poor soils, and fire regimes. These formations, while not referred to as "maquis" locally, share ecological characteristics and are typically classified as sclerophyll shrublands or heathlands. The two major areas in Australia with Mediterranean climate are Southwestern Australia and Southern Australia (Bonada & Resh, 2013). These regions are characterized by nutrient-poor soils, Mediterranean-like climates, and a high incidence of natural fires (Wisheu et al., 2000).

The flora in these areas include *Banskia integrifolia* and *Hakea laurina*, two native types of shrubs (Skeels & Cadillo, 2017). The fauna present includes snakes, mammals and birds. The Australian sclerophyll shrublands face significant threats, including land clearing for agriculture, grazing, and urban development, wild-fires, invasive, soil-borne pathogens, and climate change (Crossman et al., 2012).

However, similar-to-macchia Australian ecosystems, such as heathlands and sclerophyll shrublands, provide valuable ecological services that support economic sectors (Oskolski & Akinlabi, 2023). These include biodiversity conservation, tourism, and land stability (Kassam et al. 2012). They are also important for carbon sequestration and act as buffers against erosion and bushfires, helping reduce costs related to land degradation and disaster management.

3.3.4 USA | California

California's chaparral exemplifies a bushland type with high endemism and ecological function (Parker, 2020). Studies in southern California highlight the impacts of anthropogenic nitrogen deposition, which can shift chaparral species composition over the long term (Vourlitis et al., 2020). Fire is also a critical factor, with chaparral patches emerging after stand-replacing events in mixed conifer forests (Airey Lauvaux et al., 2016). Although chaparrals are well adapted to episodic burns, shifting fire regimes with extended suppression or overly frequent, high-severity fires can push these shrub communities toward alternative states, including forest densification or invasive annual grasslands.

On the socio-ecological side, chaparral provides forage, carbon sequestration, and recreational opportunities, but management often overlooks the role of active human stewardship (Huntsinger & Oviedo, 2014). Land-use decisions in the wildland-urban interface further complicate chaparral conservation, necessitating integrated policies that consider both hazard prevention and long-term ecosystem stability (El-Hokayem et al., 2023).

3.3.5 South Africa | Cape Region

The Cape region of South Africa presents a complex interplay of disturbance regimes, vegetation composition, restoration approaches, and ethnobotanical uses. Renowned for its biodiversity, this region encompasses a variety of bushland ecosystems, including maquis and chaparral-like vegetation, and is recognized for its high levels of endemism and species richness, comparable to tropical rainforests (Pirie et al., 2016; Pirie et al., 2017). Among the most common shrublands are renosterveld, characterized by fine-leaved shrublands often found on fertile, shale-derived soils (Quick et al., 2024); fynbos, a type of bushland dominated by evergreen, small-leaved shrubs (Cowling & Hoffman, 2021, Grobler & Cowling, 2021) and various thicket vegetation species, such as *Portulacaria afra*, *Euphorbia* spp., *Carissa* spp., and *Searsia* spp. (Cowling et al., 2019). However, this rich biodiversity is significantly influenced by fire, a central disturbance regime in the region that profoundly affects vegetation patterns and community dynamics (Cousins et al., 2017, Smit et al., 2024, Strydom et al., 2023). The fynbos biome, in particular, is highly adapted to fire, with many species requiring fire for germination and regeneration (Magadzire et al., 2019, Newton et al., 2021).

Ethnobotanical uses of plants in the Cape Region are intrinsically connected to traditional ecological knowledge (TEK). Among communities many species are utilized for a multitude of purposes and cultural practices, for instance for their medicinal properties (Afroz, 2022) or for culinary purposes (Asowata-Ayodele et al., 2016) as well as for construction materials, fuelwood, and various crafts, even for firewood (Maroyi, 2017).

3.3.6 Chile | Central

Mediterranean sclerophyllous forests and shrublands (matorral) in central Chile confront overlapping stressors such as wildfires, drought, and agricultural or forestry expansion (Cueto et al., 2025; Gutiérrez et al., 2024). Approximately 40% of these habitats face high or very high risk from both environmental and land-use drivers. Fire frequency disrupts shrub regeneration, and repeated burns particularly undermine biodiversity (Smith-Ramírez et al., 2021; Castillo et al., 2020).

Ongoing fragmentation, invasive species colonization, and a megadrought since 2010 compound the challenges, suggesting that many native shrub assemblages are not strictly fire-adapted

(Bradshaw et al., 2011). Such degradation has significant repercussions for ecosystem services like water regulation, carbon storage, and pollination (Smith-Ramírez et al., 2023). Emerging policy tools, including Payment for Ecosystem Services schemes, may incentivize landowners to maintain or restore bushland remnants, but must account for climate uncertainties (Ocampo-Melgar et al., 2024).

3.3.7 Croatia

Croatia is one of the main hotspots of Mediterranean biodiversity, due to its high richness. There is a remarkable vascular flora and not only a significant level of endemism, but also many naturalized species that have adapted to the country's climatic and environmental conditions. Croatia constitutes home to many aromatic and pharmaceutical shrubs, including sage, rosemary, and lavender, with a deeply rooted tradition in residents' cultural heritage. Their uses include both traditional folk medicine and modern pharmaceutical development. Additionally, maquis vegetation and other native species in Croatia are holding great importance and are used for food or food additives, bee plants, environmental applications, materials and for social purposes (Nikolić and Rešetnik, 2007; Z. Šatović et al., 2012). Maquis species of Croatia consist of shrubs like *Phlomis fruticosa* and *Juniperus sabina*. The endemic Croatian sibiraea (*Sibiraea altaiensis* subsp. *croatica*) is a well-known bush that is legally protected due to its endangered status.

In addition to continental ecosystems, there are also coastal ecosystems such as dunes, where maquis species are found, that face high risk due to beach construction, summer tourism, infrastructure development and pollution. To protect and conserve this natural wealth, many regulations and legislation have been enacted regarding the sustainable use and protection of wild plant species and ensuring the proper production, processing, quality control and marketing of these plants (Nikolić and Rešetnik, 2007; Z. Šatović et al., 2012). It is crucial that conservation strategies cover both terrestrial and marine ecosystems, while prioritizing the conservation of botanical heritage (Milenko Milović et al., 2023).

3.3.8 Cyprus

Maquis ecosystems in Cyprus form an essential component of the island's natural vegetation, playing a key role in biodiversity, soil conservation, and landscape stability (Ozden & Yildirim, 2019; Gucel et al., 2012). Cypriot maquis typically develop on limestone and igneous substrates and are dominated by sclerophyllous shrubs and small trees. Common plant species include *Quercus coccifera* (kermes oak), *Pistacia lentiscus* (mastic tree), *Cistus* spp., *Juniperus phoenicea*, and *Olea europaea* var. *sylvestris* (wild olive). Also support a wide range of endemic and native fauna species (Sekerciler & Ketenoglu, 2019). They act as crucial habitats for reptiles, birds (including raptors), and invertebrates. These ecosystems also serve as buffer zones, protecting forests from erosion and desertification, especially in semi-arid regions (Ilseven, 2017). Maquis in Cyprus face pressures from agricultural expansion, urbanization, tourism development, overgrazing, and frequent wildfires. Invasive species and climate change pose additional threats, leading to fragmentation and degradation of these habitats. Some maquis areas are protected under Natura 2000, the EU's network of protected areas (Barredo et al., 2016). Key conservation sites include parts of the Akamás Peninsula, the Troodos Mountains, and the Cape Greco area.

Furthermore, the maquis vegetation in Cyprus holds significant economic importance due to its contribution to various sectors such

as agriculture, tourism, and biodiversity conservation (Karousou & Deirmentzoglou, 2011). The maquis supports local beekeeping and the production of essential oils, herbs, and traditional medicinal products (Savvides et al., 2023; Della et al., 2006; Yilmaz et al. 2012). It also plays a crucial role in preventing soil erosion and maintaining the ecological balance, which benefits agricultural productivity in surrounding areas. Additionally, the scenic landscapes formed by maquis attract nature tourism and eco-tourism, providing economic opportunities for rural communities (Karadag & Aylanc, 2020). Its preservation supports sustainable development and long-term economic resilience on the island (Stylianou et al., 2020, Hand et al., 2017).

3.3.9 Egypt

The western Mediterranean region of Egypt, in particular, is characterized by Mediterranean bushland and maquis vegetation, primarily composed of evergreen sclerophyllous shrubs such as *Thymelaea hirsuta*, *Asphodelus aestivus*, and *Echinops spinosus* (Ahmed et al., 2015a; Shaltout et al., 2024). However, this region is inherently vulnerable to desertification, a complex and progressive process of land degradation affecting dryland ecosystems (Abuzaid & Abdelatif, 2021). This phenomenon is exacerbated by a combination of natural factors and anthropogenic activities, including urban expansion, tourism development, unsustainable agricultural practices, and overgrazing. All of which contribute to habitat degradation, ecosystem fragmentation, and biodiversity loss (Ahmed et al., 2015b; Elbasiouny, 2018). Additionally cause for the further intensification of ecological disruptions is the introduction and spread of invasive species, such as *Eichhornia crassipes* and *Bassia indica* significantly impacting native plant diversity and altering community dynamics (Ahmed et al., 2015a; Bedair et al., 2023; El-Khalafy et al., 2024).

Traditional ecological knowledge (TEK) and uses of shrub species are deeply rooted in the cultural practices of local communities. Many researchers have documented that Hibiscus sabdariffa, commonly utilized for both food and beverage purposes, as well as for medicinal applications, has also been employed in the treatment of cardiovascular diseases (AbouZid and Mohamed, 2011). Others have identified shrub-type plants such as *Asclepias sinaica*, *Nerium oleander*, and *Catharanthus roseus* as possessing anticancer properties, highlighting their long-standing use in folk medicine (El-Seedi et al., 2013).

These practices emphasize the critical need for the preservation of such vegetation, not only for their medicinal value but also for their cultural significance. Additionally, they underscore the necessity for developing conservation strategies to ensure the survival of these species and mitigate the impacts of invasive species and anthropogenic pressures.

3.3.10 France

In France's Mediterranean regions, particularly in Corsica, maquis shrublands exhibit high biodiversity and significant cultural importance. Research reveals shifting maquis extent due to long-term human land use, with intervals of maquis recovery after farmland abandonment or resource extraction (Maestracci et al., 2024; Ghilardi et al., 2025). Beyond historical perspectives, contemporary work demonstrates how agro-silvopastoral strategies can incorporate maquis into diversified livelihoods (Jean-Paul Dubeuf et al., 2023). Traditional grazing in France's Corsican maquis underpins local economies (Jean-Paul Dubeuf et al., 2023)

Maquis communities dominated by Ericaceae can evolve into near-forest formations when disturbances like fire are infrequent (Camagny et al., 2025). Nevertheless, repeated burning and patch fragmentation

often stabilize maquis in a low-stature, flammable state (Curt et al., 2013; Schaffhauser et al., 2011; Morandini et al., 2019). Citizen-science data further highlights invasive species challenges (Moulin, 2020). Likewise, global assessment efforts (FAO, 2024) emphasize the region's need for integrated fire management and restoration, mirroring experiences in other Mediterranean-type climates (Curt et al., 2015).

3.3.11 Greece

Greece is of great interest for the Mediterranean basin due to its geographical location. In addition, Greece is known for its biodiversity centers, and many endemic species have found "refuge" either in coastal or continental areas, where macchia is a common sight. It plays an important role in the ecosystem by providing habitats for various species and preventing soil erosion. Thousands of maquis plants are native in Greece, growing wildly in steep slopes and harsh environments. The majority of Greek maquis is reaching a maximum height of 1.5 m due to the long-lasting degradation caused by fires and overgrazing (Petaloudi et al., 2022; Karamesouti et al., 2015).

In Greece, many native species are traditionally utilized in everyday life mainly for culinary or medicinal purposes. Other plants that are also used for phytoremediation of mining sites or infertile lands. Common species of Greek garrigue, distributed in all types of include numerous endemic species of Lamiaceae taxa with medicinal and pharmaceutical properties (e.g., species of *Acions*, *Ballota*, *Calamintha*, *Cinopodium, Lamium, Marrubium, Micromeria, Nepeta, Origanum, Phlomis, Prunella, Salvia, Satureja, Scutellaria, Sideritis, Stachys, Teucrium, Thymbra*, and *Thymus genera*) and many others such as *Quercus ilex, Quercus coccifera, Phillyrea latifolia, Pistacia lentiscus, Arbutus unedo, Arbutus andrachne Erica arborea, Erica manipuliflora, Ceratonia siliqua, Myrtus communis, Spartium junceum Pistacia terebinthus, Cotinus coggygria, Cercis siliquastrum, Smilax aspera, Clematis flammula, Asparagus acutifolius*) (Foitos & Damboldt 1985, Efthymiatou-Katsouni 1998, Cheminal et al., 2020). In acidic or degraded soils, bushlands can consist of *Erica manipuliflora* and a wide variety of *Cistus* species (Korakis 2012).

3.3.12 Italy

Italy hosts a rich variety of Mediterranean ecosystems, shaped by centuries of traditional land use and human-nature interaction. While these cultural landscapes are vital for biodiversity and heritage, they are increasingly threatened by land abandonment, urbanization, and the decline of traditional practices (Blasi et al., 2017). To address these challenges, Italy's rural development strategy supports sustainable land use by revitalizing traditional agro-pastoral systems.

In the Basilicata region of southern Italy, bushland ecosystems are ecologically significant but increasingly fragile due to harsh environmental conditions and human pressures. Often found on degraded soils and steep slopes, are highly vulnerable to erosion, desertification, and fire especially where traditional grazing or vegetation management practices have been abandoned (Kelly et al., 2015). In the Apulia region of southern Italy, the unique "Gravine" gorges host distinct macchia and garrigue communities, including *Pistacia lentiscus*-dominated shrublands and thyme-rich microgarrigues. In regions where macchia and garrigue have been left unmanaged, biomass accumulation and deadwood have led to increased risks of wildfires and pest outbreaks, further threatening the ecological integrity of these systems.

Traditional knowledge systems, such as rotational grazing, seasonal fire use, and medicinal plant harvesting, reflect centuries of human adaptation to the Mediterranean environment and offer valuable insights

for adaptive management by supporting more resilient and culturally grounded conservation strategies. As Italy moves toward integrating biodiversity and sustainability goals, the inclusion of community-based knowledge and stewardship is vital to preserving the complex mosaic of its bushland ecosystems (Tuttolomondo et al., 2014).

3.3.13 Jordan

Although covering a relatively small area, Jordan's maquis ecosystems are biodiversity-rich and play a critical role in soil conservation, carbon storage, and landscape connectivity. Maquis vegetation typically occupies degraded forest land or coexists with open oak woodlands on limestone soils (Al-Qaddi et al., 2017).

The main plant species found in Jordanian maquis are *Quercus calliprinos* (Palestine oak), *Pistacia palaestina* (Palestine pistachio), *Rhamnus palaestina* (Palestine buckthorn), *Arbutus andrachne* (eastern strawberry tree), *Phillyrea latifolia* (mock privet), *Cistus creticus* and *Cistus salviifolius* (rockroses). Maquis ecosystems in Jordan also support a wide range of endemic and native fauna species, including birds (*Sylvia melanocephala, Lanius senator*, and migratory passerines), reptiles (geckos and skinks), and insects (especially pollinators and herbivorous beetles).

Ecologically, maquis contributes to erosion control (plant root systems stabilize soils on slopes, habitat connectivity (acts as ecological corridors between forest patches), regulate microclimate (shrubs help buffer temperature extremes and retain humidity), and carbon sequestration (woody biomass stores carbon, contributing to climate resilience) (Farahani, 2018), as well as provide edible plants (Qasem, 2020) and essential oils (Arnold et al., 1997). Maquis ecosystems face several anthropogenic pressures, including overgrazing by goats and sheep, deforestation and fuelwood collection, urban expansion and agriculture, climate change and presence of invasive species can displace native maquis flora.

Habitat conservation efforts to protect the maquis include the areas of Ajloun Forest Reserve, one of Jordan's most significant remnants of oak-maquis habitat, and Dibeen Forest Reserve, home to maquis communities on sandstone soils. Conservation policies include reforestation, community-based conservation, fire prevention and management, and ecotourism.

3.3.14 Lebanon

Maquis ecosystems form a key part of the country's natural heritage within the Eastern Mediterranean biome, having a crucial role in biodiversity conservation, soil protection, and climate resilience (Aad et al., 2023). Lebanese maquis generally develop on limestone substrates and in areas where original forests have been degraded due to anthropogenic pressures. Also, support a diverse array of flora and fauna and provide critical habitat corridors between forest patches, stabilize soils in hilly regions, and contribute to Lebanon's overall landscape diversity. Typical plant species present in maquis in Lebanon include *Quercus calliprinos* (Palestine oak), *Pistacia lentiscus* (mastic tree), *Myrtus communis* (myrtle), *Cistus creticus*, *Cistus salviifolius* (rockroses), *Calicotome villosa* (thorny broom), and *Sarcopoterium spinosum* (thorny burnet). Their morphology – presence of leathery leaves and aromatic oils – enables them to survive extreme Mediterranean conditions. The fauna in the maquis include migratory birds, mammals, reptiles and insects.

The maquis vegetation plays a pivotal role in the country's economy (Martiniello & Kassem, 2024; Alrhmoun et al., 2025) having a cornerstone of several traditional industries such as honey and herbal remedies

production, cosmetics, and culinary seasonings, offering income to countless small-scale olive and folk medicine producers (Hani et al., 2022; Marouf et al., 2015). Additionally, maquis wood provides sustainable fuel for rural households and raw materials for local carpentry and artisanal crafts. Lebanon has a growing network of protected areas although maquis-specific conservation is limited. However, several conservation strategies and policies indirectly benefit these habitats, including reforestation with native maquis and forest species (Talhouk et al., 2005), fire prevention programs, including community education and monitoring, grazing regulation in sensitive habitats, community engagement and environmental education to foster local stewardship (Goetz et al., 2024).

3.3.15 Libya

Libya's biodiversity can be considered as a reflection of region's ecological wealth, which has an extremely determined role in food culture, particularly in periods when the country was in decline (Mahklouf, 2020; Masoud and Zatout, 2011). Libya hosts a unique and diverse natural heritage, characterized by a wide range of native plant and wildlife species. This biodiversity is especially concentrated in the northern coastal strip, which, despite accounting for only a small portion of Libya's landmass, supports the majority of the population and offers relatively fertile soils and higher rainfall compared to the vast desert regions that cover over 95% of the country. Within this northern zone, areas such as Cyrenaica and Marmarica are especially significant, containing more than 1,350 plant species, or approximately 70% of Libya's flora (Yacoub et al., 2013).

Mediterranean bushlands are found in the Jebel Akhdar region of Cyrenaica, with *Juniperus phoenicea* often covering up to 80% of the area. Other typical Libyan maquis species include *Quercus coccifera*, *Myrtus communis, Calicotome spinosa,* and *Ceratonia siliqua.* In dry areas *Asphodelus ramosus* and *Artemisia herba-alba* are established. However, these plant communities are increasingly under threat due to a range of natural and human-induced pressures. In recent days, even *Juniperus phoenicea* communities are decreasing, possibly due to climate change and unsustainable management practices.

Aside from their ecological role in the food chain – particularly in low-income regions – many native plants in Libya are also used traditionally for medicinal purposes, construction, furniture-making, and fuelwood. These multiple uses highlight how essential native plant biodiversity is to the daily lives and survival strategies of local communities.

3.3.16 Montenegro

Located in the south-west of the Balkans, Montenegro, despite its modest size, hosts remarkable botanical diversity and possesses exceptional ecological richness, shaped by its varied topography and climate and due to its complex geological and biological history, shaped through millennia of climatic and ecological transitions across the Balkan peninsula (Foster, 2006; Dajić Stevanović et al., 2014). The climate ranges from Mediterranean conditions along the Adriatic coast to a more continental climate inland. Numerous microclimates exist in the region, particularly in the coastal zones, valleys, highlands and plateaus, offering a high level of biodiversity (Foster, 2006). Rocky landscapes characterize most of Montenegro's southern Karst zone. The removal of forests from these areas for domestic fuel and construction led to high soil erosion and, ultimately, to the replacement of woodlands by maquis. In Montenegro, species such as myrtle and holm oak dominate, while climbing plants such as sarsaparilla, heather, thorny bushes, strawberry trees and laurel can also be found. The coastal town of Bar also supports a maquis shrubland.

Also noteworthy is the interaction between urban and natural ecosystems. As is known, the city of Podgorica stands out as a typical example of this interaction. Podgorica holds over a third of the total flora of Montenegro, which holds an astonishing level of botanical diversity not only at the national but also at the European level (Stešević et al., 2014). Ethnobotanical research has uncovered a deep well of traditional knowledge among local populations, and chemical and pharmacological studies of native plants have already yielded promising results, revealing that there are some less documented endemic plants that represent both a cultural heritage and a potential frontier for new botanical discoveries (Dajić Stevanović et al., 2014).

3.3.17 Morocco

Morocco, a geographically, climatically, and ecologically unique Mediterranean country, boasts remarkable biodiversity, making it a compelling study area. This biodiversity is partially safeguarded by a network of national parks, such as Tazekka National Park in the Eastern Middle Atlas, which showcases varied landscapes and forest ecosystems, though it faces developmental obstacles (Najat et al., 2021). Morocco's ecosystems are home to high levels of biodiversity and provide essential services such as soil protection, water regulation, and livelihoods for rural populations. However, overgrazing, land use change, and weak institutional coordination have led to widespread degradation, particularly in semi-arid regions. Recent strategies call for participatory, decentralized management approaches to align conservation goals with the socio-economic needs of local communities (Serbouti et al., 2023).

In Morocco's semi-arid and arid Mediterranean maquis ecosystems, hypogeous fungi such as Tuber and desert truffle species (Terfezia and Tirmania) play a vital ecological role by forming symbiotic mycorrhizal relationships that enhance plant resilience to drought and soil degradation. These fungi not only support ecosystem functioning but also hold significant economic value, with Morocco being a key producer of edible truffles like *Tuber oligospermum*, which are harvested from bushland and exported for culinary markets.

Ecosystem services in Morocco can be significantly improved at both national and watershed levels through targeted land management practices such as reforestation, protection of native vegetation, and pasture management, especially in degraded and arid regions (Kusi et al., 2021). Morocco's integrated sustainability efforts now emphasize biodiversity conservation, water and energy resource management, and the strategic use of renewable energy, solid waste, and biomass, all aimed at mitigating climate change and supporting rural livelihoods through circular economy principles (Arabi et al., 2024).

3.3.18 Palestine & Israel

Mediterranean bushlands (garrigue/maquis) in Palestine & Israel face historical and contemporary land-use pressures, from livestock grazing to urban encroachment (Levin et al., 2013; Manspeizer & Karnieli, 2024). Different successional stages can be selectively managed for biodiversity or other aims. However, *Quercus calliprinos* commonly outcompetes deciduous species under combined cutting and grazing regimes (Agra & Ne'eman, 2011). Repeated fires on Mount Carmel favor early successional shrubs like *Cistus salviifolius*, impairing forest regeneration (Tessler et al., 2016).

In Palestinian contexts, bushlands in sites like Wadi Al-Quff and Wadi Qana exhibit significant floristic diversity (Qumsiyeh & Al-Sheikh, 2023; Qumsiyeh et al., 2016; Mahmoud et al., 2021). Yet uncontrolled

fires, extensive grazing, and invasive plant collection reduce these ecosystems' resilience (Heresh, 2016). Moreover, local communities, mostly on Palestine, rely on shrub species for medicine and food, indicating that restoration efforts benefit from aligning with traditional ecological knowledge (Abouauda & Auda, 2011; Alrhmoun et al., 2025).

3.3.19 Portugal

Bushlands and maquis in Portugal play central roles in both ecological succession and socio-economic uses. Several studies highlight the vigorous post-disturbance recovery of maquis communities in landslide, post-quarry, and post-fire scenarios (Neto et al., 2017; Meira-Neto et al., 2011). Nitrogen (N) enrichment experiments show that increased N can alter species composition and slow down litter decomposition, thus changing maquis successional trajectories (Dias et al., 2013). Historical modeling indicates that shrublands in the Iberian Peninsula have shifted in response to climatic fluctuations, with northern refugia for thermophilous shrubs (Casas-Gallego et al., 2025). While warming extends the growing season for high-elevation shrubs (Rudley et al., 2023), drought may limit hydraulic functioning. Long-term rehabilitation projects, such as quarry revegetation, confirm that native shrubs can persist on nutrient-poor substrates, reflecting their adaptability (Oliveira et al., 2011).

Bushlands also co-occur with cork and holm oak stands, necessitating decision support tools to balance provisioning, biodiversity, and fire prevention (Garcia-Gonzalo et al., 2014; Palma et al., 2015; Nocentini et al., 2022). These systems contribute to ecosystem services like soil retention and cultural values (Seixo et al., 2023; Simonson et al., 2013). Among the diverse shrub species, Artemisia herba-alba, a bush herb present in both Portugal and California, is traditionally used for tea and wormwood. Recent studies highlight its bioactive compounds with potential anticancer effects, particularly against colorectal cancer, showcasing how Mediterranean shrublands harbor species with both ecological and medicinal significance (Bou Malhab LJ et al., 2024).

3.3.20 Slovenia

Slovenia is one the smallest, in area, countries of Europe, and despite its small size, harbors a great treasure of biodiversity, as it includes six different landform units due to its surface morphology. Slovenia has the highest average landscape diversity that's why it is considered as the miniature of Europe (Papež Kristanc et al., 2024; Perko, 2020).

Slovenian regions such as the south of Ljubljana include a typical Mediterranean landscape, where maquis communities can be found. Slovenia also has some subalpine shrub communities and tall herbs, as well as spruce forest species that can be found across the country. The shrub *Alnus viridis* is a broad-light-green-leafed alder distributed in Europe and North America, also found in Slovenian Alps. It has the ability to grow on poor soils, and an important role in nitrogen fixation, and this is why it is used in land restoration projects (Dakskobler et al., 2013).

In Slovenia, there is a linear connection between wild species and gastronomy, as certain wild species have played a dominant role in the diet of the locals from centuries past to the present. In earlier times, the collection and consumption of wild species was primarily driven by economic incentives, meaning they were a factor of survival. Particularly during times of war or economic hardship, endemic species were the stars of the kitchen. However, over the years, changes in lifestyle and environmental conditions have imposed new standards, resulting in the replacement of some wild species that were once heavily consumed with others, which are now part of intensive cultivation systems. Nowadays,

the relationship between wild and cultivated plant species is particularly dynamic, and gradually, native species are gaining ground in Slovenian cuisine through the decisive contribution of traditional knowledge and wisdom, which is passed down from the older generation to the younger ones (Papež Kristanc et al., 2024; Perko, 2020).

3.3.21 Spain

The Mediterranean maquis in Spain, is increasingly under pressure from a variety of environmental and socio-economic challenges. Native leguminous shrubs such as *Colutea arborescens* and *Dorycnium pentaphyllum* have proven highly effective in reducing soil erosion and runoff, especially when used to revegetate degraded lands. Well-adapted to the Mediterranean climate, these species support long-term ecosystem recovery while reinforcing traditional, low-impact land management strategies (Garcia-Estringana et al., 2011). Locally adapted practices - ranging from seasonal mobility and resource rationing to communal storage and ecological forecasting - have enabled communities to maintain essential ecosystem services and respond collectively to crises (Gómez-Baggethun et al., 2012). Transhumance, a traditional form of seasonal livestock movement, remains deeply embedded in Spain's Mediterranean landscapes and continues to sustain a wide range of ecosystem services, including seed dispersal, fire prevention, and soil fertility (Oteros-Rozas et al., 2012).

However, growing trends of rural depopulation and land abandonment have led to the collapse of traditional agro-silvo-pastoral mosaics, replacing them with increasingly homogeneous forested landscapes. This shift, while seemingly positive in terms of forest expansion, has been shown to reduce landscape heterogeneity and threaten open-habitat species, undermining biodiversity once supported by diverse land-use practices (Otero et al., 2015). Despite formal protection, many cultural landscapes have undergone significant spatial fragmentation and ecological transformation, often due to insufficient integration of traditional land-use practices into conservation planning (Marine et al., 2020).

In southeastern Spain, studies show that dense *Pinus halepensis* plantations - often introduced through historical reforestation - tend to suppress understory biodiversity, suggesting that thinning and structural diversification are necessary to enhance the conservation value of fragmented forest patches (Zapata & Robledano, 2014). Preserving and revitalizing these knowledge systems is crucial, not only for biodiversity and ecosystem services, but also for strengthening local resilience to environmental change (Hernández-Morcillo et al., 2014).

3.3.22 Syria

Maquis ecosystems in Syria are an integral part of the Mediterranean vegetation belt, characterized by evergreen, sclerophyllous shrublands. The structure ranges from low, dense bushland to taller thickets, particularly in areas with reduced human interference. Dominant plant species in Syrian maquis are *Quercus calliprinos* (Palestine oak), *Pistacia palaestina* and *Pistacia lentiscus*, *Cistus incanus* and *Cistus salviifolius* (rockroses), *Myrtus communis* (myrtle), *Arbutus andrachne* (eastern strawberry tree), and *Rhamnus alaternus* (Italian buckthorn).

Syria's maquis supports a range of fauna, including birds (*Lanius senator, Otus scops*), reptiles (*Chalcides ocellatus*), mammals (small carnivores such as foxes and badgers), and insects (pollinators and decomposers). The maquis ecosystems in Syria also perform key ecological functions, such as erosion control, (plant root systems anchor soils on slopes), microclimate regulation (shading and evapotranspiration moderate

local conditions), and carbon storage (especially important in degraded forest-transition zones).

Expect deforestation and wood harvesting, wild-fires, urbanization, overgrazing, and climate change, the presence of armed conflicts adds an additional critical factor threatening the integrity of Syrian maquis ecosystems (Al-Qaddi et al., 2017). The maquis vegetation in Syria plays a vital role in the country's rural economy and ecological stability. The aromatic herbs harvested from maquis serve as raw materials for traditional medicine, culinary ingredients, and local artisan essential oils, contributing to household incomes and informal markets. Maquis wood is also used for fuel and small-scale woodworking crafts. Syria's maquis contributes significantly to socioeconomic resilience and environmental sustainability across many of its semi-arid regions (Lalani et al., 2018).

3.3.23 Tunisia

Maquis ecosystems in Tunisia are primarily found in the northern and northwestern parts of the country. These ecosystems play a crucial role in biodiversity conservation, soil protection, and climate regulation. Typical maquis formations develop on calcareous soils and degraded forest lands.

Dominant vegetation includes *Quercus coccifera* (kermes oak), *Pistacia lentiscus* (mastic tree), *Myrtus communis* (myrtle), *Erica arborea* (tree heath), *Arbutus unedo* (strawberry tree), *Rosmarinus officinalis* (rosemary), *Cistus monspeliensis* and other *Cistus species*, and *hypogeous fungi* (Zambonelli et al., 2014). These shrubs exhibit xerophytic adaptations such as tough, leathery leaves and deep root systems, allowing them to survive summer droughts and poor soils. The faunal component includes birds, reptiles, mammals and insects.

These ecosystems help stabilize soils on steep terrain, contribute to the hydrological cycle, and serve as carbon sinks (Boutagayout et al., 2023). Their structural complexity provides shelter and breeding grounds for many species. The main threats of the maquis are due to anthropogenic pressures, including wood harvesting, extensive grazing (Kirk et al., 2019), agricultural expansion, urbanization, fires, and climate change (Coelho et al., 2004). The maquis vegetation in Tunisia plays a key role in the country's economy, particularly in rural and semi-arid regions (Akakpo et al., 2024). Comprising aromatic shrubs like rosemary, sage, thyme, and other drought-adapted species, as well as small oak and pistachio trees, this native ecosystem supports several important industries, including beekeeping and extraction of essential oils from aromatic plants. Furthermore, wood provides raw material for artisanal crafts, which are essential income streams in marginalized areas. Lastly, its scenic landscapes support eco-tourism and rural tourism initiatives.

Several maquis areas are included in Tunisia's protected area network. Reforestation, fire management, sustainable grazing, community involvement, research and monitoring are some of the strategies adopted to conserve the maquis.

3.3.24 Turkey

Local communities in Turkey are characterized by a deep understanding of ethnobotany. These practices not only contribute to community well-being but also support biodiversity through selective harvesting and in-situ conservation. Ethnobotanical knowledge in this context thus represents a living cultural heritage, integrating ecological insight, traditional identity, and sustainable resource use.

A wide array of plant species is traditionally used in Turkey's Mediterranean maquis ecosystems, particularly for medicinal and

nutritional purposes, while regional practices further reinforce the importance of ethnobotanical traditions. Commonly known and utilized maquis and shrub species include *Vitex agnus-castus, Ceratonia siliqua, Salvia spp., Thymus spp., Rhus coriaria, Laurus nobilis, Myrtus communis,* and *Pistacia lentiscus*, valued for both their practical and symbolic roles (Yildirim & Kargioglu, 2015; Yilmaz Kolanci, 2017; Kok et al., 2020; Culu, 2021). There are local communities which are regularly consumed in food, health, and culinary culture, *Tamus communis, Foeniculum vulgare,* and *Vitex agnus-castus* among them (Karadag, 2015) or continue to use *Origanum* spp., *Lavandula stoechas*, and *Hypericum* spp. in daily life for both medicinal and culinary purposes (Sicak et al., 2013; Sari et al., 2010).

Moreover, nomadic and semi-nomadic groups or communities such as the Tahtaci and Yoruk, are prone to continue to uphold traditional land-use systems and customary strategies such as transhumance, rotational grazing, and sacred area conservation, selective plant harvesting, and , demonstrate place-based ecological knowledge shaped by environmental gradients and seasonal rhythms and contribute to biodiversity and ecological regeneration (Buyuksahin, 2017, Cakmak, 2010; Can, 2010).

This widespread ethnobotanical engagement, preserved through oral culture and practice, exemplifies a sustainable and intergenerational interaction with the Mediterranean landscape. The tension between formal conservation frameworks and traditional land-use systems highlights the need for integrative approaches that respect local knowledge and practices. The integration of folk culture with ecological knowledge in rural tourism simultaneously promotes economic development and cultural preservation (Ekici, 2016).

COUNTRY / REGION	MAIN BUSHLAND TYPES	DOMINANT SPECIES	KEY PRESSURES
Albania	Maquis and garrigue	*Caparis sp* (capers), *Cerotonia siliqua* (carob tree), *Laurus nobilis* (laurel), *Glucyrrhiza glabra* (licorice scent), *Murtus communis L* (myrtle plant), *Rosa canina* (rosehip) *Sparteum juneum* (yellow spanish broom), *Vitex agnus-castus L* (lilac chastetree), *Arbutus unedo* (strawberry tree), *Artemisia vulgaris* (artemisia), *Cistus ladanifer* (cistus), *Hypericum perforatum* (St. John's wort) *Lavandula stoechas* (lavender), *Mentha pulegium* (pennyroyal) *Origanum vulgare* (oregano), *Rubus ulmifolius (*elmleaf blackberry), *Salvia officinalis* (salvia), *Thymus vulgaris* (thyme) *Pistacia lentiscus* var Chia (mastic)	• Urban expansion • Rural abandonment • Tourism pressure • Climate change • Wildfires • Drought • Overgrazing • Overharvesting of herbs • Erosion • Mining • Invasive species
Algeria			
Australia (Southwestern and South)			
USA (California)	Chaparral		
South Africa (Cape Region)	Fynbos		
Central Chile	Matorral		
Croatia	Maquis and garrigue		
Cyprus			
Egypt			
France			
Greece			
Italy			
Jordan			
Lebanon			
Libya			
Montenegro			
Morocco			
Palestine & Israel			
Portugal			
Slovenia			
Spain			
Syria			
Tynisia			
Turkey			

4. ECONOMIC ANALYSIS AND SUSTAINABLE BUSINESS MODELS

4. ECONOMIC ANALYSIS AND SUSTAINABLE BUSINESS MODELS

While several studies have examined the ecological functions and management of Mediterranean scrublands, much of this literature remains focused on biophysical processes, species interactions, and conservation outcomes rather than on integrated economic valuation or livelihood-oriented management frameworks (Novara et al., 2014; Rogosic et al., 2015; Froustey et al., 2024).

4.1 ECONOMIC VALUATION OF ECOSYSTEM SERVICES

Among the methods used to determine the economic value of the services provided by Mediterranean shrublands, market valuation, stated preference methods and shadow pricing techniques stand out. Market valuation calculates the economic contribution of directly saleable products. This includes aromatic plants, non-wood products and animal products. However, as this method only covers direct commercial products, it under-represents regulatory and cultural services. Expressed preference methods quantify the value of non-market services through contingent valuation (CVM) and choice experiments (CE). These methods capture the value that individuals attribute to ecosystem services through willingness to pay (Molina et al., 2016; Tagliafierro et al., 2013). Shadow pricing techniques have been used to calculate the economic value of regulatory services such as carbon sequestration. The Social Cost of Carbon (SCC) has been an important tool for quantifying the economic value of carbon storage and sequestration services in rural landscapes within climate regulation assessments (Mirici et al, 2024).

The economic value of Mediterranean shrublands is influenced by many factors. Climate change is causing significant fluctuations in carbon sequestration capacity. Higher temperatures and reduced rainfall reduce the growth rates and carbon storage capacity of shrublands (Gratani et al, 2013; Riera et al, 2007; Carrión-Prieto et al., 2017). Land use changes, especially agriculturalization and urbanization, leads to shrinking shrublands and loss of ecosystem services. In the long term, this change leads to a loss of both ecological and economic value (de Groot et la, 2022; Rezgui et al, 2024; Mirici et al., 2024). Valuation of ecosystem services may vary across social groups and respondent characteristics. Bernués et al. (2014) report differences between farmers and citizens and between local and general populations, while Riera et al. (2007) show that higher-income respondents were more willing to pay for climate-change mitigation programs in Catalan shrublands. Policies and subsidies directly affect the economic value of ecosystem services. In particular, support mechanisms such as the European Union's Common Agricultural Policy (CAP) encourage conservation activities when designed correctly but can accelerate habitat loss when designed incorrectly (Bernués et al. 2014; de Groot et al. 2022).

4.2 ECONOMIC CONTRIBUTIONS OF ECOSYSTEM SERVICES

4.2.1 Carbon sequestration and climate regulation

Mediterranean shrublands provide climate regulation services through carbon sequestration. Carbon storage capacities vary depending on shrub species and soil characteristics. Research shows that species such as *Cistus ladanifer* and *Erica arborea* have particularly high carbon sequestration potential (Carrión-Prieto et al. 2017). Biomass measurements and photosynthetic rate analyses used to quantify carbon capacity revealed that Mediterranean shrublands can sequester approximately 80 Mg CO_2 per hectare per year, while maintaining a total accumulated carbon stock of 45 to 73 Mg CO_2 equivalent per hectare depending on the species (Gratani et al, 2013; Carrion-Prieto et al, 2017)

The potential for carbon credits was assessed using a social carbon cost approach. Integrating bushland into carbon markets offers the opportunity to provide direct economic benefits to local communities. The financial value of the carbon sequestration service is estimated at approximately USD 590 per hectare per year (Gratani et al, 2013). These findings provide evidence that bushland ecosystems provide climate regulation services not only locally but also on a global scale.

4.2.2 Water regulation and soil conservation

Water regulation is another critical ecosystem service provided by Mediterranean shrublands. By increasing rainwater infiltration, shrubs reduce surface runoff and contribute to the recharge of groundwater resources. Analyses using water yield models show that precipitation and evapotranspiration (prec_coef and eto_coef variables) have a

direct impact on water regulation. These models show the contribution of shrubs to the water cycle, especially in coastal areas and on sloping terrain (Lasanta et al., 2024; Sánchez-Canales et al., 2012). Erosion control is also an important service provided by shrubs. The contribution of root systems to soil stability reduces the risks of flooding and landslides. Hydrological indices and soil organic carbon values confirm that soil health and water retention capacity are high in shrublands (Gratani et al, 2013; Pirastru et al, 2014). The economic impact of these services is felt indirectly in areas such as agricultural productivity, water supply security and natural disaster mitigation.

4.2.3 Biodiversity and habitat provision

The economic impact of habitat provision is based on indirect benefits rather than direct income generation. Nature-based tourism and recreation activities in particular increase the economic value of this biodiversity (de Groot et al., 2022; Raviv et al., 2020; Bernues et al., 2014). Integration of tools such as remote sensing techniques and Geographic Information Systems (GIS)-assisted modeling have enabled spatial analysis of ecosystem services, especially over large areas. Methods such as the InVEST model and Regression Kriging have generated important data for policy makers by providing precise value estimates (Vizzarri et al, 2017; Mirici et al., 2024; Sanchez-Canales et al, 2012). Studies conducted within nature conservation programs have shown that habitat quality is directly related to the efficiency of ecosystem services. This finding suggests that habitat management should be aligned with conservation and economic development objectives.

4.2.4 Cultural values and ecotourism

Mediterranean shrublands constitute an important social and economic resource for local communities through the cultural values they offer. Landscape aesthetics, traditional land use, folkloric values and nature-dependent lifestyles increase the cultural importance of these ecosystems. The natural beauty of the bushlands provides economic returns through activities such as nature walks, photography, bird watching and recreation. Ecotourism has become an important sector for income diversification and job creation in regional economies (Bernues et al., 2014; Raviv et al., 2020; de Groot et al., 2022). Various surveys have found that people's willingness to pay for the conservation of natural landscapes is high. This result shows that cultural ecosystem services can directly translate into economic value. Contributions to landscape aesthetics and cultural identity are prominent elements that support the integration of nature conservation and economic growth objectives in regional development strategies.

4.2.5 Economic contributions by sector

The ecosystem services provided by Mediterranean shrublands directly support different economic sectors, including agriculture, forestry, ecotourism, and new sectors such as carbon markets and payment mechanisms based on ecosystem services (PES). In the agricultural sector, extensive livestock activities rely on fodder resources from the bushland. Shrublands increase the sustainability of livestock activities with low input costs (Rogosic et al., 2011; Lasanta et al., 2019; Lecegui et al., 2022). On the other hand, the forestry sector utilizes resources such as non-wood products from the bushland, aromatic plants and mushrooms are economically valuable. Trade in these products provides direct income to local economies (Masiero et al., 2016; Hernández-

-Rodríguez et al., 2015). Ecotourism is another important sector that supports rural development (Bernués et al., 2014; Raviv et al., 2020; de Groot et al., 2022). Ecotourism provides activities such as trekking, nature observation and cultural tourism that provide economic returns from the aesthetic and biological values offered by bushland areas. Lastly, carbon markets and PES have the potential to create new sources of income from bushland ecosystems by supporting conservation and economic growth objectives together (Gratani et al., 2013; Masiero et al., 2016; Mirici et al., 2024).

4.3 SUSTAINABLE MANAGEMENT AND BUSINESS MODELS

4.3.1 Existing sustainable business models

Sustainable business models developed for the conservation and economic utilization of Mediterranean maquis and bushlands support both the continuity of ecosystem services and local economic development. The main models applied in the literature for this purpose are extensive livestock farming, carbon credit systems, ecotourism initiatives and multifunctional land use strategies.

In extensive livestock management, low-intensity livestock practices support vegetation conservation and reduce fire risks in bushland areas. This approach ensures sustainable use of natural grassland areas and creates economic benefits for local communities. Livestock grazing provides a natural barrier against fire by controlling overgrowth of shrubs. Therefore, the extensive pastoral model is considered a sustainable management strategy from both ecological and economic perspectives (Lasanta vd., 2024; Lecegui vd., 2022).

Integration into carbon credit mechanisms can link carbon sequestration services to market mechanisms and creates a strong incentive to conserve agroforestry and restored forestlands. Carbon credit projects enable local communities to generate direct income from nature conservation activities. For this, carbon stock measurements and monitoring systems have been developed, and the annual carbon sequestration capacity of the bushland has been certified and offered to the market (Carrión-Prieto et al., 2017; Gratani et al., 2013).

The aesthetic and biological values offered by bushlands are used as an economic resource in nature-based tourism activities. Ecotourism initiatives generate economic income through activities such as

nature walks, bird watching and rural cultural experiences, while raising awareness of nature conservation. This model supports long-term sustainability as it is based on the principle of conservation and utilization of natural resources (Bernués et al., 2014; Lasanta et al., 2024, de Groot et al., 2022).

Land use refers to the management of shrublands not only for a single purpose but also by integrating different types of use. Within the scope of this strategy, activities such as agriculture, forestry and tourism are planned together, thus benefiting from various dimensions of ecosystem services at the same time. This holistic approach makes it possible to both protect ecosystem health and generate income from different sectors (de Groot et al., 2022).

4.3.2 Sustainability challenges and solutions

There are various environmental, political and economic challenges in implementing sustainable business models. In particular, agricultural policies and rural development subsidies have decisive effects on the conservation or destruction of shrubland. Targeted strategies could be adopted to overcome these challenges.

Climate change threatens the resilience of bushland ecosystems and the continuity of the services they provide. Increasing temperatures, droughts and fires weaken the structural integrity of shrublands. Policies need to be designed to be flexible, sensitive to local conditions and ensure coordination across sectors. Adaptive management strategies should be developed to reduce this risk. Land planning based on climate change scenarios, fire prevention measures and water management practices should be prioritized (Riera et al., 2007; Gratani et al., 2013; Masiero et al., 2024; de Groot et al., 2022; Vizzarri et al., 2017; Lasanta et al., 2024).

Support programs, such as the European Union's Common Agricultural Policy (CAP), can promote nature conservation when designed correctly. But misguided subsidies can accelerate habitat loss, leading to serious losses in ecosystem services (de Groot et al., 2022; Bernués et al., 2014; Lecegui et al., 2022). As a solution, incentive systems focused on nature conservation should be developed and environmental service production should be supported. In addition, direct payments to landowners for sustainable land use should be encouraged (Bernués et al., 2014; Lecegui et al., 2022). Payment for ecosystem services (PES) systems offer an approach that directly rewards nature conservation activities (de Groot et al., 2022; Bernués et al., 2014; Masiero et al., 2016).

One of the most effective strategies against environmental degradation is to implement nature-based solutions. By supporting natural processes, nature-based solutions to environmental degradation (NBS) approaches provide both ecological recovery and cost-effective solutions (Masiero et al., 2024; Gratani et al., 2013). Within the scope of nature-based solutions in shrublands, practices such as habitat restoration, natural grassland management and protection of water resources should be prioritized (Lasanta et al., 2024; de Groot et al., 2022). These approaches will support the conservation and enhancement of ecosystem services.

4.4 PROPOSED SUSTAINABLE BUSINESS MODELS

4.4.1 Ecotourism and cultural tourism

The aesthetic and cultural values offered by the Mediterranean bushlands provide a strong basis for ecotourism and cultural tourism activities. Studies (Tagliafierro et al., 2013; Bernués et al., 2014) have shown that natural landscapes offer services to which individuals attribute high economic value. In particular, activities such as nature walks, birdwatching and rural cultural tours allow for economic benefits through the conservation of bushland ecosystems (Bernués et al., 2014). Critical factors for success include the active involvement of local communities, tourism planning based on nature conservation principles and careful management of visitor capacity (Bernués et al., 2014; Raviv et al., 2020). Ecotourism activities not only generate direct income but also contribute to raising awareness of nature conservation.

4.4.2 Aromatic and medicinal plant production

Aromatic and medicinal plants growing in bushland ecosystems offer an important economic resource. De Groot et al. (2022). reported that Mediterranean shrublands have significant potential as natural aromatic plant reservoirs. Controlled collection or cultivation of such plants both maintains ecosystem health and generates economic income. Value chain creation and marketing strategies are decisive for the success of this business model. Rezgui et al. (2024) demonstrated that local development can be supported through value-added processing and direct marketing of aromatic and medicinal plant products. Community participation should be encouraged by increasing the role of cooperatives or producer associations in the production process. This approach also has the potential to reduce rural migration by improving local income distribution.

4.4.3 Marketing carbon credits and ecosystem services

Marketing carbon sequestration services is one of the powerful ways to extract economic value from bushland ecosystems. Masiero et al. (2016) showed that it is possible to consider Mediterranean shrublands as a potential source of income in carbon markets. Conducting carbon stock measurements and completing certification processes in shrublands makes it possible to sell carbon credits. The viability of this model depends on the use of accurate carbon measurement methods and transparent certification processes (de Groot et al., 2022). Furthermore, ensuring that local communities directly benefit from carbon revenues increases the social acceptance and long-term sustainability of this model. At the policy level, it is recommended to create incentive mechanisms to facilitate access to carbon markets (Masiero et al., 2024).

4.4.4 Public-Private partnerships and cooperative models

Public-private partnerships and cooperative models offer significant potential for sustainable management of shrublands. De Groot et al (2022) noted that multi-stakeholder management models promote the efficient use of ecosystem services.

In public-private partnerships, public institutions set conservation objectives, while the private sector provides investments and operational competence. In cooperative models, producers and landowners participate directly in management and have a say in decision-making (de Groot et al., 2022). The success of these models depends on building trusting relationships, developing fair income-sharing mechanisms and establishing long-term financing strategies (de Groot et al., 2022). Supporting local cooperatives not only generates economic income but also strengthens rural development by increasing social solidarity.

5. FOCUS GROUPS FINDINGS ON MEDITERRANEAN BUSHLAND

5. FOCUS GROUPS FINDINGS ON MEDITERRANEAN BUSHLAND

INTRODUCTION

For the purposes of this Handbook, focus groups were conducted in Portugal, Greece, Turkey, and Cyprus with experts, local community members, and practitioners to discuss the values and challenges of the Mediterranean bushlands and provide better insights on their views and experiences. The MedSEVa focus groups revealed both shared Mediterranean challenges and locally grounded solutions. Bushlands, often undervalued, emerge as central to ecological resilience, cultural continuity, and sustainable rural economies. Their future depends on integrating TEK with modern science, fostering education and innovation, and developing governance systems that empower communities to manage maquis ecosystems sustainably.

Figure 7. Shrubland landscapes
Photos: Carlota Flieg

5.1 CULTURAL AND HISTORICAL SIGNIFICANCE

Across Portugal, Greece, Turkey, and Cyprus, Mediterranean bushlands were consistently described as deeply rooted in cultural heritage. In Cyprus, archaeological evidence links their use to the Neolithic period, with plants like pistacia, olive, and arbutus essential for food, fuel, and tools. Greek participants highlighted the Chios mastic, recognized by UNESCO as Intangible Cultural Heritage, demonstrating how traditional crops intertwine cultural identity with modern branding. Similarly, Portuguese ethnobotanical traditions, such as medicinal plant use passed down through generations, underscore the continuity of TEK. In all contexts, TEK serves as both heritage and a practical tool for sustainable land use. Yet, participants emphasized that this knowledge is at risk due to its erosion, generated by modern agricultural intensification, delocalization of practices, and limited integration into education.

5.2 ECOLOGICAL VALUE AND BIODIVERSITY

The focus groups reaffirmed that Mediterranean shrublands are biodiversity hotspots and ecological infrastructures. They provide pollinator habitats, regulate water, sequester carbon, and protect soils. Cyprus hosts nearly 1,700 plant species, many endemic, with maquis serving as reservoirs of wild relatives of cultivated crops, which are vital genetic resources especially under climate change. Greek participants stressed the multifunctionality of maquis species such as carob and aromatic herbs, which enhance soil fertility, provide natural pest control, and thrive in drought-prone conditions. Turkish discussions also echoed this, pointing to bay laurel, sage, and oregano as key species with economic and ecological roles. Collectively, participants called for a shift in perception: from viewing shrublands as "marginal wastelands" to recognizing them as strategic ecological assets.

Figure 8. Chios mastic gum, Greece, Chios, September 2025
Photos: Anna Gkotzamani

5.3 CLIMATE CHANGE AND ENVIRONMENTAL CHALLENGES

All groups highlighted climate change as the dominant threat to maquis ecosystems. In Greece, participants reported that extreme weather, such as unexpected rainfall or heat stress, is reducing yields of traditional crops. Cypriot experts described increasing drought, invasive species, and saltwater intrusion, which degrade habitats and lead to extinction of native juniper species. In Turkey, sustainability is compromised by overharvesting, wildfires, and legislative gaps. Portuguese participants further emphasized wildfire risks and the role of managed agricultural land as firebreaks. Despite regional variations, a common theme emerged: current land-use practices and policies are often incompatible to heterogeneous landscapes, leading to degradation rather than resilience.

5.4 TRADITIONAL ECOLOGICAL KNOWLEDGE AND EDUCATION

TEK was consistently highlighted as both a valuable resource and a vulnerable heritage. Portuguese contributions showcased medicinal plant traditions and phytotherapy as living TEK yet underscored its absence from formal education modules. Greek participants noted that TEK is disappearing due to delocalization but also pointed to permaculture and cooperatives as movements reviving it. Education was identified as a crucial vehicle for TEK transmission. Empirical learning, through demonstration fields, botanical gardens, and field visits, was recommended across countries. In Portugal, teachers advocated for curricula that connect students with local ecosystems. Turkey emphasized using social media and international case studies to engage youth.

5.5 ECONOMIC VALORIZATION AND SUSTAINABLE LIVELIHOODS

A shared finding was that Mediterranean bushlands possess untapped economic potential. Greek participants highlighted mastic, carob, and aromatic herbs as "forgotten crops" with strong market demand in food, pharmaceuticals, and eco-tourism. In Portugal, participants pointed to essential oils, honey, and hunting-based economies as emerging valorization pathways. Cyprus emphasized ongoing uses such as capers, wild asparagus, and beekeeping, which remain embedded in local livelihoods. Turkish discussions identified market barriers, particularly long supply chains and unregulated harvesting, but also highlighted global demand for laurel oil and other non-timber forest products. Key recommendations included developing certification and branding schemes (PDO, PGI, heritage crops), supporting cooperatives and shortening supply chains to increase farmer income, as well as expanding eco- and agrotourism as complementary income sources.

5.6 GOVERNANCE, POLICY, AND INNOVATION

Participants across all countries agreed that governance and policy frameworks need greater alignment with local ecological realities. Uniform regulations often fail in heterogeneous landscapes, as shown in Portugal's Guadiana Basin or Crete's water-stressed regions. Key governance challenges include insufficient support for small-scale businesses and sustainability-oriented farmers, overemphasis on industrial agriculture and non-endemic, water-demanding crops, as well as weak regulation of overgrazing, wildfires, and harvesting practices. At the same time, participants stressed the potential of innovation. Portuguese and Turkish experts discussed the role of GIS, remote sensing, and participatory mapping for planning and climate

forecasting. Ethnobotanical research, genetic resource preservation, and the development of "model fields" were highlighted in Greece and Cyprus as ways to combine TEK with scientific advances.

Multi-Country Mediterranean Bushland Observatory (MCSO)

A transnational structure for coordinated monitoring and innovation.

Functions

- Standardized indicators for bushland health
- Early-warning systems for fire, drought, erosion
- A shared genetic resource bank
- Interoperable GIS layers across Portugal, Spain, Italy, Greece, Turkey, Cyprus

Governance

- Intergovernmental council
- Annual reports for EU and national ministries
- Involvement of regional universities and local TEK holders

Summary

Taken together, the four focus groups underscore the multifunctional role of Mediterranean bushlands, which combine ecological functions such as biodiversity conservation, carbon storage, water regulation, and erosion control with cultural significance as living archives of tradition, mythology, and community identity, and they also hold economic value as sources of food, medicine, eco-tourism, and green enterprises.

To safeguard these values while adapting to climate challenges, participants collectively recommended valorizing native, resilient species such as mastic, carob, bay laurel, and aromatic herbs, and revitalizing traditional ecological knowledge through education, community initiatives, and science-backed validation. They also suggested enhancing economic opportunities through certification, short supply chains, and sustainable enterprises, and promoting sustainable land and water management while limiting the expansion of water-intensive crops. Finally, participants emphasized bridging research and practice by co-producing knowledge with farmers and rural communities, and strengthening governance through supportive policies, cooperative structures, and climate-adapted regulations.

6. POLICY AND MANAGEMENT RECOMMENDATIONS

6. POLICY AND MANAGEMENT RECOMMENDATIONS

6.1 IMPACT OF EXISTING POLICIES AND INCENTIVES

Analyses in the literature show that existing policy and incentive systems have both positive and negative impacts on the conservation of bushland ecosystems. In particular, mechanisms such as the European Union's Common Agricultural Policy (CAP) can incentivize nature conservation activities when designed correctly (Bernués et al., 2014; Lasanta et al., 2019). However, if subsidies are misdirected, they have been reported to increase habitat loss by supporting agricultural expansion (Sánchez-Canales et al., 2012).

In studies conducted in Spain and Italy, payments that directly support the PES have been found to be effective in protecting shrublands (Lecegui et al., 2022; Rezgui et al., 2024). These mechanisms created motivation for conservation by making the monetary value of ecosystem services visible to landowners and local communities. As a recommendation, it is suggested to develop performance-based incentive systems based on ecosystem service production instead of direct income support. In addition, it is important to align rural development programs with nature conservation goals (de Groot et al., 2022; Lecegui et al., 2022).

6.2 LEGAL AND REGULATORY FRAMEWORKS

Finding and creating legal aspects concerning natural ecosystems

The sustainable management of bushland ecosystems and protection of TEK require a strong legal and regulatory framework. Studies have shown that existing legislation is mostly focused on forests and agricultural land, while shrublands are caught in policy gaps (Lecegui et al., 2022; de Groot et al., 2022). This complicates the conservation of bushlands, and the sustainable management of ecosystem services suggest that shrublands should be given special status in land-use planning. Vizzarri et al., 2017 classifies shrublands based on their potential to produce ecosystem services can make management plans more effective. In addition, strengthening the legal infrastructure of carbon credit systems will facilitate economic benefits from bushland ecosystems (Masiero et al., 2016; de Groot et al., 2022).

Policies and procedures promoting institutionalization

It is important to simplify certification processes and make them suitable for small-scale landowners. In general, it is emphasized at national and international level that shrublands should be recognized as an ecosystem and integrated into conservation policies (Vizzarri et al., 2017).

Similarly, several recent sources contribute to the underexplored dimension of how TEK can be institutionally protected and integrated into policy. Sevgi and Akkemik (2022) reveal that the Aegean region hosts a rich repertoire of phytonyms (plant names), which reflect deep cultural knowledge systems. Their study highlights the linguistic and classificatory aspects of TEK, underlining the importance of including vernacular plant knowledge in biodiversity and land-use policy frameworks. Ensuring linguistic representation in policy documents could enhance both recognition and protection efforts. Yolcu (2021) provides an ethnographic account of textile practices in the Ayvacik region in Turkey, linking them to ecological knowledge systems embedded in local lifeways.

Traditional wisdom through scientific documentation

Documentation of these practices strengthens the case for including TEK in national inventories of intangible cultural heritage. Moreover, initiatives like local cooperatives empower knowledge holders economically, creating incentives for the conservation and continued transmission of TEK. Agar et al. (2024) also demonstrate that TEK's medical applications are increasingly recognized in alternative medicine and pharmacognosy. The documentation and scientific testing of these practices can support their formal recognition within national health strategies. Collectively, these findings suggest that safeguarding TEK requires not only legal instruments but also participatory mechanisms that include local actors in decision-making processes. Encouraging local engagement through cooperatives, community science platforms, and linguistic preservation initiatives can significantly contribute to the resilience and continued relevance of traditional ecological knowledge systems.

6.3 TRAINING, AWARENESS RAISING AND CAPACITY BUILDING

Socio-economic findings show that sustainable bushland management is directly related to the level of education and awareness of local communities (Masiero et al., 2016; Regato, 2008). Therefore, policy recommendations should not only be limited to financial incentives but also focus on capacity building of local people.

Education programs should provide local communities with information on the importance of ecosystem services, nature-based solutions and sustainable use methods (Masiero et al., 2024). Raising awareness, especially among younger generations, of nature conservation and sustainable land use is a critical factor for long-term success.

Awareness-raising campaigns should communicate the aesthetic, cultural and economic value of shrublands to the wider public (Regato, 2008). Public support for nature conservation efforts is a factor that increases the effectiveness of policies. Capacity building should specifically target organizations such as cooperatives, village associations and local government units (Regato, 2008). Through these structures, both management effectiveness and local solidarity can be strengthened. As a result, training, awareness-raising and capacity-building programs should not only transfer knowledge but also ensure local ownership and adoption of sustainable management practices.

Figure 9. Illustration of earth degradation and restoration: two faces of the same planet. The choice is in our hands.
Source: *https://www.livescience.com/planet-earth/climate-change*

WORKSHOP AGENDA: BASIC BUSHLAND MANAGEMENT SKILLS

Community Training on Sustainable Bushland Management

MODULE 1: Introduction to Shrublands

- What shrublands are
- Why they matter (ecosystem services, culture, grazing)

MODULE 2: Threats and Opportunities

- Unsustainable grazing, wildfires, climate change
- Positive incentives and PES

MODULE 3: TEK and Local Practices

- Vernacular plant knowledge
- Traditional harvesting techniques

MODULE 4: Sustainable Use Techniques

- Habitat maintenance and vegetation monitoring
- Fire prevention and post-disturbance recovery
- Soil protection and erosion control in bushland areas

MODULE 5: Community Project Planning

- Small group work
- Design of community management plans
- Presentation and feedback

EXERCISE: "MAP YOUR SHRUBLAND"

Mapping: Identify local ecosystem services and disturbance pressures

Materials: Printed maps, markers, GPS-enabled phones.

Steps:

1. Mark important bushland areas
2. Identify threats (overgrazing, fire, invasive species)
3. Identify cultural and TEK-based sites (traditional harvesting areas, ritual sites)

7. CONCLUSION

7. CONCLUSION

Literature and case studies demonstrate that Mediterranean bushlands and maquis ecosystems are of high value both environmentally and economically. However, climate change due to human activities and nature disturbances in corporation with the extreme increase of global population are threatening the integrity of Mediterranean ecosystems. As a result, it creates an imbalance, between the ecosystem services and protection of them. Getting exhausted from human demanding there is no time for these ecosystems to recover and develop as nature commands (Ghermandi and Gonzalez, 2025).

First, shrublands provide multidimensional services concerning either human needs food, fuelwood, pharmaceuticals or environmental benefits such as carbon sequestration, water regulation, habitat provision, pollination and even aesthetic value (Bernués et al., 2014; Sánchez-Canales et al., 2012; Gratani et al., 2013, Ghermandi and Gonzalez, 2025). The economic value of these services varies regionally, that's why it is crucial to understand ecosystems functioning and to develop the ability to evaluate degradation's grade and prevent it, as much as possible.

Second, assessments of the viability of sustainable business models have shown that alternatives such as extensive livestock farming, carbon credit systems, nature-based tourism and aromatic plant production can be effective in conserving bushlands (Masiero et al., 2016; Lasanta et al., 2019; Lecegui et al., 2022; Tagliafierro et al., 2013; Raviv et al., 2020; de Groot et al., 2022). The success of these models depends on: 1) the active participation of local communities, by highlighting the meaning of traditional wisdom, 2) the availability of economic incentives by being financially profitable and implementing in large scale and 3) the

capacity to adapt to environmental threats, emphasize biodiversity and indigenous species protection and promotion (Itxaso Ruiz et al, 2020).

Third, strong and integrated strategies are needed at the policy and management level. It is important to align existing incentive systems with nature conservation goals, strengthen the legal status of bushland, and increase the accessibility of new economic instruments such as carbon markets (de Groot et al., 2022; Lecegui et al., 2022). Integration of the socio-economic dimension plays a critical role in the success of sustainable management practices. Education, awareness-raising and capacity-building programs are key tools to support local ownership and long-term sustainability.

Additionally, traditional ecological knowledge represents a valuable resource for sustainable management and restoration. Rooted in centuries of coexistence between people and Mediterranean landscapes, TEK encompasses traditional land-use systems, seasonal practices, and plant-based livelihoods that promote ecological balance and biodiversity. Integrating TEK with scientific approaches can enhance conservation efforts, reinforce rural economies, and ensure that future strategies remain culturally grounded and ecologically resilient.

Nature-based solutions, participatory management models and economic diversification should be considered together in the future management of Mediterranean shrublands. It has much importance to refer that there are some technical, financial, cultural and policy factors that can contribute to these strategies. Technical factors are strictly connected to appropriate technologies, equipment and knowledge. On the other hand, financial and cultural factors are led by communities' involvement and expansion or the limitations due to them accepting and adopting sustainable practices. Policy factors are a part of the choices that are made, which can promote or obstruct decisions relevant to sustainable management (Itxaso Ruiz et al, 2020). Every challenge can be faced with flexibility and adaptability to new climate regimes by creating coordinated environmental policies and institutions, leveraging appropriate knowledge and access to management tools, with respect to nature and the socio-cultural characteristics of each area, respectively (Itxaso Ruiz et al, 2020).

In conclusion, Mediterranean maquis and bushland ecosystems offer a powerful resource for achieving sustainable development goals. Conservation and utilization of this potential will be possible through a holistic approach, including integrated policy approaches, effective management models and strong social participation. This approach can correlate enhancement measures and adapt to climate change, traditional multifunctionality of the Mediterranean landscape and creation of healthier, more productive and diverse ecosystems.

8. BIBLIOGRAPHY

1. AbouZid, S. F., & Mohamed, A. A. (2011). *Survey on medicinal plants and spices used in Beni-Sueif, Upper Egypt*. Journal of Ethnobiology and Ethnomedicine, 7(1). https://doi.org/10.1186/1746-4269-7-18
2. Abuzaid, A. S., & Abdelatif, A. D. (2021). *Assessment of desertification using modified MEDALUS model in the north Nile Delta, Egypt*. Geoderma, 405, 115400. https://doi.org/10.1016/j.geoderma.2021.115400
3. Afroz, N. (2022). *Exploring Traditional Medicine in South Africa: A Review of Ethnobotanical Studies on Medicinal Plants*. Plant Science Archives, 14, 18. https://doi.org/10.51470/PSA.2022.7.3.14
4. Agra, H., & Ne'eman, G. (2011). *Quercus calliprinos regrowth advantage under grazing in Mediterranean maquis and its management implications*. Forest Ecology and Management, 261(1), 143–147. https://doi.org/10.1016/j.foreco.2010.09.044
5. Ahmed, D. A., Fawzy, M., Saeed, N. M., & Awad, M. A. (2015). *Effect of the recent land use on the plant diversity and community structure of Omayed Biosphere Reserve, Egypt*. Global Ecology and Conservation, 4, 26–37. https://doi.org/10.1016/j.gecco.2015.05.005
6. Ahmed, D., Shaltout, K., Hosni, H., & El-Fahar, R. (2015). F*lora and vegetation of the different habitats of the western Mediterranean region of Egypt. Taeckholmia/ Taeckholmia* (Online), 35(1), 45–76. https://doi.org/10.21608/taec.2015.12216
7. Airey Lauvaux, C., Skinner, C. N., & Taylor, A. H. (2016). *High severity fire and mixed conifer forest-chaparral dynamics in the southern Cascade Range, USA*. Forest Ecology and Management, 363, 74–85. https://doi.org/10.1016/j.foreco.2015.12.016
8. Alliouche, A., & Kouba, Y. (2023). *Modelling the spatiotemporal dynamics of land susceptibility to desertification in Algeria*. CATENA, 232, 107437. https://doi.org/10.1016/j.catena.2023.107437
9. Alrhmoun, M., Sulaiman, N., & Pieroni, A. (2025). Phylogenetic Perspectives and Ethnobotanical Insights on Wild Edible Plants of the Mediterranean, Middle East, and North Africa. Foods, 14(3), 465–465. https://doi.org/10.3390/foods14030465

10. Arabi, M., Mechkirrou, L., Malki, M. E., Alaoui, K., Chaieb, A., Maaroufi, F., & Karmich, S. (2024). *Overview of ecological dynamics in Morocco—biodiversity, water scarcity, climate change, anthropogenic pressures, and energy resources—Navigating towards ecosolutions and sustainable development.* E3S Web of Conferences, 527, 01001. *https://doi.org/10.1051/e3sconf/202452701001*

11. Asowata-Ayodele, A. M., Afolayan, A. J., & Otunola, G. A. (2016). *Ethnobotanical survey of culinary herbs and spices used in the traditional medicinal system of Nkonkobe Municipality, Eastern Cape, South Africa.* South African Journal of Botany, 104, 69–75. *https://doi.org/10.1016/j.sajb.2016.01.001*

12. Bedair, H., Shaltout, K., & Halmy, M. W. A. (2023). *A critical inventory of the mediterranean endemics in the egyptian flora*. Biodiversity and Conservation, 32(4), 1327-1351. *https://doi.org/10.1007/s10531-023-02555-5*

13. Belgacem, N., Okkacha, H., Benchohra, M., & Djamel, M. M. (2020). *Floristic diversity of the Tagdempt region, Tiaret Mountains, Algeria.* Acta Ecologica Sinica, 40(4), 296–299. *https://doi.org/10.1016/j.chnaes.2020.06.007*

14. Bernues, A., Rodríguez-Ortega, T., Ripoll-Bosch, R., Alfnes, F. (2014). *Socio-cultural and economic valuation of ecosystem services provided by Mediterranean mountain agroecosystems.* PloS one, 9 (7):e102479.

15. Blasi, C., Capotorti, G., Ortí, M. M. A., Anzellotti, I., Attorre, F., Azzella, M. M., Carli, E., Copiz, R., Garfì, V., Manes, F., Marando, F., Marchetti, M., Mollo, B., & Zavattero, L. (2017). *Ecosystem mapping for the implementation of the European Biodiversity Strategy at the national level: The case of Italy.* Environmental Science & Policy, 78, 173–184. *https://doi.org/10.1016/j.envsci.2017.09.002*

16. Bou Malhab, L. J., Harb, A. A., Eldohaji, L., Taneera, J., Al-Hroub, H. M., Abuhelwa, A., Alzoubi, K. H., Abu-Irmaileh, B., Hudaib, M., Almaliti, J., Abdel-Rahman, W. M., Shanableh, A., Semreen, M. H., El-Huneidi, W., Abu-Gharbieh, E., & Bustanji, Y. (2024). *Exploring the anticancer effect of Artemisia herba-alba on colorectal cancer: Insights from eight colorectal cancer cell lines.* Food Science & Nutrition, 13(1), e4715. *https://doi.org/10.1002/fsn3.4715*

17. Bradshaw, S. D., Dixon, K. W., Hopper, S. D., Lambers, H., & Turner, S. R. (2011). *Little evidence for fire-adapted plant traits in Mediterranean climate regions.* Trends in Plant Science, 16(2), 69–76. *https://doi.org/10.1016/j.tplants.2010.10.007*

18. Camagny, T., Ivorra, S., Terral, J.-F., Garberi, P., Carré, A., Paolini-Saez, H., Perrin, T., Bouby, L., & Delhon, C. (2025). *Macchia or forest? Toward the reconstruction of Ericaceae formations in Corsica (NW Mediterranean) during the Holocene using a quantitative wood anatomy analysis.* Journal of Archaeological Science: Reports, 62, 105014. *https://doi.org/10.1016/j.jasrep.2025.105014*

19. Carrión-Prieto, P., Hernández-Navarro, S., Martín-Ramos, P., Sánchez-Sastre, L. F., Garrido-Laurnaga, F., Marcos-Robles, J. L., Martín-Gil, J. (2017). *Mediterranean shrublands as carbon sinks for climate change mitigation: new root-to-shoot ratios.* Carbon Management, 8 (1): 67–77.

20. Casas-Gallego, M., Postigo-Mijarra, J. M., Sánchez-de Dios, R., Barrón, E., Bruch, A. A., Hahn, K., & Sainz-Ollero, H. (2025). *Changes in distribution of the Iberian vegetation since the Last Glacial Maximum: A model-based approach*. Quaternary Science Reviews, 351, 109162. *https://doi.org/10.1016/j.quascirev.2024.109162*

21. Castillo S, M., Plaza V, Á., & Garfias S, R. (2020). *A recent review of fire behavior and fire effects on native vegetation in Central Chile.* Global Ecology and Conservation, 24, e01210. *https://doi.org/10.1016/j.gecco.2020.e01210*

22. Cousins, S. R., Witkowski, E. T. F., & Esler, K. J. (2017). I*nfluence of fire on critically endangered Swartland Shale Renosterveld in the Cape Floristic Region.* Applied Vegetation Science, 21(1), 144–155. *https://doi.org/10.1111/avsc.12348*

23. Cowling, R. M., Logie, C., Brady, J., Middleton, M., & Grobler, B. A. (2019). *Taxonomic, biological and geographical traits of species in a coastal dune flora in the southeastern Cape Floristic Region: regional and global comparisons.* PeerJ, 7, e7336. *https://doi.org/10.7717/peerj.7336*

24. Cowling, R., & Hoffman, M. (2021). *Multi-decadal vegetation change in dune vegetation of the south-eastern Cape Floristic Region: Is thicket expansion without fire inevitable?* South African Journal of Botany, 142, 73–81. *https://doi.org/10.1016/j.sajb.2021.05.032*

25. Cueto, D. A., Alaniz, A. J., Hidalgo-Corrotea, C., Vergara, P. M., Carvajal, M. A., & Barrios-Saravia, A. (2025). *Chilean Mediterranean forest on the verge of collapse? Evidence from a comprehensive risk analysis.* Science of the Total Environment, 964, 178557. *https://doi.org/10.1016/j.scitotenv.2025.178557*

26. Curt, T., Borgniet, L., & Bouillon, C. (2013). *Wildfire frequency varies with the size and shape of fuel types in southeastern France: Implications for environmental management.* Journal of Environmental Management, 117, 150–161. *https://doi.org/10.1016/j.jenvman.2012.12.006*

27. Curt, T., Borgniet, L., Ibanez, T., Moron, V., & Hély, C. (2015). *Understanding fire patterns and fire drivers for setting a sustainable management policy of the New-Caledonian biodiversity hotspot.* Forest Ecology and Management, 337, 48–60. *https://doi.org/10.1016/j.foreco.2014.10.032*

28. Daoud, N., & Kadik, L. (2024). *Spatio-temporal changes of the flora, climate impact and biodiversity prediction in the presaharan wadis South of Djelfa (Algeria).* Ecological Frontiers, 44(5), 981–1001. *https://doi.org/10.1016/j.ecofro.2024.01.008*

29. de Groot, R., Moolenaar, S., de Vente, J., De Leijster, V., Ramos, M. E., Robles, A. B., Schoonhoven, Y., Verweij, P. (2022). *Framework for integrated Ecosystem Services assessment of the costs and benefits of large scale landscape restoration illustrated with a case study in Mediterranean Spain.* Ecosystem Services, 53, 101383.

30. Dias, T., Oakley, S., Alarcón-Gutiérrez, E., Fabio Ziarelli, Trindade, H., Maria Amélia Martins-Loução, Sheppard, L. J., Ostle, N., & Cruz, C. (2013). *N-driven changes in a plant community affect leaf-litter traits and may delay organic matter decomposition in a Mediterranean maquis.* Soil Biology & Biochemistry, 58, 163–171. *https://doi.org/10.1016/j.soilbio.2012.10.027*

31. Dubeuf, J.-P., Biehlmann, F., Lorton, R., Sorba, J.-M., & Valenti, M. (2023). *Assessing the operational perspectives of agrosilvopastoralism in the Mediterranean Region: Learnings from observations in Corsica.* Small Ruminant Research, 229, 107131. *https://doi.org/10.1016/j.smallrumres.2023.107131*

32. Elbasiouny, H. (2018). *Assessment of environmental sensitivity to desertification, soil quality and sustainability in an area of the North Nile Delta*, Egypt. Egyptian Journal of Soil Science, 58(4), 399-415. *https://doi.org/10.21608/ejss.2018.4741.1192*

33. El-Hokayem, L., De Vita, P., Usman, M., Link, A., & Conrad, C. (2023). *Mapping potentially groundwater-dependent vegetation in the Mediterranean biome using global geodata targeting site conditions and vegetation characteristics. Science of the Total Environment*, 898, 166397. *https://doi.org/10.1016/j.scitotenv.2023.166397*

34. Elia, M., Giannico, V., Ascoli, D., Argañaraz, J. P., D'Este, M., Spano, G., Lafortezza, R., & Sanesi, G. (2022). *Uncovering current pyroregions in Italy using wildfire metrics. Ecological Processes*, 11(1). *https://doi.org/10.1186/s13717-022-00360-6*

35. El-Khalafy, M. M., Al-Sodany, Y. M., Ahmed, D. A., Bedair, H., Haroun, S. A., & Shaltout, S. K. (2024). *Evaluation of Conservation status of the Egyptian endemic plants along the Mediterranean coastal strip region.* Journal of Coastal Conservation, 28(1). *https://doi.org/10.1007/s11852-023-01007-0*

36. El-Seedi, H. R., Burman, R., Mansour, A., Turki, Z., Boulos, L., Gullbo, J., & Göransson, U. (2012). *The traditional medical uses and cytotoxic activities of sixty-one Egyptian plants: Discovery of an active cardiac glycoside from Urginea maritima.* Journal of Ethnopharmacology, 145(3), 746–757. *https://doi.org/10.1016/j.jep.2012.12.007*

37. FAO, (2013). State of Mediterranean forests 2013. FFEM, Silva Mediterranean, *Plan Bleu, Food and Agriculture Organization of the United Nations.* FAO, Rome.

38. FAO. (2024). Restoring the Mediterranean region: status and challenges. Unasylva No. 255 – Vol. 75 2024/1. Rome. *https://doi.org/10.4060/cd1720en*

39. Froustey, N., Guyot, M., Crétet, M., Aulagnier, S., Pelozuelo, L., Ricci, J. C., 2024. *Impact of habitat management of small game species on bird communities in French Mediterranean scrublands.* Animal Biodiversity and Conservation, 47: 75-88.

40. Garcia-Estringana, P., Alonso-Blázquez, N., Marques, M., Bienes, R., González-Andrés, F., & Alegre, J. (2011). *Use of Mediterranean legume shrubs to control soil erosion and runoff in central Spain. A large-plot assessment under natural rainfall conducted during the stages of shrub establishment and subsequent colonisation.* CATENA, 102, 3–12. *https://doi.org/10.1016/j.catena.2011.09.003*

41. Garcia-Gonzalo, J., Bushenkov, V., McDill, M., & Borges, J. (2014). *A Decision Support System for Assessing Trade-Offs between Ecosystem Management Goals: An Application in Portugal.* Forests, 6(12), 65–87. *https://doi.org/10.3390/f6010065*

42. Ghilardi, M., Revelles, J., Fagel, N., Schmidt, S., & Delanghe, D. (2025). *Reconstructing the Mid- to Late Holocene human-environment interactions in Cape Corsica (Corsica Island, Western Mediterranean) based on sedimentology, pollen analyses and geochemistry.* Journal of Archaeological Science: Reports, 62, 104985. *https://doi.org/10.1016/j.jasrep.2025.104985*

43. Giuliano Fanelli, Michele DE SANCTIS, Ermelinda Gjeta, Alfred MullaJ & Fabio Attorre, *The Vegetation of the Buna River Protected Landscape* (Albania), Hacquetia 14/2, 2015, 129–174

44. Gratani, L., Varone, L., Ricotta, C., Catoni, R. (2013). *Mediterranean shrublands carbon sequestration: environmental and economic benefits.* Mitig Adapt Strateg Glob Change, 18: 1167–1182.

45. Grobler, B. A., & Cowling, R. M. (2021). *The composition, geography, biology and assembly of the coastal flora of the Cape Floristic Region.* PeerJ, 9, e11916. *https://doi.org/10.7717/peerj.11916*

46. Gutiérrez, J., Altamirano, A., Aníbal Pauchard, & Meli, P. (2024). *Proximity to forest plantations is associated with presence and abundance of invasive plants in landscapes of south-central Chile.* NeoBiota, 92, 129–153. *https://doi.org/10.3897/neobiota.92.112164*

47. Hanley, N. (2008). *Valuing Mediterranean Forests: Towards Total Economic Value, Mountain Research and Development* 28(3): 339-340.

48. Heresh, A. (2016, pp 33-42). *Introduction of ecological corridors in Palestinian landscape restoration toward a threat analysis approach.* Handle.net. *http://hdl.handle.net/2067/2978*

49. Hernández-Morcillo, M., Hoberg, J., Oteros-Rozas, E., Plieninger, T., Gómez-Baggethun, E., & Reyes-García, V. (2013). *Traditional ecological knowledge in Europe: status quo and insights for the environmental policy agenda. Environment Science and Policy for Sustainable Development*, 56(1), 3–17. *https://doi.org/10.1080/00139157.2014.861673*

50. Hernández-Rodríguez, M., de-Miguel, S., Pukkala, T., Oria-de-Rueda, J. A., Martín-Pinto, P. (2015). *Climate-sensitive models for mushroom yields and diversity in Cistus ladanifer scrublands.* Agricultural and Forest Meteorology, 213: 173-182.

51. Huntsinger, L., & Oviedo, J. L. (2014). *Ecosystem Services are Social–ecological Services in a Traditional Pastoral System: the Case of California's Mediterranean Rangelands* (Resilience Alliance Inc., Ed.) [Review of Ecosystem Services are Social–ecological Services in a Traditional Pastoral System: the Case of California's Mediterranean Rangelands]. JSTOR; Resilience Alliance Inc. *https://www.jstor.org/stable/26269476?seq=1*

52. Kelly, C., Ferrara, A., Wilson, G. A., Ripullone, F., Nolè, A., Harmer, N., & Salvati, L. (2015). *Community resilience and land degradation in forest and shrubland socio-ecological systems: Evidence from Gorgoglione, Basilicata, Italy.* Land Use Policy, 46, 11–20. *https://doi.org/10.1016/j.landusepol.2015.01.026*

53. Kusi, K. K., Khattabi, A., & Mhammdi, N. (2021). *Integrated assessment of ecosystem services in response to land use change and management activities in Morocco.* Arabian Journal of Geosciences, 14(6). *https://doi.org/10.1007/s12517-021-06719-x*

54. Kusi, K. K., Khattabi, A., & Mhammdi, N. (2021b). *Integrated assessment of ecosystem services in response to land use change and management activities in Morocco.* Arabian Journal of Geosciences, 14(6). *https://doi.org/10.1007/s12517-021-06719-x*

55. Laala, A., & Adimi, A. (2024). *Modeling the potential distribution and shift of an Algerian endangered endemic species (Cedrus atlantica) under climate change scenarios: Implications for conservation.* Journal for Nature Conservation, 82, 126744. *https://doi.org/10.1016/j.jnc.2024.126744*

56. Lasanta, T., Cortijos-López, M., Errea, M. P., Llena, M., Sánchez-Navarrete, P., Zabalza, J., Nadal-Romero, E. (2024). *Shrub clearing and extensive livestock as a strategy for enhancing ecosystem services in degraded Mediterranean mid-mountain areas.* Science of the Total Environment, 906:167668.

57. Lecegui, A., Olaizola, A. M., Varela, E. (2022). *Disentangling the role of management practices on ecosystem services delivery in Mediterranean silvopastoral systems: Synergies and trade-offs through expert-based assessment*. Forest Ecology and Management, 517: 120273.

58. Levin, N., Watson, J. E. M., Joseph, L. N., Grantham, H. S., Hadar, L., Apel, N., Perevolotsky, A., DeMalach, N., Possingham, H. P., & Kark, S. (2013). *A framework for systematic conservation planning and management of Mediterranean landscapes.* Biological Conservation, 158, 371–383. *https://doi.org/10.1016/j.biocon.2012.08.032*

59. Maestracci, P.-Y., Plume, L., & Gibernau, M. (2024). *Insect floral visitors of thermo-Mediterranean shrubland maquis (Ajaccio, Corsica, France).* Biodiversity Data Journal, 12. *https://doi.org/10.3897/BDJ.12.e118614*

60. Magadzire, N., De Klerk, H. M., Esler, K. J., & Slingsby, J. A. (2019). *Fire and life history affect the distribution of plant species in a biodiversity hotspot.* Diversity and Distributions, 25(7), 1012–1023. *https://doi.org/10.1111/ddi.12921*

61. Mahmoud, J., Hussein Ighbareyeh, Suliemieh, A., Mousa, A., & Jehad M. H. Ighbareyeh. (2021). *Biodiversity and Phytosociological Analysis of Plants in Wadi*

Al-Quf Nursery Reserve North -Western of Hebron City in Palestine. Journal of Plant Sciences, 9(1), 13–24. *https://doi.org/10.11648/j.jps.20210901.13*

62. Malkisnon, D., Wittenberg, L., Beeri, O., & Barzilai, R. (2011). Effects of repeated fires on the structure, composition, and dynamics of Mediterranean maquis: Short- and long-term perspectives. Ecosystems (New York, N.Y.), 14(3), 478–488. *https://doi.org/10.1007/s10021-011-9424-z*

63. Manspeizer, N., & Karnieli, A. (2024). *Disentangling disturbances with nested hierarchy classification of Mediterranean garrigue/maquis shrub community compositions through remote sensing and GIS.* Ecological Informatics, 82, 102728. *https://doi.org/10.1016/j.ecoinf.2024.102728*

64. Marco, Y., Jordà, G., Kherbouche, F. & Peña-Chocarro, L. (2022). *Plant use and vegetation trends in Algeria from Late Glacial to Middle Holocene: Charcoal and seeds from Gueldaman GLD 1 cave (Babors d'Akbou).* Review of Palaeobotany and Palynology, 297, 104562–104562. *https://doi.org/10.1016/j.revpalbo.2021.104562*

65. Marine, N., Arnaiz-Schmitz, C., Herrero-Jáuregui, C., De La O Cabrera, M. R., Escudero, D., & Schmitz, M. F. (2020). *Protected Landscapes in Spain: Reasons for protection and Sustainability of conservation management.* Sustainability, 12(17), 6913. *https://doi.org/10.3390/su12176913*

66. Maroyi, A. (2017). *Diversity of use and local knowledge of wild and cultivated plants in the Eastern Cape province*, South Africa. Journal of Ethnobiology and Ethnomedicine, 13(1). *https://doi.org/10.1186/s13002-017-0173-8*

67. Martínez, T. L., Romero, M. E. N., Ruiz, J. M. G. (2019). *Clearing shrubland as a strategy to encourage extensive livestock farming in the Mediterranean mountains.* Cuadernos de investigación geográfica, 45(2):487-513.

68. Martínez-Valderrama, J., Ibáñez, J., Del Barrio, G., Alcalá, F. J., Sanjuán, M. E., Ruiz, A., Hirche, A., & Puigdefábregas, J. (2018). *Doomed to collapse: Why Algerian steppe rangelands are overgrazed and some lessons to help land-use transitions*. Science of the Total Environment, 613-614, 1489–1497. *https://doi.org/10.1016/j.scitotenv.2017.07.058*

69. Masiero, M., Bottaro, G., Righetti, C., Nikolaidis, N. P., Lilli, M. A., Pettenella, D. (2024). *Riparian forests as nature-based solutions within the Mediterranean context: a biophysical and economic assessment for the Koiliaris River Watershed* (Crete, Greece). Forests, 15(5): 760.

70. Masiero, M., Pettenella, D., Secco, L. (2016). F*rom failure to value: economic valuation for a selected set of products and services from Mediterranean forests.* Forest Systems, 25 (1): e051.

71. Masoud Moustafa Mohamed Zatout, *The Roles of Exotic and Native Tree Species in Preventing Desertification and Enhancing Degraded Land Restoration in the North East of Libya*, University of Bradford eThesis

72. Meira-Neto, J. A. A., Clemente, A., Oliveira, G., Nunes, A., & Correia, O. (2011). *Post-fire and post-quarry rehabilitation successions in Mediterranean-like ecosystems: Implications for ecological restoration.* Ecological Engineering, 37(8), 1132–1139. *https://doi.org/10.1016/j.ecoleng.2011.02.008*

73. Miara, M. D., Bendif, H., Ait Hammou, M., & Teixidor-Toneu, I. (2018). *Ethnobotanical survey of medicinal plants used by nomadic peoples in the Algerian steppe.* Journal of Ethnopharmacology, 219, 248–256. *https://doi.org/10.1016/j.jep.2018.03.011*

74. Ministry of Environment (Lebanon). (2016). *Lebanon's Fifth National Report to the CBD.*

75. Mirici, M. E., Berberoglu, S. (2024). *Terrestrial carbon dynamics and economic valuation of ecosystem service for land use management in the Mediterranean region.* Ecological Informatics, 81: 102570.

76. Molina, J. R., Moreno, N., & Moreno, R. (2017). *Influence of fire regime on forest structure and restoration of a native forest type in the southern Andean Range.* Ecological Engineering, 102, 390–396. *https://doi.org/10.1016/j.ecoleng.2017.02.059*

77. Molina, J. R., Silva, F. R. Y., & Herrera, M. Á. (2016). *Integrating economic landscape valuation into Mediterranean territorial planning.* Environmental Science & Policy, 56, 120–128. *https://doi.org/10.1016/j.envsci.2015.11.010*

78. Molina, J. R., y Silva, F. R., Herrera, M. Á. (2016). *Integrating economic landscape valuation into Mediterranean territorial planning.* Environmental Science & Policy, 56:120-128.

79. Morandini, F., Santoni, P. A., Tramoni, J. B., & Mell, W. E. (2019). *Experimental investigation of flammability and numerical study of combustion of shrub of rockrose under severe drought conditions.* Fire Safety Journal, 108, 102836. *https://doi.org/10.1016/j.firesaf.2019.102836*

80. Moulin, N. (2020). *When Citizen Science highlights alien invasive species in France: the case of Indochina mantis, Hierodula patellifera* (Insecta, Mantodea, Mantidae). Biodiversity Data Journal, 8. https://doi.org/10.3897/bdj.8.e46989

81. Najat, A., Hanae, E., Mohammed, E. H., Latifa, E. H., & Jamal, C. (2021). *Impact of climate change on the phytobiodiversity of Tazekka National Park.* Sustainability in Environment, 6(2), p1. https://doi.org/10.22158/se.v6n2p1

82. Neto, C., Patrícia Cardigos, Oliveira, S. C., & José Luís Zêzere. (2017). *Floristic and vegetation successional processes within landslides in a Mediterranean environment.* Science of the Total Environment, 574, 969–981. https://doi.org/10.1016/j.scitotenv.2016.09.119

83. Newton, R. J., Mackenzie, B. D. E., Lamont, B. B., Gomez-Barreiro, P., Cowling, R. M., & He, T. (2021). *Fire-mediated germination syndromes in Leucadendron (Proteaceae) and their functional correlates.* Oecologia, 196(2), 589–604. https://doi.org/10.1007/s00442-021-04947-2

84. Nocentini, S., Travaglini, D., & Muys, B. (2022). *Managing Mediterranean Forests for Multiple Ecosystem Services: Research Progress and Knowledge Gaps.* Current Forestry Reports. https://doi.org/10.1007/s40725-022-00167-w

85. Novara, A., Pereira, P., Santoro, A., Kuzyakov, Y., La Mantia, T. (2014). *Effect of cactus pear cultivation after Mediterranean maquis on soil carbon stock,* δ13C spatial distribution and root turnover. Catena, 118: 84-90.

86. Ocampo-Melgar, A., Barría, P., Cerda, C., Venegas-González, A., Fernández, J., Díaz-Vasconcellos, R., & Zamora, J. (2024). *Payment for Ecosystem Services: institutional arrangements for a changing climate in the Chilean Mediterranean Region.* Npj Climate Action, 3(1). https://doi.org/10.1038/s44168-024-00132-2

87. Oliveira, G., Nunes, A., Clemente, A., & Correia, O. (2011). *Effect of substrate treatments on survival and growth of Mediterranean shrubs in a revegetated quarry: An eight-year study.* Ecological Engineering, 37(2), 255–259. https://doi.org/10.1016/j.ecoleng.2010.11.015

88. Otero, I., Marull, J., Tello, E., Diana, G. L., Pons, M., Coll, F., & Boada, M. (2015). *Land abandonment, landscape, and biodiversity: questioning the restorative character of the forest transition in the Mediterranean.* Ecology and Society, 20(2). https://doi.org/10.5751/es-07378-200207

89. Oteros-Rozas, E., González, J. A., Martín-López, B., López, C. A., Zorrilla-Miras, P., & Montes, C. (2012). E*valuating Ecosystem Services in Transhumance Cultural Landscapes: An Interdisciplinary and Participatory Framework.* GAIA - Ecological Perspectives for Science and Society, 21(3), 185–193. http://hdl.handle.net/10486/667460

90. Palahi, M., Mavsar, R., Gracia, C., Birot, Y. (2008). *Mediterranean forests under focus.* International Forestry Review, 10 (4): 676-688.

91. Palma, J.H.N., Paulo, J.A., Faias, S.P. et al. A*daptive management and debarking schedule optimization of Quercus suber L. stands under climate change: case study in Chamusca*, Portugal. Reg Environ Change 15, 1569–1580 (2015). https://doi.org/10.1007/s10113-015-0818-x

92. Papež Kristanc, A.; Kreft, S.; Strgulc Krajšek, S.; Kristanc, L. *Traditional Use of Wild Edible Plants in Slovenia: A Field Study and an Ethnobotanical Literature Review.* Plants 2024, 13, 621. https://doi.org/10.3390/plants13050621

93. Parker, V. T. (2020). *Chaparral of California.* Encyclopedia of the World's Biomes, 457–472. https://doi.org/10.1016/b978-0-12-409548-9.11894-9

94. Pirie, M. D., Oliver, E. G. H., De Kuppler, A. M., Gehrke, B., Maitre, N. C. L., Kandziora, M., & Bellstedt, D. U. (2016). *The biodiversity hotspot as evolutionary hot-bed: spectacular radiation of Erica in the Cape Floristic Region.* BMC Evolutionary Biology, 16(1). https://doi.org/10.1186/s12862-016-0764-3

95. Pirie, M. D., Oliver, E. G. H., Gehrke, B., Heringer, L., De Kuppler, A. M., Maitre, N. C. L., & Bellstedt, D. U. (2017). *Underestimated regional species diversity in the Cape Floristic Region revealed by phylogenetic analysis of the Erica abietina/E. viscaria clade (Ericaceae).* Botanical Journal of the Linnean Society, 184(2), 185–203. https://doi.org/10.1093/botlinnean/box021

96. Quick, L. J., Chase, B. M., Chevalier, M., Grobler, B. A., & Manzano, S. (2024). *Fire drives major Holocene vegetation shifts between subtropical and Mediterranean-type ecosystems: a case study from a biodiversity hotspot in South Africa.* Ecography, 2024(12). https://doi.org/10.1111/ecog.07485

97. Qumsiyeh, M. B., & Al-Sheikh, B. (2023). *Flora and Conservation Issues in Two Protected Areas in Palestine: Wadi Al-Zarqa Al-Ulwi and Wadi Qana.* Diversity, 15(2), 142. https://doi.org/10.3390/d15020142

98. Qumsiyeh, M. B., Khalilieh, A., Albaradeiya, I. M., Al-Shaikh, B. (2016). *Biodiversity Conservation of Wadi Al-Quff Proteccted area (Central Palestine): Challenges and Opportunities.* https://www.rscn.org.jo/uploaded_files/journal/67618187a416d1734443399.pdf

99. Raviv, O., Shamir, S. Z., Izhaki, I., Sagie, H., Negev, M., Mazor-Tregerman, M., Collins-Kreiner, N., Mansfeld, Y., Lotan, A. (2020). *The socioeconomic value of multiple ecosystem types at a biosphere reserve as a baseline for one holistic conservation plan*. Ecosystem services, 41: 101043.

100. Regato, P. (2008). *Adapting to Global Change: Mediterranean Forests*. IUCN Centre for Mediterranean Cooperation, Malaga, Spain.

101. Rezgui, F., Rosati, A., Lambarraa-Lehnhardt, F., Paul, C., Reckling, M. (2024). *Assessing Mediterranean agroforestry systems: Agro-economic impacts of olive wild asparagus in central Italy.* European Journal of Agronomy, 152:127012.

102. Riera, P., Peñuelas, J., Farreras, V., Estiarte, M. (2007). *Valuation of climate-change effects on Mediterranean Shrublands.* Ecological Applications, 17 (1): 91-100.

103. Rogosic, J., Saric, T., Herceg, N., Zjalic, S., Stanic, S., Skobic, D. (2011). *Effect of supplementation with barley and calcium hydroxide on intake of Mediterranean shrubs by goats.* Italian Journal of Animal Science, 10 (2).

104. Rogosic, J., Saric, T., Zupan, I. (2015). *Effect of Achillea Millefolium L. and Matricaria chamomilla L. on consumption of Juniperus Oxycedrus L. and J. Phoenicea L. by goats.* Annals of animal science, 15 (1): 119.

105. Rudley, D., DeSoto, L., S. Rodríguez-Echeverría, & C. Nabais. (2023). *Climate effect on the growth and hydraulic traits of two shrubs from the top of a Mediterranean mountain.* Science of the Total Environment, 902, 165911–165911. *https://doi.org/10.1016/j.scitotenv.2023.165911*

106. Sánchez-Canales, M., Benito, A. L., Passuello, A., Terrado, M., Ziv, G., Acuña, V., Schuhmacher, M., Elorza, F. J. (2012). *Sensitivity analysis of ecosystem service valuation in a Mediterranean watershed.* Science of the total environment, 440:140-153.

107. Sarmoum, M., J. Julio Camarero, & Fatiha Abdoun. (2024). *Aridification increases growth resistance of Atlas cedar forests in NW Algeria.* Forest Ecology and Management, 556, 121730–121730. *https://doi.org/10.1016/j.foreco.2024.121730*

108. Schaffhauser, A., Curt, T., & Tatoni, T. (2011). *Fire-vegetation interplay in a mosaic structure of Quercus suber woodlands and Mediterranean maquis under recurrent fires.* Forest Ecology and Management, 262(5), 730–738. *https://doi.org/10.1016/j.foreco.2011.05.003*

109. Schaffhauser, A., Curt, T., Véla, E., & Tatoni, T. (2012). *Fire recurrence effects on the abundance of plants grouped by traits in Quercus suber L. woodlands and maquis.* Forest Ecology and Management, 282, 157–166. *https://doi.org/10.1016/j.foreco.2012.06.047*

110. Schröter, D., Cramer, W., Leemans, R., Prentice, I.C., Araujo, M.B. (2005). *Ecosystem Service Supply and Vulnerability to Global Change in Europe.* Science, 310 (5752): 1333-1337.

111. Seixo, J., Carina, S., Campos, F. S., Cabral, P., Nunes, L. C., & Cunha-e-Sá, M. A. (2023). *The economic value of land-based ecosystem services in Portugal: a spatially explicit approach.* Run.unl.pt. *http://hdl.handle.net/10362/147835*

112. Senouci, F., Ababou, A., & Chouieb, M. (2019). *Ethnobotanical Survey of the Medicinal Plants used in the Southern Mediterranean. Case Study: The Region of Bissa (Northeastern Dahra Mountains, Algeria).* Pharmacognosy Journal, 11(4), 647–659. *https://doi.org/10.5530/pj.2019.11.103*

113. Serbouti, S., Abbas, Y., Ettaqy, A., Boukcim, H., Achiban, H., Abderrazzak, B., & Ghachtouli, N. E. (2022). *Evolution of wildfires, burned areas, and affected species in Middle Atlas forests (Morocco) from 2000 to 2020.* Trees Forests and People, 10, 100319. *https://doi.org/10.1016/j.tfp.2022.100319*

114. Serbouti, S., Ettaqy, A., Boukcim, H., Mderssa, M., Ghachtouli, N. E., & Abbas, Y. (2023). *Forests and woodlands in Morocco: review of historical evolution, services, priorities for conservation measures and future research.* The International Forestry Review, 25(1), 121–145. *https://doi.org/10.1505/146554823836838745*

115. Shaltout, K. H., & El-Khalafy, M. M. (2024). *Biodiversity in Egypt contributing to world biodiversity.* Journal of Ecology and Environment, 48. *https://doi.org/10.5141/jee.23.048*

116. Simonson, W. D., Allen, H. D., & Coomes, D. A. (2013). *Remotely sensed indicators of forest conservation status: Case study from a Natura 2000 site in southern Portugal.* Ecological Indicators, 24, 636–647. *https://doi.org/10.1016/j.ecolind.2012.08.024*

117. Skobic, D., Rogosic, J., Stanic-Kostroman, S., Knezovic, L. (2012). *Effects of fennel (Foeniculum vulgare L.) on consumption of two Mediterranean Juniperus species by goats.* In: Casasús, I., Rogošiç, J., Rosati, A., Štokoviç, I., Gabiña, D. (eds) Animal farming and environmental interactions in the Mediterranean region. EAAP – European Federation of Animal Sciences, vol 131. Wageningen Academic Publishers, Wageningen.

118. Smit, I. P. J., Baard, J. A., & Van Wilgen, B. W. (2024). *Fire regimes and management options in mixed grassland-fynbos vegetation*, South Africa. Fire Ecology, 20(1). https://doi.org/10.1186/s42408-024-00262-2

119. Smith-Ramírez, C., Castillo-Mandujano, J., Becerra, P., Sandoval, N., Allende, R., & Fuentes, R. (2021). *Recovery of Chilean Mediterranean vegetation after different frequencies of fires.* Forest Ecology and Management, 485, 118922. https://doi.org/10.1016/j.foreco.2021.118922

120. Smith-Ramírez, C., Grez, A., Galleguillos, M., Cerda, C., Ocampo-Melgar, A., Miranda, M. D., Muñoz, A. A., Rendón-Funes, A., Díaz, I., Cifuentes, C., Alaniz, A., Seguel, O., Ovalle, J., Montenegro, G., Saldes-Cortés, A., Martínez-Harms, M. J., Armesto, J. J., & Vita, A. (2023). *Ecosystem services of Chilean sclerophyllous forests and shrublands on the verge of collapse: A review. Journal of Arid Environments,* 211, 104927. https://doi.org/10.1016/j.jaridenv.2022.104927

121. Strydom, T., Cowling, R. M., Grobler, B. A., & Kraaij, T. (2023). *Effects of simulated fire and browsing on the resprouting of subtropical dune thicket shrubs in the southeastern Cape Floristic Region.* Plant Ecology, 224(6), 549–562. https://doi.org/10.1007/s11258-023-01321-5

122. Tagliafierro, C., Longo, A., Van Eetvelde, V., Antrop, M., Hutchinson, W. G. (2013). *Landscape economic valuation by integrating landscape ecology into landscape economics.* Environmental science & policy, 32: 26-36.

123. Talhouk, S.N., et al. (2005). *Status and conservation of the flora in Lebanon.* Biodiversity and Conservation, 14(6), 1327–1346

124. Tessler, N., Wittenberg, L., & Greenbaum, N. (2016). *Vegetation cover and species richness after recurrent forest fires in the Eastern Mediterranean ecosystem of Mount Carmel, Israel*. Science of the Total Environment, 572, 1395–1402. https://doi.org/10.1016/j.scitotenv.2016.02.113

125. Tuttolomondo, T., Licata, M., Leto, C., Bonsangue, G., Gargano, M. L., Venturella, G., & La Bella, S. (2014). *Popular uses of wild plant species for medicinal purposes in the Nebrodi Regional Park (North-Eastern Sicily, Italy)*. Journal of Ethnopharmacology, 157, 21–37. https://doi.org/10.1016/j.jep.2014.08.039

126. Vizzarri, M., Sallustio, L., Travaglini, D., Bottalico, F., Chirici, G., Garfì, V., Lafortezza, R., La Mela Veca, D. S., Lombardi, F., Maetzke, F., Marchetti, M. (2017). *The MIMOSE Approach to Support Sustainable Forest Management Planning at Regional Scale in Mediterranean Contexts.* Sustainability, 9 (2): 316.

127. Vourlitis, G. L., Jaureguy, J., Marin, L., & Rodriguez, C. (2020). *Shoot and root biomass production in semi-arid shrublands exposed to long-term experimental N input.* Science of the Total Environment, 754, 142204. https://doi.org/10.1016/j.scitotenv.2020.142204

128. Zambonelli, A., Donnini, D., Rana, G. L., Fascetti, S., Benucci, G. M. N., Iotti, M., Morte, A., Khabar, L., Bawadekji, A., Piattoni, F., Compagno, R., & Venturella, G. (2014). *Hypogeous fungi in Mediterranean maquis, arid and semi-arid forests.* Plant Biosystems - an International Journal Dealing With All Aspects of Plant Biology, 148(2), 392–401. https://doi.org/10.1080/11263504.2013.877537

129. Zapata, V. M., & Robledano, F. (2013). *Assessing biodiversity and conservation value of forest patches secondarily fragmented by urbanisation in semiarid southeastern Spain.* Journal for Nature Conservation, 22(2), 166–175. https://doi.org/10.1016/j.jnc.2013.11.002

130. Zerouali, B., Santos, C., do Nascimento, T., & Silva, R. (2023). *A cloud-integrated GIS for forest cover loss and land use change monitoring using statistical methods and geospatial technology over northern Algeria.* Journal of Environmental Management,341,118029–118029. https://doi.org/10.1016/j.jenvman.2023.118029