
European Commission
Ready, steady, green!
LIFE helps farming and forestry adapt to climate change
Environment & Climate Action

EUROPEAN COMMISSION
ENVIRONMENT DIRECTORATE-GENERAL

LIFE (*"The Financial Instrument for the Environment and Climate Action"*) is a programme launched by the European Commission and coordinated by the Environment and Climate Action Directorates-General. The Commission has delegated the implementation of many components of the LIFE programme to the Executive Agency for Small and Medium-sized Enterprises (EASME).

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Foreword(s)


Photo: European Commission

Global warming is a top priority for the European Union, and we are working hard to cut Europe's greenhouse gas emissions and in supporting other nations in doing the same.

The harsh reality is that we must still get ready for a different world, though: a substantial degree of climate change is irreversible, even in a best-case scenario. Preparing ourselves for global warming, in line with the EU strategy on adaptation to climate change, is therefore a necessity.

The EU's funding programme LIFE supports, amongst others, many first-class projects to test and implement innovative ways of adapting Europe to climate change. This brochure presents you with a selection of projects specifically dedicated to agriculture and forestry.

Enjoy the read and be inspired!

Yvon Slingenberg
Director for International, Mainstreaming and Policy Coordination
Directorate General for Climate Action, European Commission


Photo: European Commission

Climate change and biodiversity loss are inseparable threats to sustainability and must be addressed together.

On the one hand, biodiversity is strongly affected by climate change with negative consequences for human well-being and the long-term stability of ecosystems. On the other hand, the conservation and restoration of biodiversity and the sustainable use of the ecosystem services it provides contributes to climate change mitigation, adaptation and disaster risk reduction. Actions to protect biodiversity thereby increase resilience and reduce the vulnerability of people and the ecosystems upon which they depend.

The LIFE projects presented in this publication show how counteracting nature degradation and the destabilisation of ecosystems helps address climate challenges, while ensuring a sustainable future through tackling the ecological crisis. While these projects may seem a drop in the ocean, they should be seen as models that can catalyse integrated, joint action on a wider scale.

Humberto Delgado Rosa
Director for Natural Capital
Directorate General for Environment, European Commission


Photo: European Commission

Climate change is already affecting agriculture and forestry in the EU. Developing a comprehensive response to climate change is crucial for maintaining the resilience and competitiveness of the EU agriculture and forestry sectors so that they can continue to play their role as suppliers of high quality and sustainable food, climate friendly materials and products and environmental and landscape services, as well as contribute to the sustainable development of rural areas.

Adaptation is a long-term process which needs to build on a growing body of knowledge and practical experience. In this process, it is important to further engage the farming and forestry communities in the discussion on adaptation needs and in sharing good practices, as farm and forest-level changes are key components of adaptation.

The LIFE projects presented in this publication nicely complement the actions implemented under the common agricultural policy and Horizon 2020, notably by establishing good practices together with farmers and forest managers, demonstrating tailored solutions, raising awareness and stimulating a wider adoption of measures and practices.

Pierre Bascou
Director for Sustainability and Income Support
Directorate General for Agriculture and Rural Development, European Commission

The European Commission acknowledges the contributions of LIFE beneficiaries

AGRICULTURE

LIFE VinEcoS
Landgesellschaft Sachsen-Anhalt mbH - Hochschule Anhalt -Jena-Geos-Ingenieurbüro GmbH -Landesweingut Kloster Pforta GmbH

LIFE BIODELEAR
Hellenic Agricultural Organization DEMETER - AUTH(Aristotle University of Thessaloniki) -BPI(Benaki Phytopathological Institute) -UTH(University of Thessaly – Research Committee)

LIFE+ IRRIMAN
UNIVERSIDAD POLITCNICA DE CARTAGENA - CARM(Consejería de Agricultura y Agua de la Comunidad Autónoma de la Región de Murcia) -CEBAS-CSIC(Agencia Estatal Consejo Superior de Investigaciones Científicas) -CRGC(Comunidad Regantes Genil Cabra. Colectividad Santaella) -FENACORE(FEDERACION NACIONAL DE COMUNIDADES DE REGANTES DE ESPAÑA) -UCO(Universidad de Córdoba)

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oLIVE-CLIMA
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LIFE TERRACESCAPE
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Adapt2Change
Technological Education Institute (TEI) of Thessaly – Greece - National and Capodistrian University of Athens (EKPA) -The Agricultural Research Institute (ARI) -The KEK EUROPLIROFORISSI S.A. -The TEI of Piraeus (TEIP)

LIFE ADAPT2CLIMA
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sigAGROasesor
Instituto Navarro de Tecnologias e Infraestructuras Agroalimentarias S.A. (INTIA) - Agencia Estatal de Meteorología -Fundació Mas Badia -Instituto de Investigación y Formación Agraria, Pesquera, Alimentaria y de la Producción Ecológica -Instituto Técnico Agronómico Provincial -Instituto Vasco de Investigación y Desarrollo Agrario-S.A.-NEIKER -Trabajos Catastrales S.A.

LIFE AGRI ADAPT
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PTD LIFE
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SOLMACC Life
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LIFE PASTORALP
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LIFE Viva Grass
Public institution Baltic Environmental Forum Lithuania - 01 BEF LV(Public institution Baltic Environmental Forum - Latvia) -02 LU GZZF(University of Latvia) -03 Ciesis(Municipality of Ciesis) -04 Sovites(SOVITES Farm) -05 OtrMaj(Otras Majas) -06 BEF EE(Private institution Baltic Environmental Forum-Estonia) -07 EMU(Estonian University of Life Sciences) -08 Lumanda(Municipality of Lumanda) -09 Kurese(Farm Kurese Urmas Vahur FIE (self-employed entrepreneur)) -10 PVRPD(Pavilniai and Verkiai Regional Park Directorate) -11 Dubysa(Directorate of Dubysa Regional Park) -12 Silute(Silute District Municipality) -13 Hnit(JSC Hnit-Baltic) -14 IES(Institute for Environmental Solutions)

FOREST

LIFE+ DEMORGEST
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LIFE-KEDROS
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LIFE ADAPTAMED
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LIFE FORECCAsT
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LIFE MixForChange
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Farm LIFE
Stichting Van Hall Larenstein - Boefkik BV -Bosboom B.V. -Flanders Research Institute for Agriculture, Fisheries and Food (ILVO) -Horst Beheer BV -Stichting Landgoed De Koekoek -Wendeland B.V.

LIFE MOTTLES
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Views from the agriculture sector

Photo: LIFE08 ENV/E/000129

Photo: CEJA

Photo: LIFE11 ENV/ES/000641

Jannes Maes

President, European Council of Young Farmers (CEJA)

"Young farmers are environmentally conscious and aware of current and future environmental and agricultural sustainability issues. The LIFE programme provides vital assistance to farmers who wish to make their activities more environmentally friendly and find solutions that are tailored to their specific territorial needs. It also offers opportunities for collaboration among stakeholders from different sectors who share similar goals. Such transnational programmes provide an efficient platform in ensuring the sharing of best practices and achieving results at EU level."

Luis Cabodevilla

farmer using the platform of the sigAGROasesor project

"sigAGROasesor is for me a practical tool to follow in sequence all the actions needed for a crop campaign on my plots and to be able to present at the end the administrative notebook of my farm."

Alexander Kern

farmer participating in the pilot actions of the LIFE AGRI ADAPT project

"We need to invest to tackle climate change. We need to build soil fertility and provide adequate erosion control. We've reduced tillage and abandoned winter soil tillage completely. Sowing intercrops is another important measure. Our success: the carrying capacity of the areas and the soil quality have increased."

Views from the forestry sector

Photo: EFI

Marcus Lindner

Principal Natural Scientist, Resilience Programme, EFI

Georg Winkel

Head of the Resilience Programme, European Forest Institute (EFI)

"Climate change poses an unprecedented challenge to Europe's forests. The LIFE programme can assist by enabling learning and exchange of knowledge and experiences: across regions; between sectors; between science, policy and practice; and involving a broad spectrum of stakeholders and citizens. 'Demonstration and learning forests' that jointly network across countries could be an important step in making sure that all related spheres of society work together to help Europe's forests to remain resilient and able to provide services to European society even in an uncertain future."

Piotr Borkowski

Executive Director, European State Forest Association (EUSTAFOR)

"In order for adaptive forest management to be successful at a larger scale, concerted action and sound financial support must be mobilised by the EU. But the scale of the problems and the investments which are required very often exceed the capacity of state forest management organisations. Additional support instruments, such as LIFE, could support the large-scale measures needed to adapt forests to climate change. Greater emphasis on widespread prevention and preparedness is the only way to minimise the impact of damaging events."

Photo: LIFE12 ENV/ES/000730

Farming and forestry in Europe: time to get ready for climate change

Agriculture and forestry are battlegrounds in the fight against climate change. Europe is being adversely affected and is taking initiatives in response.

Photo: LIFE10 ENV/ES/000471

Photo: LIFE10 ENV/ES/000471

Agriculture, one of the sectors most vulnerable to climate change, faces many challenges: there is a need to secure food, feed, wood and fibre production, while adapting to the adverse effects of a changing climate such as:

- rising temperatures;
- increased temperature variability;
- changes in levels and frequency of precipitation;
- more frequent dry spells and droughts;
- increased extreme weather events;
- rising sea levels;
- salinisation of arable land and freshwater; and
- pest and disease outbreaks.

Forestry also faces serious challenges from climate change, notably due to the increasing frequency and severity of droughts, storms, fires and pests. Forest fire risk depends on many factors, including climatic conditions, vegetation, forest management practices and other socio-economic factors. Longer fire seasons are predicted in southern Europe with fire-prone areas also expanding northwards. Moreover, there has been an alarming increase in bark beetle outbreaks in European conifer forests in recent years. Such outbreaks are likely to increase in extent and severity in the future due to climate change.

Climate-related risks vary for different regions of Europe, with the Mediterranean most at risk, but no region remains unaffected. Farming and forest management strategies and processes need to be adjusted, with the help of available best practices, policies and tools, including financial instruments.

Photo: LIFE12 ENV/ES/000148

The European Union is a frontrunner in tackling climate change, and has the most advanced climate, energy and environmental legislation in the world. It allocates significant amounts to climate action through the LIFE programme and other financial instruments; supports ambitious agreements in international fora, like the Paris Agreement of 2015; and has introduced a solid legal framework and set of tools, both for adapting to the inevitable adverse effects and for addressing the causes of climate change.

The establishment of the LIFE programme by the European Union provides a fund dedicated to supporting projects that demonstrate innovations and that can influence policy and practice at European, national and local levels.

LIFE and climate change adaptation in agriculture and forestry

Through the LIFE programme, a broad range of adaptation measures are being tested to support farmers and foresters in the EU in introducing climate-smart production methods.

Photo: LIFE13 ENV/FR/001512

The LIFE programme has supported efforts to adapt agriculture and forestry to the challenges of climate change ever since its inception in 1992. There was a significant increase in the number of relevant LIFE projects after climate change became a distinct policy priority under the LIFE+ programme (2007-2013).

The launch of a LIFE Climate Action sub-programme in 2014 further strengthened the focus on climate change adaptation. The sub-programme provides some €864 million for mitigation and adaptation initiatives in the 2014-2020 EU multiannual financial framework.

LIFE agriculture and forestry projects tackle a broad thematic spectrum and climate change adaptation is of growing importance in projects across both sectors.

Agriculture

The LIFE programme has supported the development of best practices in agriculture that help to increase resilience. Since 1992, there have been 118 projects that contribute to climate change adaptation in agriculture. These had a total budget of €232.8 million, of which LIFE's contribution was €116.3 million.

The majority of projects have centred around the Mediterranean region. This region is expected to be the most affected by climate change, with reduced crop yields and degraded ecosystems due to increased temperatures, greater risk of drought, and declining water availability.

Projects to date have tackled a range of themes (see Figure 1).

Forestry

The LIFE programme has been an important source of support for implementing forestry climate change adaptation actions. In total, 86 projects have contributed to boosting the resilience of EU forests. These have a total budget of €141.3 million, including €74.4 million in co-funding from LIFE.

Figure 2 shows the main themes of LIFE projects addressing climate change adaptation in forests.

Figure 1

LIFE priority area 'Climate Change Adaptation': agriculture projects by sub-category

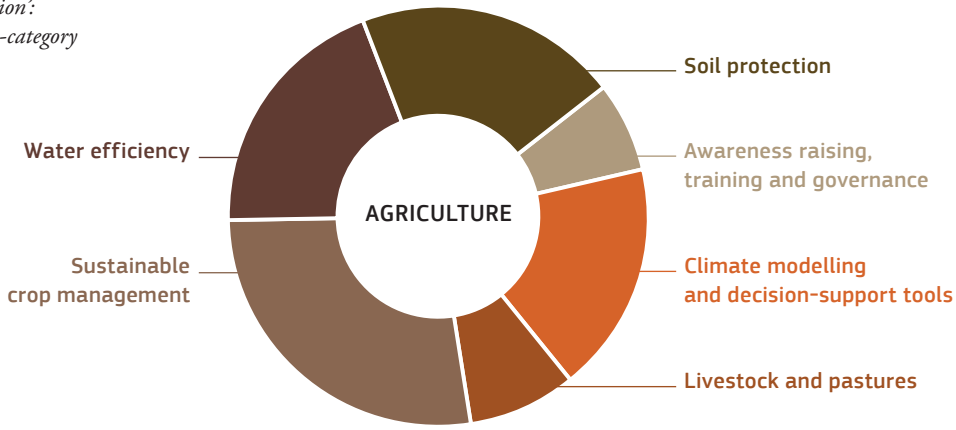
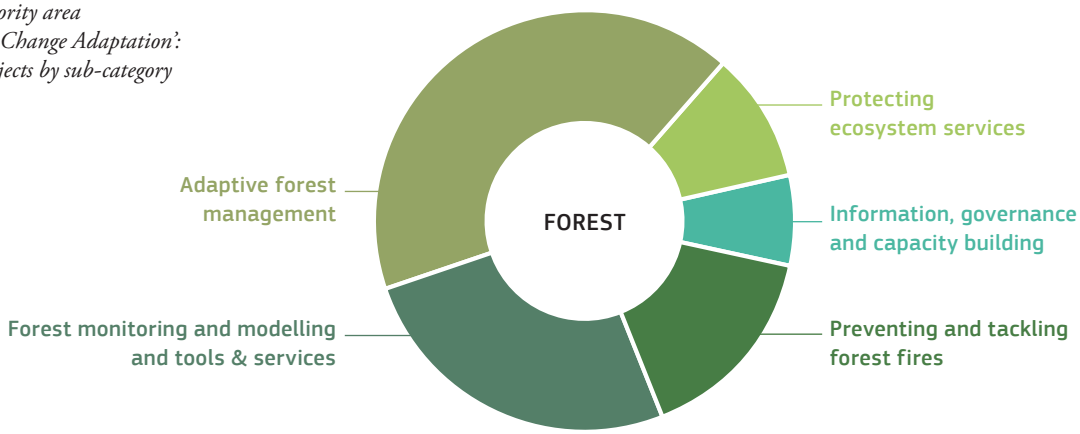


Figure 2

LIFE priority area 'Climate Change Adaptation': forest projects by sub-category



The Natural Capital Financing Facility

The Natural Capital Financing Facility (NCFF) is a financial instrument of the LIFE Programme. It is managed by the European Investment Bank (EIB). The NCFF is financing upfront investment and operating costs for revenue-generating or cost-saving pilot projects which promote the conservation, restoration, management and enhancement of natural capital for biodiversity and adaptation benefits, including ecosystem-based solutions to challenges related to land, soil, forestry, agriculture, water and waste. Projects are eligible in four areas, which are in line with the EU biodiversity strategy and the EU strategy on adaptation to climate change:

- payments for ecosystem services;
- green infrastructure;
- biodiversity; and
- adaptation to climate change.

The NCFF aims to establish a pipeline of replicable, bankable operations that will serve as a proof of concept and demonstrate to potential investors the attractiveness of such operations. It combines two components:

- the finance facility provides financing of €2-15 million per project, in the form of loans or equity, combining EIB financing and LIFE programme funding. In 2017, the maximum loan maturity was extended to 25 years.
- the technical assistance facility provides grants of up to €1 million to prepare projects, implement them, and monitor the outcomes.

The NCFF has a total budget of €175 million for the finance facility (€125 million EIB finance, €50 million LIFE) plus €10 million for technical assistance (LIFE). This is for the implementation of projects up to the end of 2021. So far, the NCFF has invested €44.5 million (or 36% of its funding). This means that millions of euros of NCFF finance are still available for new initiatives that would put them to good use. For more information see the EIB website: https://www.eib.org/en/products/blending/ncff/index.htm

Adaptation in agriculture

European farmers have to adapt to the changing climate, which often implies changes in management practices and diversification of income sources. The LIFE programme is supporting this transition.

Photo: LIFE10 ENV/ES/000471

Agriculture and climate change

The consequences of climate change on agricultural production differ significantly between the EU's climatic zones: warming is expected to lead to a northward expansion of suitable cropping areas and to an enlargement of crop diversity. This means that in northern regions climate change may actually have certain positive effects on agricultural productivity, but may also entail the use of more plant protection products and increased nutrient leaching.

Unquestionably, in southern countries the adverse effects of climate change are more evident. In particular, in Bulgaria, Greece, Spain, France, Italy, Cyprus, Malta, Portugal, Romania and Slovenia more water shortages and extreme weather events are expected to result in lower agricultural yields and the abandonment of climate-disadvantaged farmlands. However, as painfully realised during the very dry summer of 2018, Central Europe and the Baltic region can also experience dramatic losses in agricultural production as a result of extreme weather conditions.

Evidently, European farmers will have to adapt to the changing climate, which implies changes in management practices and diversification of income sources. It is of the utmost importance to support farmers who are willing to test new approaches. The results of such trials, once scaled up, can increase the resilience of European agriculture as a whole.

EU policies support the adaptation of European agriculture to climate change both from the overall perspective of the EU strategy on adaptation to climate change and the more focused common agricultural policy (CAP) and EU nature and biodiversity policies. For all relevant policy, it is necessary to consider the multifunctional role of agriculture, and to strike

a balance between economic, environmental and social aspects for Europe's different regions.

The European Commission adopted the EU strategy on adaptation to climate change in 2013 with the aim of providing a more coherent approach and improved coordination to enhance preparedness and capacity to respond to the impacts of climate change. The strategy focuses on three key objectives: promoting action by Member States; 'climate-proofing' action at EU level, especially in key vulnerable sectors such as agriculture; and better-informed decision-making by addressing gaps in knowledge and further developing the European climate adaptation platform (Climate-ADAPT).

FARM MANAGEMENT AND DESIGN

LIFE project managers have identified a number of management and marketing strategies, which they consider important components in adapting agricultural systems to the effects of climate change, and which need to run in parallel with agronomic strategies and technological approaches:

- availability of and access to skilled and independent farm advisory services;
- short value chains;
- labelling to emphasise to consumers "climate change-compatible" products;
- farm-specific adaptation plans, based on farm vulnerability assessments; and
- extension of forest areas.

LIFE's contribution to increased resilience in agriculture

LIFE provides support for best practice, pilot and demonstration projects that contribute to increased resilience to climate change in the agricultural sector. Some of the focus areas are outlined below.

SOIL PROTECTION

The LIFE programme has assisted Member States in testing and demonstrating effective methods for preventing or restoring degraded soil. Projects have successfully applied a range of soil management techniques for increasing soil fertility and reducing soil erosion, thus increasing resilience. These include no-tillage, crop rotation, use of cover crops, afforestation and reduced grazing. Such methods also increase carbon storage.

WATER EFFICIENCY

LIFE projects are helping to mainstream adaptation measures and achieve the goals of EU water policy. To manage water efficiently, projects optimise the use of this valuable resource at different levels: improving water infrastructure, expanding water retention measures, decreasing infiltration, reducing water demand, and developing techniques for reusing water.

Water-saving methods that have gone through successful field trials include:

- no-till farming – the vegetation-covered soil is less exposed to evaporation and better adapted to infiltration;
- precise irrigation techniques adapted to the actual needs of plants; and
- optimisation of groundwater use in rural coastal areas by, for example, diverting it to different locations based on its quality (salinity).

PROBLEMS IN MEDITERRANEAN AGRICULTURE CAUSED OR EXACERBATED BY CLIMATE CHANGE*

- **new pests and diseases** within local agro-ecosystems that are difficult to control using natural mechanisms, thus requiring more external inputs;
- **dry spells**, which make it increasingly difficult to grow several staple crops under rain-fed conditions, and **heatwaves** that cause sudden crop death;
- **high-intensity rains**, which cause flooding of cultivated fields and make sloping land less stable, leading to more soil erosion;
- **strong winds**/mini cyclones, which destroy crops and cause soil erosion;
- **deterioration of the quality of crops and animal products** because of adverse weather conditions, animal stress caused by high temperatures, etc.;
- **an increase in soil and water salinity**, especially on coastal farmland, making it impossible to grow many crop varieties;
- **reduced productivity of animals and land** for all the reasons mentioned above; and
- **significantly lower income for farmers** that may lead to **land abandonment**. This can have dramatic consequences, in the medium term, particularly for **food security** in southern European regions.

SOME KEY INTERVENTIONS NEEDED TO ADVANCE CLIMATE CHANGE ADAPTATION IN MEDITERRANEAN AGRICULTURE*

- **further mainstreaming of climate action**, and climate change adaptation in particular, in major sectoral policies, notably the common agricultural policy (CAP), thus optimising resource allocation and results;
- **further harmonisation of policies** on climate and the environment with those on industry and trade, to optimise results for all;
- **more targeted incentives to advance adaptation policies**, including affordable insurance, smart subsidies and reliable extension services; and
- **Raising awareness among policymakers and practitioners at all levels** of each other's needs and priorities, so that common ground can be found for successful and broadly beneficial implementation.

**Indicative list based on the conclusions of the LIFE Platform Meeting on Climate Change Adaptation in Agriculture and Forestry in the Mediterranean Region held in Madrid on 13-14 March 2018.*

AGRONOMIC STRATEGIES

- diversifying crop species and varieties; crop rotation including cultivation of cover crops; reducing or eliminating mono-cropping;
- keeping soil covered by plants and/or crop residues all year long;
- adapting stocking rates to changing vegetation cover (in livestock farms);
- choosing crops that are genetically more tolerant of extreme weather conditions, such as drought/salt-resistant crops; animal breeds that are more tolerant to environmental stress, etc.;
- returning to heritage crop varieties, which are typically more resilient, although less productive (yield stability);
- implementing conservation agriculture measures (zero and/or minimum tillage);
- adapting cropping calendars and use of early maturing crop varieties (short cycle varieties);
- agroforestry practices;
- proper organic matter management for soil improvement, with effects on increase of water retention, water infiltration, less run-off, less erosion; and
- use of compost, animal manure, green manuring.

Photo: LIFE10 ENV/ES/000471

SUSTAINABLE CROP MANAGEMENT

LIFE projects have trialled organic and precision-farming methods as a means of adapting agriculture to higher temperatures and less rainfall. Organic farming methods are an important pillar in making agriculture more sustainable. This has been demonstrated by LIFE projects in a broad spectrum of farm types, including vineyards, citrus orchards, olive groves and arable crops.

Methods to increase resilience include trials with cover crops, organic fertilisation, optimised tillage systems, crop rotation, agroforestry systems and the re-introduction of traditional crops or varieties that are better adapted to extreme weather conditions.

Importantly, projects also assess whether adaptive methods are economically viable.

LIVESTOCK AND PASTURES

Most LIFE projects dealing with meat and dairy production have focused on climate change mitigation, which means the reduction of greenhouse gas emissions. However, as climate change impacts increase, meat and dairy farmers, and their customers, will also have to adapt. LIFE projects are collecting data and developing methodologies for the assessment and monitoring of climate change vulnerability at farm level, with a view to promoting sustainable adaptation measures. These measures include grazing plans to optimise the production potential of grassland, while ensuring the proper feeding of livestock. Projects are also addressing the particular adaptation challenges facing alpine pasturelands.

CLIMATE MODELLING AND DECISION-SUPPORT TOOLS

Climate models and decision-support tools are vital for understanding when climate change may pose particular types of risks to specific ecosystems and for deciding on appropriate responses, such as early stage prevention. LIFE projects have piloted a number of tools that help farmers make better decisions about how much water to use, what inputs to add (and when), and so on.

TECHNOLOGICAL APPROACHES

- high efficiency irrigation methods and adoption of the deficit irrigation methodology;
- decision-support systems on farms, based on updated weather forecasts (early warning);
- precision farming for efficient use of resources (irrigation, pest and disease control, fertilisation);
- plant wind breaks along farm perimeters; and
- reuse of treated water for irrigation.

AWARENESS-RAISING, TRAINING AND GOVERNANCE

The development of efficient adaptation measures is crucial to meeting the challenges of climate change. LIFE can be a bridge between testing and uptake of such practices. Projects have involved stakeholders such as farmers, advisors, agronomists and food processing and retail businesses.

On-site demonstrations, training, workshops and guidelines have helped to raise awareness of climate change adaptation measures in agriculture, and have started to mainstream their use.

Some of the methods trialled by LIFE projects are summarised in the tables below. On the following pages you can read more about the solutions developed by specific projects.

Ensuring the future of wine production in Europe

Photo: LIFE13 ENV/FR/001512/Neethling

LIFE shows how viniculture can be adapted to climate change through actions to reduce soil erosion, water stress, and pests and diseases, while promoting biodiversity and ecosystem services.

Saale-Unstrut in Saxony-Anhalt is one of the major wine-producing regions of Germany. A mild micro-climate in the Saale and Unstrut valleys means plenty of sunshine (c. 1 600 hours per year) and low rainfall. However, climate change is starting to have an impact on the region, with winegrowers facing an increasing incidence of drought and torrential rain, more hot days and more winter wind storms.

"Viticulture on steep slopes suffers in particular," explains Jörn Freyer from the Land Company of Saxony-Anhalt. "Increased soil erosion and increased water stress are two main risks to deal with."

Mr Freyer is leading a project called LIFE VinEcoS, which is testing climate change adaptation measures in the Saale-Unstrut region that can make vineyards more resilient. These methods are likely to be relevant to other European wine regions. Methods being trialled at the state winery Kloster Pforta and other commercial vineyards include:

- minimal or no pruning to support self-regulation and reduce labour;
- multifunctional seed mixtures to increase biodiversity and reduce soil erosion on steep slopes; and
- sheep grazing to reduce use of pesticides and machinery.

New seed mixtures and grazing bring benefits

Results from monitoring in 2017 indicate that the multifunctional seed mixtures are a useful tool for increasing biodiversity: "the number of plant species was more than three times higher than in conventionally sown plots. Simultaneously, the number of bee species was more than four times higher and the number of butterfly species was up 50%," says Mr Freyer. This is in line with the goals of the EU pollinators initiative, which was adopted in June 2018 and is the first-ever EU initiative on pollinators[1].

The introduction of sheep grazing led to a 25% reduction in the number of hours working with machinery per hectare. In addition, the combination of grazing and new seed mixtures has increased vegetation cover, which should help to prevent soil from being washed down hillsides after heavy rainfall.

"The frequency of using pesticides is an important indicator of plant diseases," explains Mr Freyer. "Compared to conventionally treated (mowed) plots, 22% less pesticides have been used in grazing plots," he says.

Tools and recommendations

By the time the project ends next year, it will have developed a toolset to evaluate ecosystem services in vineyards. "New methods need to be cost-effective first and foremost," cautions Mr Freyer. The LIFE VinEcoS team is measuring the ecosystem services provided by the pilot plots in Saale-Unstrut in order to have well-grounded data that other winegrowers will trust. This can be the basis for the further uptake of successful methods and practices. "The evaluation and monetisation of ecosystem services provides information on positive side effects of new measurements, which might be cost-intensive at the beginning," he says.

The project is drafting recommendations to help winegrowers adapt to climate change, and it is working with the regional Ministry for Agriculture and Environment to create agri-environmental schemes that support the transfer of successful methods. As well as regular meetings with the local community in Saale-Unstrut, LIFE VinEcoS is sharing its know-how with winegrowers and scientific institutes in Austria, Hungary and France. "Viticulture faces major challenges which will influence how vineyards are cultivated in the future," says Mr Freyer.

Find out more
Website: https://www.life-vinecos.eu

1. http://ec.europa.eu/environment/nature/conservation/species/pollinators/index_en.htm. The EU Pollinators Initiative sets strategic objectives and actions to be taken by the EU and its Member States to address the decline of pollinators in the EU and contribute to global conservation efforts.

Controlling the pests that plague citrus fruits

LIFE projects are demonstrating innovative approaches to pest control and irrigation that will reduce pesticide use and save water, and reduce overall CO_2 emissions.

The Mediterranean fruit fly (*Ceratitis capitata*), commonly known as the medfly, is a severe pest for major fruit crops including citrus trees. The LIFE BIODELEAR project has developed a low-cost attractant, which selectively attracts female medflies and almost no non-targeted insects.

Currently, repeated applications of synthetic insecticides are used to control medfly, but these are harmful to human health and the environment. The application of a mass trapping strategy with an environmentally-safe attractant would provide an "important alternative" to the use of such pesticides, says project leader Vassilis Mavraganis, from the Hellenic Agricultural Organisation, DEMETER.

The LIFE project was set up to demonstrate such an alternative control strategy on citrus trees, which presents a challenge owing to their extended fruiting period with different fruits ripening at different times. A novel attractant called Biodelear was shown over a two-year application period to be effective for mass trapping, resulting in reduced fruit infestation at levels similar to or even lower than in conventionally-treated orchards, and better than the current state-of-the-art alternatives. "It also helped eliminate the use of insecticide and thus had no negative impact on biodiversity," says Dr Mavraganis.

The project has already received positive feedback from farmers, though cost is a consideration. Citrus fruits have low market prices, and farmers fear that returns are insufficient for investing in a control strategy against the medfly. Such concerns, however, could be overcome given the farmers' initial reports of production increases. Therefore, the goal over the next five years is to get 20% of citrus farmers to adopt the project's medfly mass trapping strategy in the project areas. This would lead to a reduction of pesticide use against medfly of around 30%, according to Dr Mavraganis.

The next steps for the project team will focus on developing controlled release dispensers for the new attractant and then commercially producing them. "Following a detailed and thorough business plan, Biodelear dispensers could become available to market in the next three years," he says.

Furthermore, the project has implications for the whole farming community in the Mediterranean region, given that the medfly attacks more than 260 different fruits, flowers, vegetables and nuts. When infestations are not controlled, medfly can completely wipe out citrus, stone fruits, pomegranates, peppers, figs and other crops.

Find out more
Website: http://www.biodelear.gr/

Photo: LIFE09 ENV/ES/000441

Photo: LIFE13 ENV/GR/000414

Rainfall is infrequent and irregular in south-east Spain. The project LIFE+ IRRIMAN implemented an efficient irrigation management system in this region. It is based on the 'deficit irrigation' approach, to optimise irrigation during drought-sensitive crop stages, and the use of woody crops. The project showed how it is possible to reduce the use of water to irrigate crops by 30% without reducing quality. The approach also demonstrated an increase in crop yield of 10% along with a 30% reduction in the leaching of nitrates through run-off and a significant reduction in CO_2 emissions from the soil. Increased water productivity also reduces the need for chemical inputs, such as fertilisers.

Find out more
Website: https://irrimanlife.eu/

Reducing risks to olive farming

To address the threats of quick decline disease and low soil fertility in olives, LIFE is demonstrating the benefits of new techniques involving plant breeding and sustainable farming practices.

DID YOU KNOW

The EU has around 5 million hectares of olive plantations, an area equivalent to the size of Slovakia.

The bacterium *Xylella fastidiosa*, commonly known as XF, causes quick decline syndrome, a serious and rapidly-spreading disease of olives and other woody crops. In 2013, more than one million olive trees in the Apulia region of Italy developed olive quick decline syndrome, causing major economic losses. It has already been found in Germany, Spain and France, and has the potential to spread to other woody species and across important agricultural areas in countries with similar climatic conditions.

"Climate change is generating milder winters in southern Europe, which is expected to exacerbate the spread of XF," says Teresa Carrillo, who is coordinating the project LIFE RESILIENCE. Elimination and containment of XF is difficult, and the removal of infected plants is costly and has an ecological impact. "The European agricultural sector is at risk of losing millions of euros because of this disease, especially in some of the world's main producers of olive oil, such as Spain, Italy and Greece," she says.

The project is working on two ways of helping olive farmers adapt to XF. The first is to show that crossbreeding can produce resistant varieties of olive plants that are suitable for intensive olive cultivation. This will lead to new, highly-marketable products. Since starting work in the summer of 2018, the project team has already "performed crosses between olive cultivars according to their resistance to *Xylella fastidiosa* and positive agronomical characteristics," says Ms Carrillo. "The selected seedlings from the first crossings (501 genotypes) were planted in an experimental field to characterise their agronomical traits. Genotypes from a second crossing will be planted in the summer of 2019."

LIFE RESILIENCE is also implementing sustainable practices and technologies on pilot olive (and almond) plots in Spain, Italy, and Portugal, covering 250 ha in total. Measures such as cover crops and reduced tillage will help to increase resilience to XF and future climate change impacts by:

- increasing biodiversity;
- improving plant and soil health;
- optimising inputs; and
- lowering chemical exposure.

Importantly, the goal is to achieve these without reducing yield. "New varieties resistant to *Xylella fastidiosa* and a model of sustainable practices could increase the resilience of olive trees to pathogens and minimise the risk of losses. Healthy trees on high-quality soils managed with an efficient use of resources and greater farm biodiversity could maximise production and the quality of the final product," says Ms Carrillo.

Expected project outcomes by 2022 include:

- a 30% increase in soil and plant health;
- a 20% reduction in water consumption in olive fields; and
- a 60% reduction in production costs.

The project will produce a handbook of best practices, including natural vector control methods, so that olive farmers across Europe can benefit from the knowledge gained. Results will also be applicable to other crops such as almonds, grapevines and citrus trees. The project beneficiary Galpagro oversees more than 18000 ha of olive groves which could be managed with the new techniques developed through LIFE RESILIENCE.

Find out more
Website: http://www.liferesilience.eu/

LIFE
RESILIENCE

oLIVE-CLIMA: improving soil fertility in olive-growing areas

Photo: LIFE11 ENV/GR/000942

Photo: LIFE11 ENV/GR/000942/Georgios Psarras

DID YOU KNOW

Most olive trees live for hundreds of years. This longevity means that olive products may be the only food deserving of carbon credits, a benefit that may be commercially useful to producers for the promotion of olive oil.

A growing problem for olive farmers in the Mediterranean region is the low percentage of organic matter in soils. Prior to the LIFE project oLIVE-CLIMA, no one had systematically tested alternative olive cultivation techniques under Mediterranean conditions. The project primarily focused on the potential of olive-growing areas to capture more carbon in soils, and to reduce greenhouse gas emissions. In addition, the oLIVE-CLIMA team, led by ANATOLIKI, the development agency for eastern Thessaloniki in Greece, tried out several practical measures that can help farmers adapt to a changing climate:

- the return of organic matter from olive trees (chipped/shredded branches);
- composting;
- weed management;
- non-soil tillage; and
- new pruning methods.

The trials took place on 120 olive groves with different soil climatic conditions in the south Peloponnese and Crete. “The pilot plots showed an increase in soil fertility, enhanced biodiversity and yield,” says Natassa Kasapi from ANATOLIKI.

Systematic implementation of the measures increased the rate of soil organic matter build up (e.g. an increase of 27% from an olive grove in Chania), to reverse the trend of CO_2 losses, erosion and desertification. Increasing soil organic matter in the root zone of the olive trees not only contributes to long-term storage of carbon removed, it also plays a significant role in improving tree health, and the uptake of minerals and water. These are critical factors for trees under climate change-induced stress.

“Among the practices introduced, the most important seems to be pruning,” notes Ms Kasapi. Changes in the way trees are pruned, including systematic annual pruning, increased photosynthesis and carbon sequestration. Adapted pruning was also found to increase wood mass and olive oil production per hectare, with no intensification of inputs. “It has become obvious to olive growers that oLIVE-CLIMA pruning can smoothen the year-to-year alternate bearing of olive trees, a situation that exhausts the trees in the ‘on’ years, rendering them susceptible to adverse conditions in the ’off’ years, with a detrimental effect on yields and production cost,” she says.

The project’s success encouraged Greece to revise its rural development programme to pay olive farmers for machinery to shred pruning waste for return to the land. “The proposed grant for the wood shredding per hectare is under discussion,” adds Ms Kasapi.

A set of guidelines produced by oLIVE-CLIMA shows how olive-growers across the Mediterranean could follow their lead. YouTube videos demonstrating the project’s adaptation actions have been viewed more than half a million times, indicating the scale of interest. The project partnership is now working to develop a certification process for the net carbon balance so that it can create an eco-label for climate-friendly olive oil.

Find out more
Website: http://www.oliveclima.eu/

Restoring drystone terraces to increase resilience

A LIFE project is rebuilding drystone walls to restore agricultural terraces on Greek islands, so reducing soil erosion and promoting biodiversity, rural development and ecosystem resilience.

For centuries, farmers on the Aegean islands cultivated drystone terraces. The practice fell out of favour in the second half of the 20th century: "imported food was becoming increasingly less expensive, with local communities becoming more exposed to globalisation," explains Theodora Petanidou from the University of the Aegean, an expert in terrace farming and its implications on the Aegean environment and biodiversity. "Local economies also turned to other sectors such as tourism. Furthermore, large-scale livestock grazing, mainly sheep and goats (which is to a large extent EU-subsidised) discouraged landowners from continuing to cultivate terraces that could easily be damaged by high livestock numbers," she adds.

Abandoning drystone terraces makes the islands' ecosystems more vulnerable and susceptible to climate change impacts, such as landslides. "Cultivated drystone terraces could function as green infrastructure, contributing to ecosystem resilience," says Professor Petanidou. "They allow cultivation of marginal lands with poor and particularly dry soil and enhance ecosystem services by improving rainwater percolation, reducing soil erosion by holding soil in place, reducing wildfire risk, and favouring local biodiversity."

Return to Andros

Now the University of the Aegean is leading a project, LIFE TERRACESCAPE, that is working with local farmers on Andros to bring this tradition back. The island's heritage is steeped in it, with over 2700 km of drystone terraces, more than 15 times the length of its coastline. Andros's terraces are distinct and particularly beautiful: "they are constructed almost entirely of schist stone and built using a special technique particular to the island," explains Professor Petanidou. The terraces are also noted for large-scale stone beehives and bee gardens.

The project is re-establishing cultivation on over 150 hectares of abandoned terraces. This involves setting up a drystone wall 'school' to transfer know-how. One of the project partners, the agricultural research institute HAO-DEMETER, has already started cultivating local varieties of barley and lathyrus for use in the restored terraces. It will gather data on the cultivars' characteristics and their impact on soil structure and microbial communities to propose climate-smart agricultural practices.

"Rehabilitating the terraced landscape would never be sustainable if there was no economic payoff from its use," says Professor Petanidou. LIFE TERRACESCAPE is creating a land stewardship organisation – the first in Greece – to manage voluntary agreements with private landowners, farmers and shepherds. Through the land stewardship organisation, these stakeholders will also work with food and tourism businesses to promote and certify climate-smart local produce.

Planning for replication

A strategic adaptation plan for agriculture will enable outcomes to be transferred to rural communities on other Aegean islands. "The adaptation plan will be capable of being implemented as a vulnerability assessment and action prioritising tool for sustainable land management," says Professor Petanidou. The project will set up a committee to encourage local, regional and national authorities to use it to formulate more efficient climate adaptation policies for the region.

"Networking with European organisations is already providing valuable knowledge from leaders in their fields of expertise, such as Xarxa de Custodia del Territori and the International Scientific Society for Drystone Interdisciplinary Study," says Professor Petanidou.

Find out more

Website: http://www.lifeterracescape.aegean.gr/en/

Adapting to desertification

Systems developed using LIFE funding are enabling trees to establish with less need for water and are promoting soil fertility, to help farmers adapt to desertification.

The impact of climate change-induced phenomena, such as heatwaves and prolonged drought, is expected to increase the risk of desertification and forest fires, particularly in regions where water scarcity is already a concern. Developing adaptation measures aimed at reducing the vulnerability of ecosystems and strengthening their resilience is therefore of crucial importance.

"LIFE The Green Link is trialling an innovative growing method that uses 'water buckets' made from recycled cartons to plant trees in arid areas without irrigation. Dubbed the Cocoon® system, it provides a water buffer for the young sapling, basically helping it to bridge the first prolonged drought period," explains Sven Kallen of Volterra, one of the project partners. The Cocoon® has a cylindrical shelter to protect the young tree from the sun, dry winds and feeding animals. "It basically creates a microclimate for the plant so it can focus on the development of its roots," he says.

The Cocoon® is designed to produce strong and independent trees, which do not need frequent external irrigation during establishment and which can survive in extreme conditions.

How does it work?

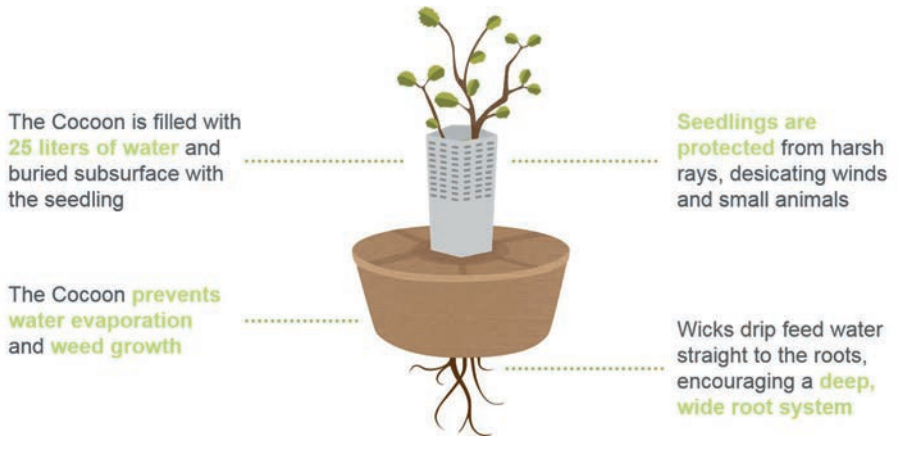
Sven Kallen: "The Cocoon® consists of a reservoir that is made of recycled waste cartons, and potentially also crop residues to ensure impermeability during the first survival period. It is only filled once during the planting process. The water is transported to the tree in a spaced and controlled way by seepage. As the reservoir degrades and empties over time, the pits serve as nano-catchment to collect water when it rains. In addition, the degraded deposit is converted into organic soil-enhancing substrate. The Cocoon® typically holds water for 2-4 months, then starts to slowly disintegrate. The idea is that after the tree survives its first summer, it will have become established with a sufficient root system to tap into underground moisture."

Huge water savings

According to the project, the Cocoon® system uses at least five times less water in the first year of a tree's life than conventional irrigation. "Over the lifetime of a tree we're talking thousands of litres," says Mr Kallen.

Success breeds replication

LIFE The Green Link has already planted 24 000 trees in three countries (four sites in Spain, plus one each in Italy and Greece). These have been joined by a further 125 000 trees planted through replication efforts. The project ends in March 2020 and, says Mr Kallen, "private sector involvement is really picking up. Companies are interested to plant trees to sequester carbon and offset their emissions." He expects an additional 300 000 trees with protective Cocoons to be planted in Spain by next March, fully financed by replication partners from the private sector.



Opportunities for farmers in adaptation

"Loss of land fertility and productivity is closely linked to economic impoverishment and social crisis," says Simona Castaldi from the University of Campania Luigi Vanvitelli in Italy. Adapting to climate change is not only a huge challenge, it is also an opportunity to address these issues and open up new income sources for farmers. Professor Castaldi is leading a project called LIFE DESERT-ADAPT which is testing a 'desertification adaptation model' (DAM) in parts of Italy, Spain and Portugal.

"DAM is based on three pillars: economic adaptation, environmental adaptation and social adaptation," she says. Economic adaptation means diversifying, using mainly local species suitable to climate extremes, avoiding methods that cause land degradation, and avoiding intensive agriculture in the most fragile areas.

"The land use plan must always be a mosaic where crops are alternated with natural areas where biodiversity is restored and nurtured to provide key ecosystem services for the whole area." DAM's holistic approach combines methods such as inter-planting, reforestation, water-saving technologies and soil protection to increase resilience. As well as improved biodiversity, the beneficiary expects to achieve an average net carbon removal of one tonne of CO_2 per hectare using the new model.

"Each landowner has to define the right balance of functions to be applied in his or her own land, but the final outcome should be a mosaic where no piece of land is abandoned or left without an appropriate function," she explains.

LIFE DESERT-ADAPT is working with 10 landowners across the three countries, a pilot area of 1 000 ha. During its preparation phase (2017-2018), the project team drafted 10 DAMs, as well as baseline scenarios of ecosystem services, desertification risk maps, and climatic projections to 2050 for each area.

SOCIO-ECONOMIC BENEFITS

The implementation phase (2019-2022) involves developing eight new sources of income for farmers: sustainable agro-products and ecosystem services adapted to projected changes in climate. These are expected to generate an extra €100 per hectare per year.

The project also seeks to include the local population ('social adaptation'): "locals might work part time on DAM development or on a voluntary basis in exchange for some of the produced income, for example, or organise and lead guided eco-tourism," says Professor Castaldi.

"We want to show the effectiveness of a sustainable and holistic framework of land management that can at the same time preserve land integrity and quality, generate income and support social inclusion."

"The aim is to make farmers less dependent on CAP funding as the sole solution to low productivity in areas under desertification risk. Only adaptive sustainable land management can allow farmers to continue to use their land in a productive way in the long term," says Professor Castaldi.

Find out more
Website: http://www.desert-adapt.it

If each hectare planted stores approximately 150-200 tonnes of CO_2, that means in total the project will sequester around 75 000 tonnes of CO_2 over the lifetime of the trees in a total area of some 500 ha. "For a LIFE demonstration project that is pretty spectacular," says Mr Kallen.

The system is already commercially available (www.landlifecompany.com), but "planting time (and thus investment costs) are still relatively high," he explains. Automation of planting to reduce costs is high on the Landlife Company's wish list.

Find out more
Website: http://thegreenlink.eu/

"Over the lifetime of a tree we're talking thousands of litres of water"

Water-efficient and climate-resilient agriculture

LIFE projects are developing innovations in water use efficiency to help increase olive and citrus yields and support a shift towards climate-resilient agriculture in the Mediterranean.

Climate change is projected to put the EU's water resources under increasing strain, particularly in Mediterranean areas. "Summer water availability may fall by 20-30% to 40-50%. There could be 35% more water basin areas under severe water stress. Crop yields will decrease by 30% due to high temperatures and reduced water availability, while exposure to drought risks will increase the vulnerability of agriculture," says Lia Kountoura from Hyetos, a consultancy specialising in the management of water.

She is leading a project called LIFE AgroClimaWater that is working with two farmers' organisations in Crete (Greece) and one in Basilicata (Italy). "The main objective is to promote water efficiency and to support the shift towards climate-resilient agriculture in Mediterranean countries through the development of water management adaptation strategies," says Ms Kountoura. Stakeholder buy-in is essential. "Any effort for efficient water management to help agriculture adapt to climate change cannot succeed unless the main water users in the agricultural sector are involved."

The pilot actions focus on olive, citrus and peach orchards. The farmers taking part are adapting their methods to achieve the highest possible yields, despite low or erratic water availability. In practice, this involves techniques such as fertigation, in which fertilisers are injected into irrigation systems, reducing nutrient losses. Other good agricultural practices under investigation include:

- mulching (to reduce water evaporation losses);
- appropriate pruning and weed mowing (to reduce transpiration water losses);
- increasing soil organic matter (to reduce deep percolation waste);
- maintaining natural vegetation and introducing slope barriers (to reduce surface run-off); and
- irrigation based on weather-station data (to waste less irrigation water).

The water management adaptation strategies have been designed according to the European Water Stewardship (EWS) standard. This rewards "the use of water that is socially equitable, environmentally sustainable, and economically beneficial, achieved through a stakeholder-inclusive process that involves site- and catchment-based actions," according to the website of the European Water Partnership (www.ewp.eu), the not-for-profit organisation that developed the standard.

The EWS standard can help farmers to achieve compliance with regulatory measures set out in the EU Water Framework Directive and Blueprint 2012.

Impressive results

After only two years of implementation, LIFE AgroClimaWater has achieved impressive results.

In Italy:

- up to 30% less water lost through transpiration;
- a 15% reduction in water use (and 50% less nutrient use) due to fertigation; and
- a 15% reduction in surface water run-off.

"Our adaptation strategies are transferable to other areas facing similar climate challenges"

In Greece:

- improved water efficiency, supporting the adaptability of crops to extreme drought conditions (as experienced in 2018); and
- a 26% increased yield of the pilot plots even though the extreme climate conditions of 2018 had negative effects on agricultural production in general.

The project has developed governance action plans that have been adopted by the three farmers' organisations. These cover the following:

- compliance with legal requirements related to water use;
- identification and monitoring of the interrelation of water with other resources;
- internal and external transparency and raising awareness on water topics;
- emergency preparedness and response plans (e.g. for droughts); and
- accounting and reporting mechanisms to promote financial transparency.

This improved governance will contribute to more efficient use of water.

Transfer of practices

The three farmers' organisations taking part in LIFE AgroClimaWater represent more than 10000 farmers and 280 companies. "Their participation in this project will motivate a huge number of their members to apply the proposed good agricultural practices," says Ms Kountoura.

The project is also developing two guides for agricultural cooperatives and other farmers' organisations on how to create and apply water management adaptation strategies that meet the EWS standard. These will be published in Greek, Italian and English.

"Our adaptation strategies are transferable to other areas facing similar climate challenges," says Ms Kountoura. In particular, LIFE AgroClimaWater will be taking part in agricultural fairs in Spain and Cyprus to persuade farmers in those countries to implement its methods and spread water-efficient agriculture across the Mediterranean region.

Find out more
Website: http://www.lifeagroclimawater.eu/

Reusing water for greenhouse cultivation

The Greek-led LIFE project Adapt2Change showed how farmers growing crops in greenhouses can adapt when water supplies are scarce. It developed a closed, fully automated, hydroponic system and tested it out in prototype greenhouses in Greece and Cyprus.

The project's greenhouses were powered by renewable shallow geothermal energy. Due to the widespread availability of this energy source, the results are applicable across the EU.

"Adapt2Change introduces an innovative approach through the development of sophisticated prototype greenhouses that will minimise water demand in the agricultural sector and will reduce energy demand as well as decrease pollution attributed to agriculture," says Alex Papachatzis, Professor of Pomology at the University of Thessaly, one of the project partners.

The closed hydroponic system in the prototype greenhouses used 45% less water than a conventional greenhouse, and up to 70% less than open-field cultivation. Installing rainwater recirculation systems meant that 100% of the water could be reused in some cases. The addition of a cooling system was shown to have the potential to increase water use efficiency by up to 75%, compared to a conventional greenhouse.

Adapt2Change has published guides and manuals that other farmers and growers can use to replicate its methods:

- plans and blueprints for the development of identical systems;
- a practical guide for greenhouse water recycling system design and implementation;
- a shallow geothermal application manual for greenhouse agriculture;
- a water recycling guide;
- a guide to environmentally-friendly agricultural production; and
- a guide to sustainable water use for greenhouse horticulture.

The project also proposed reforms to agricultural policy in respect of its findings on water recycling. Results are being expanded upon in the INTERREG project "MED-Greenhouses".

Find out more
Website: https://www.adapt2change.org/en/home

Decision-support tools for sustainable crop production

LIFE projects have developed agricultural decision-support tools that are reducing water consumption, optimising fertiliser use, and providing early warnings of pest and disease outbreaks.

Such decision-support tools are vital for understanding when climate change may pose particular types of risks to specific ecosystems and for deciding on appropriate responses, including for early stage prevention.

LIFE ADAPT2CLIMA has developed a decision-support tool that can help farmers on Mediterranean islands adapt to climate change. The project has been testing it out in Crete, Sicily and Cyprus. "While all EU countries are expected to be affected by climate change, Mediterranean islands are considered particularly vulnerable," says project manager Christos Giannakopoulos.

The new tool "simulates the impacts of climate change on crop production and the effectiveness of selected adaptation measures," he explains. "Farmers will be able to gain insight on the expected changes in climatic conditions and on their impacts on agriculture, as well as on the available adaptation options for addressing these impacts and their effectiveness."

The tool provides information on:

- climate change projections;
- the impact of climate change on the production of a set of crops;
- the impact of climate change on the hydrological conditions of the islands' pilot areas;
- crop vulnerability assessments; and
- the effects of adaptation options.

Projected impacts of different climate change scenarios on crop yields are of particular interest to farmers. In Cyprus for instance, in the period 2031-2060, climate change impacts could reduce the average grape harvest by 52% and tomato yields by 26%.

Conversely, in Crete under the same scenario, tomato yields are projected to fall by 9%, while Sicily could be more adversely affected (68% lower yield).

The decision-support tool also includes the projected fluctuations of groundwater level in the pilot areas. "The need for better management of groundwater resources is of primary importance," says Dr Giannakopoulos. In Crete, for instance, "a significant additional decrease in the groundwater table of between 4 to 12 metres is expected, depending on the pilot area." Additionally, projected impacts of climate change on drought severity and intensity are also shown in the ADAPT2CLIMA tool. On all three islands, "relatively more severe and intense drought events are foreseen, affecting surface water storage," he adds.

The aim of the water assessment included in the tool is to support regional authorities in their efforts to develop water efficiency strategies in the agricultural sector that can counter the predicted impacts of climate change on water availability.

LIFE ADAPT2CLIMA aims to have its decision-support tool hosted on the Climate-ADAPT platform (see p. 37).

While results from the project will, to varying degrees, be included in forthcoming adaptation policies in Greece, Cyprus and Italy, Dr Giannakopoulos believes its long-term impact "lies more in the educational and awareness-raising potential of this tool. Through its usage, a stakeholder partakes in a larger climate change adaptation discussion and better understands the mechanisms, variables and stakes involved."

Find out more
Website: http://adapt2clima.eu/en/

sigAGROasesor: real-time recommendations for Spanish farmers

INTIA is a public advisory service for farmers, based in Navarre, Spain. "In the last few years the role of the advisory service has changed," says Alberto Lafarga from INTIA. "It's less about one-to-one meetings with farmers and more about providing tools they can use."

This is especially the case with younger farmers. "We are mostly working with this small community. They are very professional, and very efficient in their use of the tools and in agriculture development," he says.

With co-funding from LIFE, INTIA developed the LIFE AGROgestor project. The project team set up a geoportal for extensive agriculture called sigAGROasesor. It includes:

- four decision-support systems;
- environmental indicators;
- a list of variables and procedures;
- a database of farmers and pilot plots;
- a database of soil analysis in all regions of Spain;
- maps of the different areas involved in the project;
- a good practices guide;
- a user guide for the tool; and
- a report on environmental indicators.

In terms of responding to climate change adaptation, there are two main tools. "The first is related to water use," says Mr Lafarga. In Navarre, more than 100 000 ha of land is irrigated for agriculture. "Management of irrigation is a critical issue from an economic point of view and from a technical point of view for the crops," he adds. The sigAGROasesor tool gives farmers "very precise" information on water use, which enables them to optimise usage.

"This tool has been very well received by farmers," notes Mr Lafarga. "Some communities are starting to be concerned about the availability of water. The last year has been very dry and it is possible that we are going to have water restrictions. Our tool is useful for farmers because they have to adapt to this lack of water – adapt their crop decisions, inputs and sowing etc. We can then advise them on crops with a lower water demand and how to adapt to this scenario."

The platform also includes a fertiliser tool. By calculating the balance of nitrogen, phosphorus and potassium in the soil, it can advise farmers on optimum fertiliser use at each moment in the development of the crop. "Around 80% of the users are growing arable crops – wheat, barley, maize and beet," says Mr Lafarga. "We are also preparing the tool for use in horticulture – tomatoes, spinach, etc."

The LIFE project developed models that take into account potential yields. "What we're doing with the platform is to 'modelise' the cycle of the crops; the key stages of development that are more critical to take decisions, such as when to apply fertiliser," explains Mr Lafarga. The models use real-time temperature data to calculate the critical moment for applying nitrogen to the crops.

In the last couple of years, sigAGROasesor has added remote-sensing data to make the models even more accurate. It is also providing farmers with an early warning system against new pests and diseases, a significant threat to agriculture linked to climate change. "We have established a collaborative model, which takes information from the farmers and passes on warnings through the platform to the users," he says.

"We now have around 400 farmers using the platform, representing around 12 000 ha, so it's significant. We are, little by little, increasing the number of farmers," says Mr Lafarga. "One thing that we are getting from users is that they only like to use a smartphone. Our challenge now is to create apps with the same services, more or less, but in a small format so they can be used by farmers in their tractors in the field, where they are working."

Find out more

Website: https://www.agroasesor.es/en/

Bringing awareness of climate change vulnerability to individual farms

A LIFE project developed a 'climate change check' for farmers that assesses individual farm vulnerability and helps them to develop appropriate climate change adaptation measures.

"Agriculture is one of the sectors that is most exposed to climate change. The LIFE AGRI ADAPT project can show farmers how they have been affected so far by climate change, and how they could be affected in the near future," says project manager Patrick Trötschler, from nature foundation Bodensee-Stiftung in Germany.

His team have been working in four rural pilot areas particularly at risk from climate change, in order to develop a knowledge base for the assessment and monitoring of vulnerability at farm level. "It's about transforming the knowledge that is there regarding climate change and what it means concretely for the farm in its region," he says.

From weather to climate

"Our experience is that farmers are often focused on weather, so it's a short-term view. They are not focused on climate, which is a long-term view. With our methodology we can show them how climate change could affect them in the next 30 years."

The starting point for LIFE AGRI ADAPT was the European Commission's 2009 map of climate risk zones for agriculture. Bodensee-Stiftung wanted to develop a project with a European partner in each of the four zones: Atlantic, Continental, Northern and Southern. This aim was achieved, as the project includes partners and pilot actions in Spain, France, Germany and Estonia.

"We want to show farmers that climate change is progressing – and the first easy actions won't be sufficient in 10 years"

"The basic idea was to develop an assessment methodology that is suitable for all the four European climatic zones – and able to assess different farm types," explains Mr Trötschler.

The end result is a 'climate change check' that is applicable for livestock (dairy and beef), arable and permanent crop farms throughout Europe.

Agro-climatic zone tool

LIFE AGRI ADAPT is working with pilot farms in each of the four climatic zones. Using observed climatic data and climate projection data from the European Commission's Joint Research Centre (JRC), the project has developed an agro-climatic zone (ACZ) tool. The detailed JRC data is available for all parts of Europe and for grids of 25 km². The project team has been able to locate all 120 of its pilot farms within these small grids – effectively it is farm-specific climate data.

The ACZ tool can provide 62 agricultural climatic indicators for the recent past and the near future. These 'crop IDs' identify climate-specific needs of plants such as winter wheat, maize and rapeseed. "We know from our crop IDs how these plants have developed in the past and how they could develop in the future," says Mr Trötschler. By presenting farmers with specific information, such as a doubling of the expected number of days over 25 degrees Celsius in the next 30 years, he believes they will begin to think more about adaptation.

Farm vulnerability tool

LIFE AGRI ADAPT's second tool is its 'farm vulnerability tool'. This is based on interviews with farmers: "we bring in specific farm issues, information about the type of farm and its strategy; whether or not has it already implemented adaptation measures, experiences in previous years, and so on," explains Mr Trötschler. Each interview is used to make a SWOT analysis, which is the basis for a farm-level adaptation plan.

Together the ACZ and farm vulnerability tools bring climate change to farm level. "The tools enhance awareness of climate change and awareness of vulnerabilities, possible solutions and their efficiency," he adds.

Training farm advisers

The project's tools are designed to be used by farm advisers rather than directly by farmers. The LIFE AGRI ADAPT team is presenting its methodology and planning training for advisers. In the remaining months of the LIFE project – it finishes in autumn 2019 – they will be developing a web tool that will include climatic and yield data for some grids, as well as some suggestions for adaptation measures - efficiency measures, substitution measures and redesign measures. "The web tool is not really on the farm level, but it's an option to approach farmers as advisers and technicians," says Mr Trötschler.

Workshops at the pilot farms have been a good way for other farmers and agricultural stakeholders to learn more through concrete demonstrations of some of the adaptation measures and their effects.

The project has also created a training pack that is available in five languages. "We give presentations and training in agricultural colleges and to adviser organisations. We present the climatic indicators and our methodology, and we discuss possible adaptation options with them," he explains.

LIFE AGRI ADAPT has also invited the food business sector to its training workshops and webinars. There has been increasing interest since the 2018 drought in Germany made it difficult for some of these firms to obtain raw materials. "There are concrete requests now from food businesses and food standards organisations to present our methodology," says Mr Trötschler. "They are starting to think that it's part of quality management and risk management. If they have suppliers that are well adapted to climate change then they have more security in terms of quality and quantity."

Preparing farmers for the future

According to Mr Trötschler, "it's clear that in this project period of three-and-a-half years we won't see so much implementation of concrete measures. It's more a process of making farmers aware and showing possible solutions for the future. We want to show farmers that climate change is progressing – and the first easy actions won't be sufficient in 10 years."

"Farmers always talk about their maximum yield, but that's only one part, and if they are so focused on this aspect, they go for high risks, and use a lot of inputs: fertilisers and pesticides. Then if it doesn't work due to climate impacts, they lose a lot of money," he explains. "What we discuss is not to be so focused on annual maximum yield, but to follow a strategy of more regular high yield, over 10 years."

"It's a process and our project can support this – to raise awareness and to push them to try something new," concludes Mr Trötschler.

Find out more
Website: https://agriadapt.eu/

Sustainable meat and dairy production

With the help of LIFE, livestock farmers are demonstrating methods for sustainable adaption to climate change, including reducing heat stress in animals and dynamic rotational grazing.

Most LIFE projects dealing with meat and dairy production have focused on climate change mitigation (e.g. reducing methane emissions from livestock). However, as climate change impacts increase, meat and dairy farmers and their customers will have to adapt. LIFE AGRI ADAPT is developing a knowledge base for the assessment and monitoring of climate change vulnerability at farm level. It is also promoting sustainable adaptation measures.

As detailed in the previous section, LIFE AGRI ADAPT's assessment methodology

SOME OF LIFE AGRI ADAPT'S RECOMMENDATIONS FOR LIVESTOCK

Sustainable adaptation measures for livestock farms focus mainly on reducing heat stress and enhancing fodder autonomy (in all climate risk regions):

- appropriate density of animals in buildings;
- improved cooling systems (open barns with passive ventilation, installation of ventilators, shelter for animals outdoors, shading of barns);
- increase fodder storing capacity;
- increase fodder autonomy and diversification;
- high number of drinking troughs; and
- grazing management plans to increase quantity and quality of pasture in extensive livestock systems.

The main results of LIFE AGRI ADAPT:

- climate change vulnerability assessment methodology usable for the main farm types in Europe (i.e. automatic calculation of 70 different agroclimatic indicators);
- vulnerability assessment implemented on 120 pilot farms across Europe;
- training pack on sustainable adaptation in agriculture (available in five languages, free download: www.agriadapt.eu);
- more than 20 demonstration workshops for farmers, advisers and other agricultural stakeholders;
- dissemination of the project results also to the food business sector and insurance companies; and
- AgriAdapt webtool (new web-based service to evaluate and reduce the vulnerability of European farms to climate change, available end of 2019).

'Dynamic rotational grazing'

The French project PTD LIFE introduced a concept known as 'dynamic rotational grazing' to improve grassland management. Working with 120 livestock breeders (cattle, sheep and goats), it tested new herb species better adapted to climate change, and developed adapted grazing plans to optimise the production potential of grassland and ensure an appropriate diet for herbivores. These demonstration methods were thoroughly monitored by farming experts, and were found to have positive impacts on aerobic biodiversity in soils, fertiliser use, carbon capture, greenhouse gas emissions and farming profitability.

Find out more
Website: https://www.life-ptd.com/

is applicable to all four European climatic zones – Southern, Atlantic, Continental and Northern. Project manager Patrick Trötschler says: "The climate change check that we have developed is applicable for livestock farms, arable farms and permanent crop farms throughout Europe."

The project has also developed a 'Dairy Milk Tool' with indicators for milk production linked to climate constraints.

For livestock farmers, "one of the main problems is heat stress for the animals," he explains. "One of the technical solutions is to have well air-conditioned buildings; it's crucial, you could install ventilation systems or you could reduce herd density."

Spreading the risk

Another measure the project is testing is to increase farms' 'fodder autonomy'. "If you have diverse fodder crops, you spread the risks," says Mr Trötschler. "A lot of farms are highly specialised in producing only two or three crops, and that is a problem because the risk of climate change impact is very high." Instead, some of the pilot farms participating in LIFE AGRI ADAPT are experimenting with a wider variety of crops or animals, which also diversifies their income.

Find out more
Website: https://agriadapt.eu/

Economically-viable adaptation on farms

A LIFE project is demonstrating climate-friendly farming practices – nutrient recycling, crop rotation, reduced tillage and agroforestry – in Sweden, Germany and Italy.

"The SOLMACC LIFE project focused on demonstrating that farming practices can contribute to climate change mitigation and adaptation, while being economically viable to the farmer," explains project coordinator, Tereza Maarova, from the European group of the International Federation of Organic Agriculture Movements (IFOAM EU).

The project implemented climate-friendly practices at 12 demonstration farms in Sweden, Germany and Italy. These consisted of:

- optimised on-farm nutrient recycling (e.g. composting);
- optimised crop rotation with legume-grass leys;
- optimised tillage systems; and
- agroforestry.

The project fostered a strong collaboration between the participating organic farmers, local advisers and scientists. This enabled hard data to be gathered about the impact of the different practices. Each farm assessed their adaptation potential, with a favourable potential for those practices that maintained or increased crop yields; and those that maintained or improved soil quality (compaction, humus content, water-holding capacity).

Impacts on climate change adaptation

Nutrient recycling:
Composting of different materials helped to stabilise and, in some cases, increase crop yields, while improving soil quality. This improves farms' resilience against extreme weather events, such as heavy rainfall and droughts. Better soils can absorb higher amounts of water without causing surface run-off.

Crop rotation:
Introducing leguminous crops also helped to stabilise or improve yields. The impact was most pronounced on farms that had little or no legumes beforehand.

Reduced tillage:
Project farms reduced tillage to promote soil health and structure. This meant ploughing less frequently (every second year), ploughing less deeply, and, in some cases, not ploughing at all. Importantly, there was no observed decrease in crop yields from implementing reduced tillage practices.

Agroforestry:
The various agroforestry practices mostly led to stable yields, but the impact on soil was unclear.

Photo: LIFE12 ENV/SE/000800

Photo: LIFE12 ENV/SE/000800

Photo: LIFE12 ENV/SE/000800

Adapting in different climates

Between them, the 12 organic demonstration farms represented different farm types: livestock, arable, mixed, horticultural, small, big, family-owned, etc. They also covered several different climatic regions of Europe (from warm Mediterranean to cool continental).

The northernmost farm taking part in the project was Trägsta Gård, a mixed farm 70 km from Östersund in Sweden. Farmers Eva and Torgny Widholm have 140 dairy cows, 260 hectares of arable land, and 20 hectares of grazing land. They have been farming organically since 2008.

"We have worked hard to make our production more efficient and rationalised," says Mr Widholm from Trägsta Farm. "Taking the step to streamline from a climate perspective seems like a natural next step. It is important to spread our experience to others."

The importance of such testimonials cannot be overstated, believes Eric Gall, IFOAM EU policy manager. "Mainstreaming climate-friendly farming practices requires role models for other farmers and consumers in a society that needs to rapidly transition towards a sustainable future."

"In particular, farmers will need a long-term perspective and an appropriate amount of technical advice and policy support to shift their agricultural practices," he says. "Ultimately a transition of agriculture and food production towards agroecology is needed, which will require a significant research effort and a renewed common agricultural policy that better rewards farmers who take action to protect public goods, our natural resources, and our climate."

Measures introduced during the SOLMACC project included:

- setting up a biogas plant to treat animal manure and generate heat and electricity;
- extending the usage period of forage legume leys (crops cultivated to improve soil quality) from 4 to 5 years;
- reducing the depth of tillage for most fields; and
- managing a silvopastoral system (mixed forest and grazing area) on 15-20 hectares.

These actions had a marked impact on adaptation potential in terms of crop yields and soil quality:

- the use on fields of liquid and solid manure residues from the biogas plant has increased yields by more than 10%, as well as increasing the farm's resilience and independence;
- extending the cycle for forage legume leys provided roughage for the dairy herd, and increased soil fertility and yields. A higher proportion of roughage in the feed ration improves rumination and cows' health. With no need to buy concentrates the carbon footprint of milk is smaller;
- reducing ploughing depth has potentially increased organic matter in the top soil, while also limiting soil erosion and increasing the soil's capacity to hold water. Significantly, operational and labour costs were lower with reduced tillage; and
- the new silvopastoral system protects biodiversity and diversifies farm income (enhanced grass production, spruce for wood pulp, birch for firewood, pine cuttings for sawmills).

Find out more
Website: http://solmacc.eu

Adaptation in alpine pasturelands

To adapt mountain pastures to the impacts of climate change, LIFE is assessing strategies for livestock grazing and sustainable farming that also slow the rate of land abandonment.

"Ecosystems of the Alps are 'hot spots' of climate and land-use changes. This is particularly true for permanent grasslands," explains Camilla Dibari from the LIFE PASTORALP project. Alongside a changing climate, socio-economic changes, including depopulation and the abandonment of mountain farming systems, have affected the quantity, quality, botanical composition and biodiversity of permanent grasslands. This has negative consequences on associated ecosystem services, such as carbon sequestration and the cultural values of mountain landscapes.

Many alpine regions lack specific measures to manage climate change impacts on pastures. LIFE PASTORALP, which runs from 2017-2022, aims to fill this gap by assessing and testing adaptation measures, building capacity and developing better management strategies for alpine pasturelands. It is working with local communities in two national parks in the Alps: Parc National des Ecrins (France) and Parco Nazionale Gran Paradiso (Italy).

The project team has been mapping the main types of pastureland ecosystem above 1 700 m, and analysing socio-economic issues that influence how local communities manage pastures. They have also carried out a comprehensive review of national and European policy frameworks and evaluated available adaptation options. The project is now using a combination of process-based, machine-learning and economic models to identify how pastures will evolve under future climate scenarios.

Farmers and shepherds help define measures

"Management adaptations to forage quality and quantity have always been part of the pastoralist 'toolbox' to preserve mountain grasslands," notes Ms Dibari. "However, livestock farmers will possibly face new and unexpected challenges linked to expected climate change. Greater climate variability, for instance, is a major threat to pasture management as it requires flexibility and an enhanced capacity for quick adaptations."

The project's strategy focuses on understanding livestock farmers' perceptions of changes and their capacity for adaptation. "A preliminary list of adaptation strategies to face future changes in pasture management has been identified by means of stakeholder consultation workshops," says Ms Dibari. This is important because one of the project's main goals is "the acceptance of the proposed adaptation strategies by local actors and stakeholders to ensure continuity," she explains.

LIFE PASTORALP will create a platform for its tools, and create synergies with the EU strategy on adaptation to climate change. The project will also train shepherds, farmers and technicians in the use of adaptation measures.

Revitalising local markets

"We believe that the project will have important socio-economic effects on the local economy and population of the national parks, both during and after its implementation," says Ms Dibari.

It will help the national parks to manage their territories, combining sustainable farming activities with the conservation of natural resources and wildlife. Farmers will be able to promote high-quality products with 'climate-friendly' branding. "Local markets could be revitalised, boosting local economies. The sustainability of Alpine rural communities will increase, while abandonment of lands and migration is expected to slow down," she says.

Defining environmental and socio-economic indicators for pastureland and consolidating results into guidelines will enable other alpine regions to benefit from lessons learned. The project will also provide guidance on integrating its adaptation measures into the common agricultural policy and rural development programmes.

Find out more
Website: http://www.pastoralp.eu/home/

Fertile soils and resilient grasslands

Photo: LIFE12 ENV/IT/000578

LIFE is helping create climate-resilient grasslands by increasing soil fertility, preventing soil erosion, enhancing biodiversity, and promoting multifunctional farms.

The Italian project LIFE HelpSoil introduced conservation agriculture practices on the plain of the river Po. These practices, including the use of cover crops, crop rotation and no-till farming, improved soil quality and demonstrated a significant climate change adaptation potential.

Soil constitutes the largest store of terrestrial carbon and therefore it plays a key role in combating climate change. Moreover, agricultural ecosystems depend on high-quality soil for the provision of water and nutrients for plant growth and the regulation of the water cycle. However, these soil functions are threatened by the changing climate.

The conservation agriculture practices introduced by the LIFE HelpSoil project have demonstrated how fertility and organic matter content of soil can be increased, along with biodiversity. Fertile soil that is rich in organic matter is less vulnerable to erosion and desertification, and requires fewer chemical inputs. In the medium-term, therefore, fewer pesticides and fertilisers will be required and less energy consumed, thus lowering crop production costs.

The project tested subsurface drip irrigation, an effective no-tillage soil management practice that reduces evapotranspiration. The resulting need for less water represents a good climate adaptation measure, as well as another cost saving for farmers. Due to the success of the project's trials on three pilot plots (c. 3-5 ha each), more farms in the Po plain are implementing this type of irrigation.

LIFE HelpSoil also promoted livestock manure management by applying trailing-shoe, shallow injection, and 'fertigation' systems. It adapted these techniques, which are expected to increase manure and slurry efficiency, to prevent the soil becoming compacted. "We collected agronomic and ecological data to assess the extent that all these conservation agriculture techniques can deal with the impact of climate change," says Stefano Brenna, the project's technical manager.

Easing the transition

"Shifting from conventional to conservation soil management practices, however, requires time," cautions Mr Brenna. "Priority should be given to actions, such as demonstration, training and information activity, to ensure that farmers can acquire the skills and the experience needed."

This transition was helped in Italy by the inclusion of measures to support the uptake of these soil management practices in the form of regional rural development programmes.

Nevertheless, land management practices must be adapted to specific local conditions, and changing to a more sustainable approach requires farmers to rethink their overall strategies. They need opportunities to share experiences, given that "results are often not immediate, but in the long term", emphasises Mr Brenna.

The improved health of the soil was reflected in the presence of two to three times more earthworms and 30% more microarthropods. Fossil fuel consumption was reduced by 50-60% due to reduced mechanisation, with related reductions in CO_2 emissions, while maintaining similar crop yields to conventional soil management.

Overall, the project helped implement strategies for improving soil and for supporting the goals of the common agricultural policy for sustainable agricultural production and efficient use of soil, water and other natural resources. "The dissemination of soil conservation practices can help to prevent soil erosion, avoid soil com-

paction, increase organic matter content and biodiversity in soils," concludes Mr Brenna. "In the long term, the adoption of those techniques can generate significant socio-economic benefits, allowing crop cultivation with fewer chemical inputs, lower energy consumption and mechanical work, while maintaining the same profitability for farmers."

Find out more
Website: http://www.lifehelpsoil.eu/

Resilient grasslands: LIFE Viva Grass

Many semi-natural grasslands in Lithuania, Latvia and Estonia have been degraded by intensive agriculture and, in remote areas, marginalisation and land abandonment.

"The loss of grassland biodiversity leads to degradation or even destruction of ecosystem services. It would require enormous financial investments to maintain or provide these services artificially," says Rita Grinienė, environmental communication expert at the Baltic Environmental Forum Lithuania. This NGO led the LIFE Viva Grass project, which developed an IT tool to help planners at local and regional authorities strengthen the link between social, economic and environmental factors in grassland management. This will make these ecosystems more resilient in the face of climate change.

The project contributed to the mapping and assessment of ecosystems and their services in the Baltic states. The Viva Grass Tool provides a framework and methodology for expert-based assessment of agro-ecosystem services in the three countries. Policymakers can use it to identify 'hot spots' that deliver large numbers of high-value ecosystem services and 'cold spots' providing services of no or low value.

"The policymakers can then take measures to safeguard the hot spots and promote measures which help to alter land use in cold spots, to achieve better delivery of ecosystem services and better land management practices in those areas," explains Ms Grinienė.

TOWARDS MULTIFUNCTIONAL FARMS

The project team also restored over 150 ha of grasslands at nine pilot sites in the three Baltic states, where they tested options for multifunctional use of grassland ecosystem services. Based on the results of these trials, the NGO has the following recommendations for farmers: "consider producing higher-value products and making the farm multifunctional. This means making end products (e.g. ice cream) rather than just raw materials (milk), and it means diversifying production (e.g. by combining farming with tourism and/or nature conservation)," says Ms Grinienė.

Find out more
Website: http://vivagrass.eu/


Photo: LIFE13 ENV/LT/000189/Žymantas Morkvenas


Photo: LIFE13 ENV/LT/000189/Žymantas Morkvenas


Photo: LIFE13 ENV/LT/000189/Žymantas Morkvenas

Copernicus
Europe's eyes on Earth

Copernicus Sentinels © ESA

The European Union launched the Copernicus Earth Observation programme to offer data from a network of satellites to European information services. This unique information is provided free-of-charge to these services, and is openly accessible to users. The information includes data on land-use change and forest cover, which can be combined with data from ground-based, airborne and seaborne measurement systems.

Copernicus is coordinated and managed by the European Commission. It is implemented in partnership with Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for Medium-Range Weather Forecasts (ECMWF), EU Agencies and Mercator Océan.

Copernicus provides detailed climatic datasets and information through monthly reports in near real-time. The Climate Change Service, in particular, makes seasonal forecast data and sector indicators and tools available to users to support climate adaptation actions. A specific tool, named AgriCLASS, is designed to improve understanding of the impacts of climate change on crops. It combines climate variables with agricultural data to create down-scaled region-specific crop impact indicators. Furthermore, the tool can deliver information in a format directly useful for crop growers and managers, food manufacturers, retailers and policymakers.

In 2018, Copernicus launched a Climate Data Store. This makes freely available a wealth of information about the Earth's climate, tools for adaptation, and climate simulations. The EU INSPIRE Directive has helped in the shift to standardised environmental and geographical data. Therefore, projects working at farm or forest level will be able to build on these datasets and adapt them to more local circumstances.

A number of LIFE projects have used satellite data to develop tools to make forestry or agriculture more resilient to climate change. For instance, 'fuel maps' that are used to prevent forest fires in Greece have been updated to include Copernicus data. The maps were initially developed by the University of Thessaloniki for the LIFE project, ArcFUEL.

Other LIFE projects developing vertical data applications for use in forestry and agriculture include LIFE+ ForBioSensing PL (see pp. 44-45) and sigAGROasesor (see p. 25).

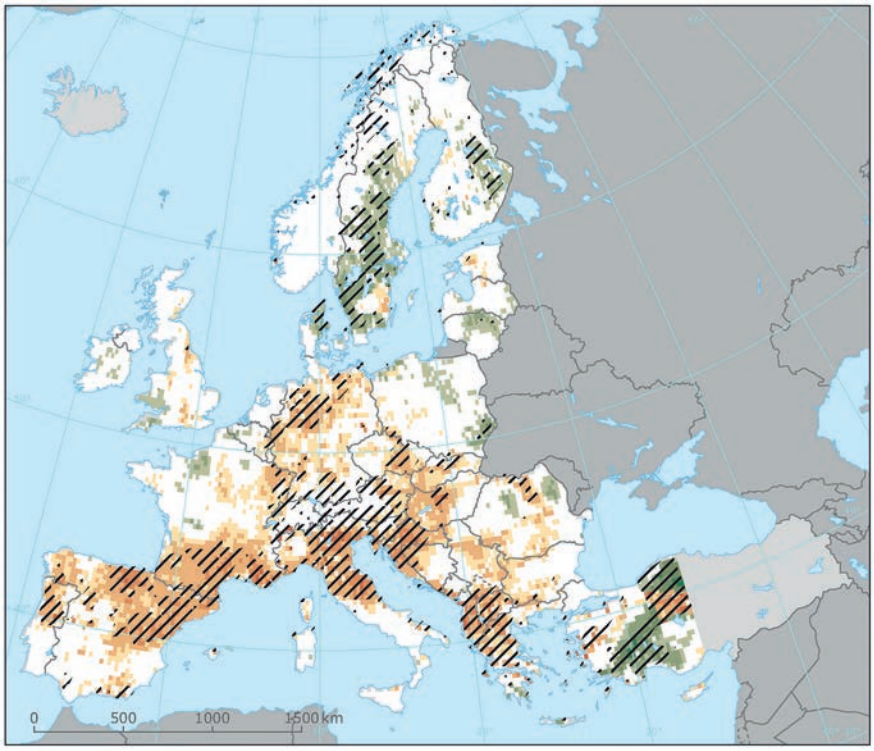
The Alps © ESA, contains modified Copernicus Sentinel data (2018)

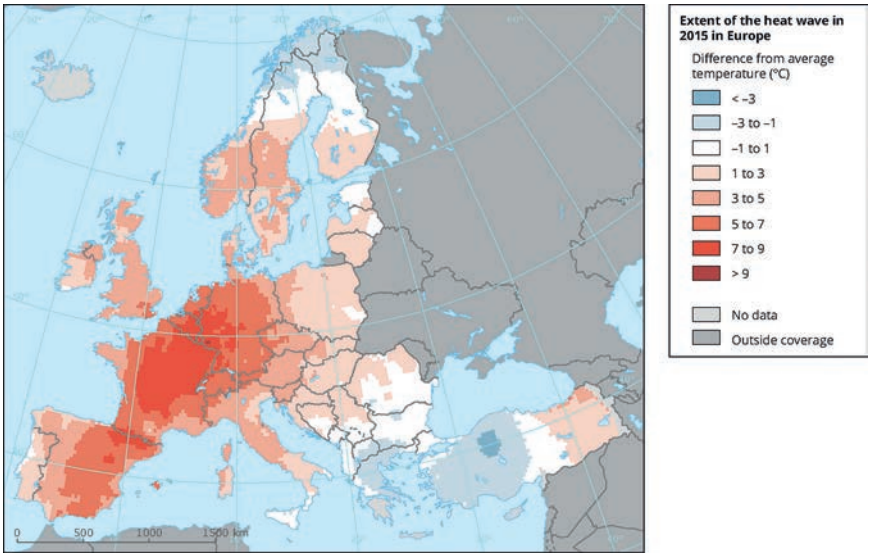
Zaragoza, Spain © ESA, contains modified Copernicus Sentinel data (2018)

Read more:
About Copernicus: https://www.copernicus.eu/en/about-copernicus
Climate Data Store: https://cds.climate.copernicus.eu

Climate ADAPT

SHARING ADAPTATION INFORMATION ACROSS EUROPE





The European Climate Adaptation Platform Climate-ADAPT is a partnership between the European Commission and the European Environment Agency (EEA). Climate-ADAPT is maintained by the EEA with the support of the European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation (ETC/CCA).

This initiative is linked to Priority 2 (better informed decision-making) of the EU adaptation strategy. The platform supports Europe in adapting to climate change by helping users to access and share data and information on:

- expected climate change in Europe;
- current and future vulnerability of regions and sectors;
- EU, national and transnational adaptation strategies and actions;
- adaptation case studies and potential adaptation options; and
- tools that support adaptation planning.

Climate-ADAPT provides information on EU policies for 12 socio-economic sectors, including agriculture and forestry, with links to key resources, case studies and specific indicators. The user base mostly consists of experts, researchers and decision-makers.

Key LIFE adaptation projects, including many of those described in this brochure, can be found in a dedicated section of the Climate-ADAPT portal.

Soil moisture content was modelled using a soil moisture balance model in the upper soil horizons (up to 1 m) © EEA

Average temperature anomalies (∞C) for Europe between 28 June 28 to 4 July. Baseline period is 1964-1993. © EEA

Read more:

Climate-ADAPT homepage: www.climate-adapt.eea.europa.eu

LIFE projects page: https://climate-adapt.eea.europa.eu/knowledge/life-projects/life-projects

Adaptation in forestry

Forest owners and managers face similar challenges to Europe's farmers. It is necessary to adapt to climate change and to modify management approaches, preserving forests and their ecosystem services, and addressing both financial risks and opportunities. The LIFE programme is supporting the implementation of new approaches to better adapt forestry to changing climatic conditions.

Climate change, in some cases combined with past management choices, has resulted in more fragile forest ecosystems and therefore more vulnerable rural areas.

Impacts include a change in the geographical distribution of tree species, water stress, and more frequent pest and disease outbreaks. Elevated levels of atmospheric carbon may also have an impact on the growth and productivity of forests. Climate change will also alter the biodiversity and dynamics of forest ecosystems, in conjunction with management effects, and these changes will in turn affect the resilience of forests.

Larger forest fire outbreaks remain a constant threat throughout Europe, particularly in the Mediterranean region. Even though such fires are not always directly linked to a warmer climate, droughts, heatwaves and dry spells are expected to intensify, especially across southern Europe. These projected changes would increase the length and severity of the fire season, the area at risk, and the probability of large fires. Forest

fires also contribute to climate change by emitting carbon dioxide and other greenhouse gases. Further impacts of forest loss include floods, landslides and higher wind speeds during storms.

Across the board, from old growth forests and wooded nature reserves to plantations, Europe's forests all face climate change and its consequences. New ways are needed to manage forests and forested landscapes to reduce wildfire risks, enhance forest resilience to weather extremes and pests, whilst improving forest biodiversity and ecosystem service provision. This is especially important in urban areas where forests contribute to human health and wellbeing, and provide important sites for recreation. Resilient forests also perform better as carbon sinks, absorbing CO_2 and contributing to climate change mitigation.

Making forests and farmland more resilient to climate change generally requires a panoply of measures and a systems approach. Agroforestry – a farming system that combines trees with crops and (optionally) cattle on the same land – is an opportunity for both agriculture and forestry. Such a system contributes positively to biodiversity, increases resilience and productivity, and sequesters more atmospheric carbon per area than conventional agriculture. It therefore is more resource-efficient and can boost the livelihoods of small shareholder farmers, and ultimately improve food security.

FOREST AND WOODLAND STRATEGIES TO INCREASE RESILIENCE

- selective tree breeding to enhance genetic diversity in forests and protect endangered genetic resources increases disease resistance, drought tolerance, and the ability to cope with more frequent and more destructive storms and fires;
- management practices that focus on mixtures instead of monocultures make forests more resilient, enhance energy and resource efficiency, protect forestry-related jobs, increase competitiveness and expand business opportunities within the bio-based industries; and
- alternative forest management strategies that focus on targeted tree species, rotation and silviculture techniques can enhance conservation and biodiversity potential and other ecosystem services provided by European forests.

LIFE's contribution to increasing resilience in forestry

The LIFE programme is helping forestry to adapt to the demands of a changing climate at European, regional, national and local levels. Some of the focus areas are outlined below.

PREVENTING AND TACKLING FOREST FIRES

Climate change is increasing the frequency, severity and duration of forest fires. More droughts, storms and heatwaves increase the risk of large forest fires, more carbon released into the atmosphere, and a greater likelihood of soil erosion.

LIFE has co-funded more than a dozen projects that have raised awareness of the causes of forest fires and taken steps to prevent them. Actions have included mapping 'forest fuel' –

PROBLEMS IN MEDITERRANEAN FORESTRY CAUSED OR EXACERBATED BY CLIMATE CHANGE*

- heightened **fire risk**, which increasingly materialises in the form of destructive forest fires primarily in the Mediterranean region but elsewhere too;
- **(invasive) pests and diseases** that can no longer be controlled by natural mechanisms existing within the local ecosystems;
- **invasive forest species, partly due to globalisation, but exacerbated by climate change;**
- **water stress** caused by prolonged dry spells and heatwaves; and
- **fragile forest ecosystems, lower forest productivity and vulnerable local communities** due to a combination of climate change impacts and inadequate management choices made in the past.

SOME KEY INTERVENTIONS NEEDED TO ADVANCE CLIMATE CHANGE ADAPTATION IN MEDITERRANEAN FORESTRY*

- **diversification of forest stands** to moderate climate change impacts, including pests and diseases, and forest fires;
- **diversification of the income of forestry-dependent communities**, introducing new revenue-producing activities, such as collection and processing of deadwood for energy production;
- **redirecting the focus on the most profitable forest products**, e.g. through selective felling for the timber frame construction industry to promote wood building;
- introducing more elements of **close-to-nature forestry and increased biodiversity**; and
- **better forest management**, for instance using historic data and forecast models to optimise when forest work takes place. Good management can create a more resilient forest in the (near) future.

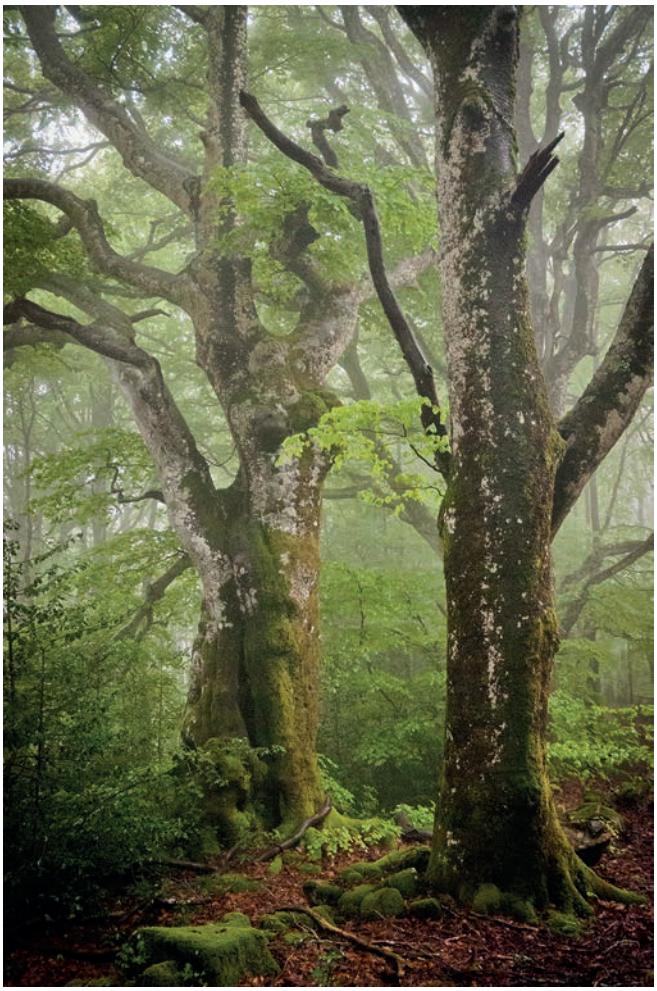
**Indicative list based on the conclusions of the LIFE Platform Meeting on Climate Change Adaptation in Agriculture and Forestry in the Mediterranean Region held in Madrid on 13-14 March 2018.*

vegetation levels that can turn a small fire into a large one. Projects have also addressed issues such as tree species composition, which affects the amount of water a forest needs.

In Europe, most forest fires are caused by human activity, so awareness campaigns targeted at forest users have been another important focus of LIFE.

FOREST MANAGEMENT AND DESIGN TO INCREASE RESILIENCE

- easy access to EU level satellite data – for instance through the European Forest Data Centre – and to local adaptation strategies is a prerequisite for forest management that adapts to climate change;
- well-designed forests should deliver cross sectoral adaptation-related benefits, e.g. flood prevention, food and shelter for livestock;
- environmental certification can create 'sectoral' competition for market-based timber products and ensure sustainable and resilient approaches are upscaled; and
- LIFE projects can raise awareness of best practices and encourage networking between foresters, forestry associations, the construction industry, government agencies, local authorities and other stakeholders.



FOREST MONITORING AND MODELLING & OTHER TOOLS AND SERVICES

The LIFE programme provides support for monitoring of forests. This can help to identify future risks, such as the spread of pests and pathogens, more efficiently. It can also contribute to changes in forest management and policy in response to climate change. For instance, co-funding from LIFE is being used to identify changes in forest structure and tree species composition within Białowieża Forest in Poland.

In France, a project has developed a decision-making tool to analyse existing forest stands and reforestation works as the basis for management strategies that are adapted to the local context and changing climate.

Modelling of climate change risks by LIFE projects helps to make forest-based industries more resilient. It can also guide them in the development of alternative production systems.

ADAPTIVE FOREST MANAGEMENT

The LIFE programme has supported more than 30 projects that have tried out new adaptive approaches to forest management. These include trials of agroforestry systems, which are beneficial for biodiversity, diversification of income, and carbon sequestration (see pp. 52-53).

Changes to silvicultural practices have improved the structural diversity, biodiversity and natural regeneration capacity of forests. Climate change is altering the tree species found in forests. The LIFE programme is supporting investigations into such changes and providing the knowledge that will inform adaptive management in the future.

Measuring the health of forests through key indicators of resilience enables policy priorities to be addressed and taken up more rapidly. It also supports the development of new legislative standards to sustain forest ecosystems, for instance on ozone levels (see LIFE MOTTLES, p. 55).

TECHNOLOGICAL APPROACHES TO INCREASE RESILIENCE

- satellite and remote sensing data, for instance, from Sentinel-1 and Sentinel-2 satellites of the Copernicus programme, enable more in-depth understanding of how climate change is affecting forests; and
- decision-support systems allow rapid classification of forest vegetation into fuel types. This has enabled LIFE projects to develop 'fuel maps' for forest fire prevention.

PROTECTING ECOSYSTEM SERVICES

Many LIFE projects have taken action to protect forest ecosystem services such as carbon storage, water retention, biodiversity etc. This includes improving the structural diversity of forests in nature conservation areas and their surroundings, and fostering the capacity of ecosystems to self-organise to cope with water stress, heat and other consequences of climate change.

INFORMATION, GOVERNANCE AND CAPACITY-BUILDING

Six forestry LIFE projects have specifically focused on raising awareness, building capacity or improving governance; many more have included actions of this kind as part of a wider goal.

Examples of the ways in which LIFE helps make forests more resilient are outlined in the boxes in this introduction. The work of specific projects is shown in more detail on the following pages.

Measures to prevent forest fires

Photo: LIFE12 ENV/ES/000730/Laura Fuentes

LIFE is demonstrating innovative approaches to prevent forest fires, such as 'fuel maps', modified tree compositions with fire-resistant varieties, and climate-adaptation felling.

Forest fires are expected to become more severe as a result of climate change. Addressing factors such as tree species composition, management practices, public awareness and the forest economy can help to prevent forest fires.

"The configuration of the landscape and the structure of the Mediterranean forest, with large amounts of combustible materials, gives rise to high-intensity, fast-moving fires that are hard for fire fighters to control, especially large forest fires, which spread from tree crown to tree crown with devastating effects," says Teresa Cervera, from the LIFE+ DEMORGEST project, which took place in Catalonia (Spain) from 2013-2017.

"It is essential to find tools capable of reducing the ability of large forest fires to spread, and preventing surface fires from turning into crown fires," she explains.

Catalonia began developing its ORGEST silvicultural models in 2004, as a means of sustainably managing forests and protecting them from large fires, while enabling them to continue to produce wood, cork, pine nuts and other goods. The resulting ORGEST guidelines are a set of benchmarks for forest management, for the various tree formations in the region. They can be used by forestry experts to optimise sustainable production and to create and maintain structures that are less susceptible to crown fire formation. More specifically, planned measures include the clearing of fire protection strips, and the planting of mixed stands of species with different fire-resilient features.

The LIFE+ DEMORGEST project (together with a complementary LIFE Nature project called Life+ Pinassa) provided an opportunity to put the models into practice. It applied them at landscape scale in two pilot areas with high fire risk: Aleppo pine forests in southern Catalonia and black pine forests in the pre-Pyrenees and Central Catalonia.

At stand scale, the project created a network of seven demonstration plots where 10 of the ORGEST models were tested. These plots were planted with a range of appropriate pine and oak species, e.g. Scots pine (*Pinus sylvestris*) and holm oak (*Quercus ilex*).

Specific actions included "selective treatments that allow part of the undergrowth and high tree cover to be maintained in a way that it is compatible with a production objective. This reduces both implementation and maintenance costs by facilitating control of the undergrowth without the need for new interventions," explains Ms Cervera.

Applying the ORGEST guidelines in areas at high risk "reduces forests' vulnerability to large forest fires. When they are applied at strategic points, they become more efficient and it makes it easier to put out fires," she says.

Multifunctional forest management

As well as calculating the reduction in fire risk from applying ORGEST models, the project assessed their contribution to other forest ecosystem functions and services, such as carbon storage, water use efficiency, and biodiversity. "This makes it possible to progress towards the design of truly multifunctional silviculture for Catalan forests, as well as tools for supporting its application," says Ms Cervera.

The project calculated that the investment needed to implement the forest fire prevention methods, in accordance with the ORGEST guidelines, can provide 2.5 times the invested amount in terms of ecosystem services. For example, the ORGEST models have an annual CO_2 absorption rate that is 60% higher than in non-management scenarios, while water use efficiency increases by up to 40%.

"Multifunctional forest management will be of key importance in a climate change context. At present, we know which ORGEST models, and which species, most increase the amount of carbon sequestered and the efficiency of water use[2]. Criteria have also been established for increasing biodiversity in managed forests. It is likewise essential to focus on the difficulties involved in regenerating pine forests, the management of mixed stands, and the role played by micro-stations," she says. Micro-stations account for micro-climate (e.g. wind, humidity), as small differences can be important in relation to climate change.

In addition to the demonstration plots, LIFE+ DEMORGEST created four martelo-scopes for training of forest workers. These are wooded stands covering around one hectare in which all the trees are numbered and measured and their locations identified. "These actions accelerated progress in the acquisition of knowledge and the practical application of the proposed forestry guidelines," says Ms Cervera. Training of forestry companies in new operating criteria started during the LIFE project.

In Catalonia, 58% of the forest management plans approved between January 2014 and June 2017 use the ORGEST silvicultural models. Over half of those have a combined production-prevention objective. "For the best locations, selection, retention and facilitation criteria have been introduced for the highest quality species or individuals. This leaves the door open for the future use of products with a higher added value, without compromising the profitability of current management," points out Ms Cervera. "In many cases, the application of the forestry models proposed in the ORGEST guidelines requires adaptation felling to be carried out. This should be seen as an investment to optimise a stand's yield."

Find out more
Website:http://cpf.gencat.cat/en/cpf_03_linies_actuacio/cpf_transferencia_coneixement/cpf_projectes_europeus/cpf_life_demorgest/

2. Water is used 40% more efficiently in forests that follow the ORGEST guidelines, and 60% more carbon is stored.


Photo: LIFE10 ENV/GR/000617/ArcFUEL Consortium

ArcFUEL: mapping 'forest fuel' to identify fire risks

Areas within forests have different degrees of fire risk. High and low risk areas can be identified from data on the amount of vegetation and its condition. For instance, in lower-risk forests the trees are well-spaced with high branches, undergrowth is relatively clear, and there are access roads nearby.

These types of variables are used to classify fire indicators such as 'forest fuel' volumes. Such fuel maps are ex-

Photo: LIFE10 ENV/GR/000617/ArcFUEL Consortium

tremely useful, but also costly to produce and update, since vegetation is not static and continues growing each year.

The Greek-led LIFE project ArcFUEL attracted teams from several Mediterranean countries to develop a common tool for creating high-definition and low-cost forest fuel maps for the whole of Greece and Portugal, and for pilot regions in Italy and Spain.

The first stage involved developing vegetation maps based on satellite (Landsat) imagery and ancillary data, such as topography or land use maps. This capitalised on research from the European Joint Research Centre (JRC) about fuel classification schemes for Europe's forest regions. The next stage was a detailed fieldwork survey, after which the project team established rules for creating a semi-automatic process of transforming vegetation maps into fuel maps.

"ArcFUEL provides a methodological 'plug-in' that feeds already available fire propagation models with up-to-date and accurate fuel maps contributing in a significant way to forest fire management, situation awareness and crisis management," explains project manager Marc Bonazountas. The maps help local authorities, firefighters, and foresters in their daily operations.

The end result is common systems that, in line with the EU's INSPIRE Directive on the standardisation of environmental data, could be "easily reused, visualised and exploited by any interested partner or community," says Professor Bonazountas.

The Greek Department of Forestry, of the Ministry of Environment, Energy and Climate Change, continues to use the fuel maps. Since the LIFE project ended, a team at the University of Thessaloniki, led by Professor Ioannis Gitas, has updated the maps to include data from the Copernicus satellites (see p.36). "Users trust maps from space more than those produced using conventional terrestrial methods," says Professor Bonazountas. "Copernicus data offers a powerful input to science and technology for environmental management, especially for forest fires."

Find out more:
Website: http://www.arcfuel-project.eu

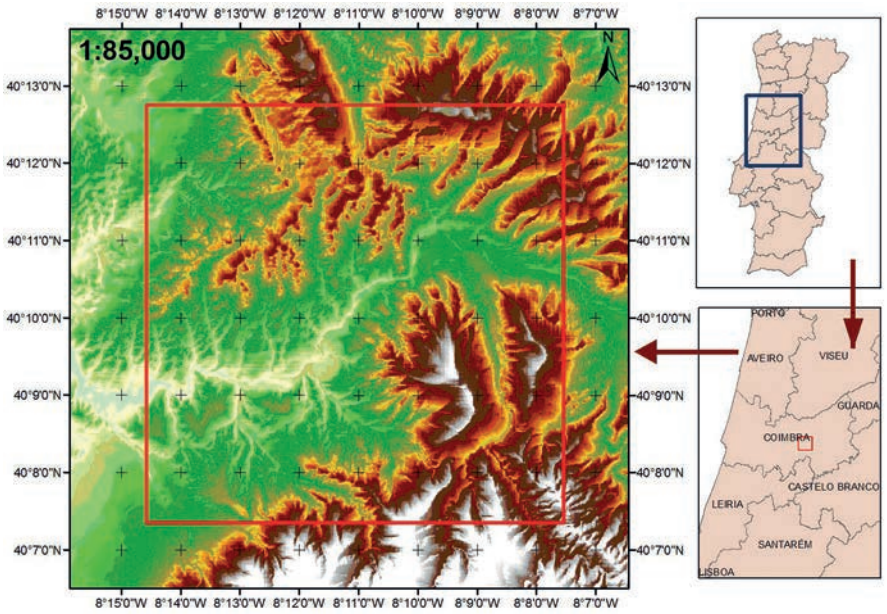


Photo: LIFE10 ENV/GR/000617/ArcFUEL Consortium

Monitoring and modelling improves resilience of forest ecosystems

Photo: LIFE13 ENV/PL/000048/K.Pilch

The LIFE programme supports forest monitoring and modelling with the aim of improving forest management to address climate change issues.

The Białowieża Forest is one of the largest remaining parts of a huge primeval forest that once stretched across the European Plain. Today, it covers an area of more than 140 000 ha in Poland and Belarus.

"Białowieża Forest is old, it's unique," says Krzysztof Stereńczak from the project LIFE+ ForBioSensing PL. "Many people think that the whole Polish part of the forest (c. 62 000 ha) is a protected area, which is not true. Most of it is managed forest and there are some rules that foresters need to follow. By observing processes in the natural or partly-natural forest we can understand something of what can happen in managed forests. This is practical knowledge."

Dr Stereńczak and his colleagues are using co-funding from LIFE to identify changes in forest structure and tree species composition within Białowieża Forest. "We are using remote-sensing data to provide the most accurate up-to-date information about the stands," he explains.

Using methods such as airborne laser scanning, LIFE+ ForBioSensing PL is generating a new baseline of maps and other key data, including growing stock, canopy cover, location of dead trees, in particular due to spruce decline, and the large-scale spatial distribution of forest stands. "Our aim is to provide data to the people who take care of the forest."

Knowledge of different climatic parameters can be used later in modelling and to understand the different factors influencing the forest's ecosystems. This in turn will help national park and forest district

managers implement relevant protection activities.

The level of detail the project is generating means, for instance, that it is able to map the progress of spruce decline down to single tree level (and there are 22 million trees in Białowieża Forest's top layer!). It has developed a method for classifying the number of dead trees, which has enabled it to provide information on the locations of dead spruce and advise on where action should be taken first. Also, because the project lasts seven years (ending in 2021), the project team is able to monitor forest dynamics over time. "From 2015 to 2018 we have a full map of changes: we can check the spread of spruce decline, the direction, and the cause. And with modelling we can forecast what would replace those old spruce stands. And this is a proxy for climate change," says Dr Stereńczak.

Regeneration after spruce decline

The project team used hemi-spherical images to create a model of light conditions under the canopy. "This is a proxy for regeneration – the micro-climate under the forest cover – so we can add that to our field-based inventory. It helps us understand what kind of species we can expect to grow back in those specific areas," he adds.

"What we can see in general is that when the first layer is dead, under we find mainly hornbeam, although in some places spruce is regenerating well. We have an issue with pine trees, which are disappearing from Białowieża Forest. In the past there were fires in the forest and there were open areas where the pine could grow. And now that the reserve is old, with oak, lime-tree and hornbeam stands, it's very dark there, so pine does not regenerate," explains Dr Stereńczak.

Putting data into action

"We are giving stakeholders very precise and objective information. They really have data for making decisions in the future," says Dr Stereńczak. "For instance, the Białowieża National Park took most of our data and is using [it] to manage bison and lynx populations."

The project has already signed close to 60 agreements to share its results with statutory authorities, universities and so on. "We honour the idea of open data for everyone and make it available to all stakeholders – for free."

The work of LIFE+ ForBioSensing PL has generated huge interest from the scientific community and ecologists. "We have a unique dataset. There's no other like it in the world. It makes it possible to do very detailed studies of forest ecology, climate change and so on. After five years of intensive monitoring we are already recording some changes due to climate change," concludes Dr Stereńczak. "We can see for which species climate change has a positive result and for which there is a negative response. Spruce is obvious; it's negative. We can think about the future and implement some practical rules for the future composition of the stands in the managed forests."

Find out more
Website: http://www.forbiosensing.pl/

Italy's biodiverse beech forest ecosystems

There are around 15 million hectares of beech forests in Europe, with the majority found in mountainous areas of central and southern Europe (the species lives from sea level up to altitudes of 1 800 m). The most biodiverse beech forests in the EU are found in the Apennine mountains of central and southern Italy.

"Apennine beech forests are often in the highest forested belt on the mountains. Climate change is pushing other tree species up towards the tree line. The effect on Mediterranean beech forests is to reduce their room to grow and their growth rate," says Ugo Chiavetta of Italy's Council for Agricultural Research and Economics.

Dr Chiavetta is leading LIFE AFORCLIMATE, a project that is creating a detailed forecast model and monitoring forests to assess the impact of climatic factors on beech ecosystems.

"Currently, forest management planning does not incorporate climate change adaptation into the relevant variables to be considered," he explains. LIFE AFORCLIMATE's decision-support system, which incorporates climatic factors among its considered variables in forest management planning, will enable forest managers to determine the optimum moment for silvicultural treatments to take place in terms of regeneration capacity, production capacity and biodiversity.

"It can help to improve the resilience of the whole ecosystem," says Dr Chiavetta. The beta version of the tool is already in use. "We have shown that using the Copernicus programme's Sentinel-1 satellites it is possible to monitor the cycles of beech forests with six-day precision."

Find out more
Website: https://www.aforclimate.eu/it/

Reducing the risk of habitat loss from forest fires

A LIFE project is protecting cedar habitats at risk from climate change, especially more frequent forest fires, in Cyprus by introducing new forest management practices.

Forests in the Mediterranean region have become more at risk of fire in recent decades as temperatures have increased and fire seasons become longer. This is a significant threat to rarer habitat types and species, such as Cyprus cedar (*Cedrus brevifolia*) which is endemic to Cyprus.

The LIFE-KEDROS project carried out a series of protection measures to maintain the good conservation status of Cyprus cedar habitat in the Koilada Kedron-Kampos Natura 2000 site. It took action to enhance the habitat's resilience and capacity to adapt to climate change, introducing several forest management measures for the first time in Cyprus.

The Cyprus cedar habitat occurs in scattered stands covering just 264 ha of the Natura 2000 network site within Paphos State Forest in the Troodos Mountains. The habitat's reduced distribution makes it extremely vulnerable to ecosystem changes and impacts, according to project manager Andreas Christou from the Department of Forests, of the Ministry of Agriculture, Rural Development and Environment of Cyprus.

"As well as forest fires, Cyprus cedar is under threat from dieback due to periodic droughts, increasingly frequent insect attacks, damage from extreme weather conditions and intensive competition from the pine tree species *Pinus brutia*," he says.

Silvicultural interventions were carried out for the first time in the Natura 2000 site, creating favourable ecological conditions for growth by controlling competing vegetation and reducing competition between mature and young cedar trees. Other restoration measures focused on increasing stand density and expanding the Cyprus cedar habitat at its margins. Restoration of 12 ha of degraded habitat and the closure of 10 km of forest roads led to improved habitat connectivity and stability.

A seed bank was used to ensure that enough seeds are available for reforestation when natural stands are seriously affected by forest fire or disease. Furthermore, Dr Christou says: "The establishment and maintenance of a new Cyprus cedar stand outside its natural area enhances the possibilities for the habitat's preservation in case of severe impacts due to climate change."

Combating fire risks

To minimise the threat posed by forest fires, the project designed and applied both fire prevention and pre-suppression measures. These included constructing two 90-tonne water tanks and improving site access to enable firefighters to respond faster and more effectively. It established patrols throughout the fire season and installed information boards and warning signs, restricting access to unauthorised individuals. Furthermore, controlled grazing by domestic and wild animals was encouraged to reduce the amount of flammable vegetation on the ground, while dry herbaceous vegetation was removed along roads to the south of the site, which can also serve as fire breaks.

"The project demonstrates how to effectively plan, implement, evaluate and test new management approaches in the national context that can be replicated in other areas in Cyprus, but also in other Mediterranean coniferous forests that extend over only a limited area," concludes Dr Christou.

Find out more
Website: http://www.life-kedros.eu/

Protecting ecosystem services

Forests provide many important ecosystem services. LIFE projects are aiming to maintain these services even under the effects of climate change, by making forests more resilient.

Forests provide numerous ecosystem services, including carbon storage, water retention to reduce flood risk, preventing erosion and landslides, maintaining biodiversity, purifying water, and providing wood for homes, furniture and heating. They also play an important role in human health and provide opportunities for recreation.

Such essentials of living are threatened by the impact of climate change. Many LIFE projects have taken action to protect forest ecosystem services. In Austria, for instance, a project in the Ausseerland region is improving the structural diversity of forests in Natura 2000 sites and making 'ecological corridors' for forest species.

"The forests of the Styrian Dachsteinplateau and Totes Gebirge Natura 2000 sites provide protection against erosion, avalanches and rock falls. They filter the water and, just like bogs, they have a buffer effect during heavy rainfall. They provide habitats for lots of forest species and are frequently used by locals as well as tourists for recreation. As these forests are owned by the Austrian Federal Forest Corporation, they produce wood in a sustainable way," says Anna-Sophie Pirtscher, who is leading the LIFE Ausseerland project on behalf of the corporation.

"Our large forest areas have lately suffered from windthrows, longer and hotter summers, and bark beetle outbreaks," explains

Photo: LIFE12 NAT/AT/000321/NEEMO EEIG/Cornelia Schmitz

Ms Pirtscher. "In the karst mountainous areas, fewer standing trees mean a higher risk of erosion, less water buffering and filtration, and the loss of habitats for protected forest species. So, with the LIFE project, measures were taken to prepare the forests for climate change and to strengthen their resilience," she says.

Natural rejuvenation

The team focused first on natural rejuvenation. Where afforestation was needed, they planted larch, stone pine and deciduous trees alongside existing spruce trees. "We tried to create diversity in the forest stands," notes Ms Pirtscher. "Where possible, we left deadwood standing or lying. More deadwood supports woodpeckers and other predators of bark beetles and it keeps the ground fertile. The goal was about 35 solid cubic metres of deadwood per hectare, which we reached." The project has already enhanced the structural diversity of more than 2600 ha of formerly spruce-dominated forests.

Spruce trees were stripped of bark to prevent the spread of bark beetles. The project also kept small patches of meadows and adapted 560 ha of forest areas as "stepping stone habitats" for capercaillie. A further 261 ha of different but closely linked habitat types were developed into a 'biotope network' of freshwater habitats, peatlands, forests and meadows. These restored ecosystems have been integrated into the Natura 2000 network.

Effects on ecosystem services

"It is hard to measure the effects of forest management actions within the life span of a LIFE project," cautions Ms Pirtscher. Nevertheless, she is confident that LIFE Ausseerland is having a "positive" and "sustainable" effect on ecosystem services within the project areas: "forest stands have been optimised, but their area has stayed the same. The condition of other species and plants has improved because there is more forest structure and dead wood."

Due to improved quality and connectivity of habitats the number of capercaillie has increased, she says. Annual counts of the number of display places (leks) and number of males in Ausseerland gradually increased from 1998 to 2015, from 54 to 62 display places and 118 to 154 males.

One of the project's key lessons for others is "to focus on the whole forest ecosystem, especially when the aim is to have more diversity of tree species. The management of game should be included in adaptation strategies," she concludes.

DID YOU KNOW

Dead wood supports woodpeckers and other predators of bark beetles and it keeps the ground fertile.

Find out more

Website: https://www.bundesforste.at/natur-erlebnis/life-projekt-ausseerland.html

Photo: LIFE12 NAT/AT/000321/F. Pritz

LIFE ADAPTAMED: adapting to climate change in protected Mediterranean forests

"Promoting adaptation to climate change means fostering the capacity of ecosystems to self-organise," says Francisco Javier Cano-Manuel León, project director of LIFE ADAPTAMED. This Spanish project is working to increase resilience to climate change impacts in three representative Mediterranean protected areas of socio-economic importance: the Doñana wetlands, the high mountain range of Sierra Nevada, and the sub-desert coastal area, Cabo de Gata, all in Andalusia.

"The sites are very diverse, and the ecosystem services that they provide are also extremely diverse," explains the project director. These include:

- soil retention;
- water provision/regulation;
- carbon storage;
- oxygen production;
- temperature regulation;
- pollination/seed dispersal;
- recreation; and
- nature tourism.

"The main effects of climate change in Andalusia are an increase in temperatures, a decrease in rainfall in many areas, and a higher frequency of extreme weather events, including prolonged droughts. Given these effects, the ecosystems targeted in the project, according to their current structure, are very vulnerable to processes of forest decay, pests and fires," notes Mr Cano-Manuel León.

LIFE ADAPTAMED is introducing "adaptive management", based on proactive action plans. This involves optimising the density of forests, so that the trees have enough water, light and nutrients, taking into account predicted future climatic conditions. This will improve tree health and "facilitate the natural entry of seeds of other plant species," he says. "The resulting forest will be able to evolve towards a more diverse mixed forest ecosystem with a greater capacity to act as a reservoir of biodiversity, where plants of different ages, types and species coexist. A more heterogeneous forest will provide a greater variety and quality of ecosystem services."

MEASURING THE IMPACT OF ADAPTIVE MANAGEMENT

The project is analysing images from the Modis, LandSat and Sentinel-2 satellites to infer indices directly related to the capacity of the project areas to provide ecosystem services. The ecosystem functions it is measuring are carbon gain (primary production), vegetation structure-related functions, water regulation, and energy balance (albedo/surface temperature).

This landscape-scale analysis is complemented by "field-scale monitoring, based on specific indicators, such as pollinators, seed dispersal, soil composition, vegetation structure and so on," explains Mr Cano-Manuel León.

"We expect to increase diversity and spatial heterogeneity, to reduce water uptake and to improve the presence of key ecosystem species such as pollinators, seed dispersers and natural predators of pests. That will increase soil fertility, carbon storage and resilience, and will reduce pest outbreaks, fires and forest decay phenomena," he adds.

The project team is summarising the lessons of its work in technical manuals for managers of protected areas and commercial forests, and for scientific researchers. "Many problems that involve climate change adaptation must be faced through teamwork among multidisciplinary teams. Adaptive management procedures give the opportunity to work together and to combine efforts," says Mr Cano-Manuel León.

Just as significantly, LIFE ADAPTAMED is pushing for a new approach to site management. "We want to highlight the functions that support the rich biodiversity in the protected areas of southern Europe," he concludes.

Find out more
Website: https://www.lifeadaptamed.eu

A tool for long-term adaptation where three climate zones meet

A LIFE project has created a smartphone app to help forest managers in a French nature park develop a climate change adaptation strategy that builds ecosystem resilience and boosts the local economy.

Located on the southern limit of the Massif Central in France, the Haut-Languedoc Regional Nature Park is a meeting point for the Mediterranean, Atlantic and Alpine climates. Two-thirds of the park area is forested. Climate-related extreme weather events, such as the droughts of 2003 and 2006 that caused significant dieback in conifer plantations, can have a large impact on local economies.

Therefore, "local forest owners, forest managers and elected representatives are looking for tools to help them to adapt their forests to climate change," says LIFE FORECCAsT project coordinator Juliane Casquet, from the Haut-Languedoc Regional Nature Park.

The LIFE FORECCAsT project responded to this demand by creating a tool to support decision-making for forest management, which takes into consideration and anticipates a range of climate change scenarios. The tool, a mobile phone app called 'FORECCAsT by BioClimSol', performs a complete diagnosis of existing forest stand and reforestation works. It combines both field data collected by the user (location, forest characteristics, soil characteristics and sanitary problems) and georeferenced data collected by the project (topographic data, current and future climate data).

Such information is then analysed using the BioClimSol method developed by the project partner, National Centre for Forest Ownership (CNPF). This consists of a reforestation module to help with species selection, and a forest stand module to provide guidance on treatments. "The project analysis provides the basis for suggested management strategies that are adapted to their local context, the current climate, and the climate to come," Ms Casquet explains.

The app is designed for use by forest managers, as well as trained forest owners and local elected representatives. It will be available for free for the park from the second half of 2019, and for elsewhere in France from 2020. "We want these forests to become better adapted to climate change, to be more resilient and to keep providing their ecosystem services despite the changes in their environment," she says.

Demonstration sites

Additionally, the project is creating a network of 24 field test sites that comprise existing forest stands and reforestation areas. At these sites, the project team is testing a range of forest management procedures and tree species that are considered better adapted to climate change. Procedures include planting mixed forest stands, reducing tree density to lower water consumption, mitigating risks, encouraging natural regeneration to create mixed-aged stands, and enrichment planting with desired tree species. These sites, which will be monitored in the long term, will be used to demonstrate ways of adapting forests to a changing climate.

The project results will be replicable outside France, and the app and other tools can be readily transposed to other contexts. To disseminate its approach, for example, the project is holding an international symposium in November 2019 for other projects in Europe that are developing methods, models and tools to adapt forests to climate change.

Find out more
Website: http://www.foreccast.eu

Adapting forest policies

LIFE projects contribute to the development and implementation of legislative standards for forest management in support of climate adaptation policy, including indicators for resilience.

In Catalonia, the LIFE MixForChange project is transferring the results of trials on silvicultural techniques into management tools to safeguard sub-humid Mediterranean forests. The region has around 10% of the approximately 1.5 million hectares of this forest type in Europe.

"We are designing and implementing innovative forest management models across 164 ha in Mediterranean sub-humid conditions in Catalonia, particularly in mixed forests dominated by sweet chestnut (*Castanea sativa*) and oak and pine species," explain project coordinators Jaime Coello and Míriam Piqué, of the Forest Sciences Centre of Catalonia.

The models incorporate aspects of close-to-nature forestry with a particular focus on individual trees or small tree groups. These interventions include:

- selective clearing of undergrowth;
- tree marking;
- thinning and felling;
- pruning; and
- enrichment planting.

They also include the main principles of climate change adaptation for silviculture: an anticipatory, integrative, local-scale and flexible management, working with natural processes, supporting increased complexity and enhancing vitality. In practice, this means maintaining a forest micro-climate to reduce the development of the undergrowth, encouraging the presence of more species and functional groups, and promoting the most vigorous trees.

Positive response

At the mid-point of the project in 2019, things are progressing well. "In general, the management principles are very positively perceived: the forest owners have agreed on the management implemented, the workers have understood the technical aspects of implementation, and potential users have indicated their interest in replicating these methods in other areas," confirm Mr Coello and Dr Piqué. "The public administration is also interested in the replication of these forest management models and is already integrating them into forest policy related to climate change adaptation."

The project has also produced a protocol for the identification and assessment of standing timber value, and vulnerability maps for the forests with regard to water scarcity and forest fires.

"We expect to increase the resilience to climate change impacts of these forests and to improve forest management in Mediterranean sub-humid conditions, with an increase in stand persistence, biodiversity indicators and added-value forest products," they conclude. "The silvicultural models proposed are highly transferable to all sub-humid Mediterranean forests in Europe."

Find out more
Website: http://www.mixforchange.eu/

Putting agroforestry to the test

LIFE has co-funded projects showing how agroforestry theories can be put into practice, using cover crops and other techniques that contribute to climate change adaptation strategies.

Photo: LIFE11 ENV/ES/000535/Jose Luis Marcos Robles

Agroforestry involves growing trees or shrubs in and around crops or pastureland. It has been shown to increase biodiversity, reduce erosion, slow water run-off and enhance productivity and resilience. It is therefore a potential tool in the farmer's climate change adaptation toolbox.

Sustainable agroforestry in semi-arid Spain

Under the leadership of the University of Valladolid, between 2012 and 2017, the LIFE project OPERATION CO_2 sought to evaluate the feasibility of increasing carbon sequestration in Europe through sustainable forestry and agroforestry management actions.

The agroforestry part of the project took place on two pilot plots of 25 ha. One was located at Ayoó de Vidriales in Castille and Leon, the other at San Mateo de Gállego in Aragon. "The chosen areas share diverse environmental issues such as soil compaction, erosion, drought, fire risk and desertification," notes technical manager Salvador Hernández Navarro, of the University of Valladolid.

The communally-owned Ayoó de Vidriales fields had been left uncultivated for over 15 years, leading to soil degradation and increasing the risk of wildfires. The land in San Mateo de Gállego, part of the semi-arid Los Monegros area, "has typically grown low-yield cereals on a biannual rotation cycle of wheat and barley, followed by a year of fallow land," he says.

The OPERATION CO_2 project team drew up agroforestry plans for the pilot sites. These were "based on the specific characteristics of the designated areas and a variety of species was selected to cover a wide range of uses, for example, wood, biomass, fruit

Photo: LIFE11 ENV/ES/000535/Jose Luis Marcos Robles

trees, aromatic herbs, border protection and annual crops, amongst others," explains Professor Hernández.

Trees and crops were treated with mycorrhizal fungi, which increase root capacity and allow the plant to adapt better to periods of drought. Each plot was sub-divided into three zones, in order to compare the effects of different mycorrhizal treatments: 100% treatment; 50% treatment; and no treatment (control zone).

In the first year of the project, soil was decompacted by means of vertical ploughing, crops were sown on cultivation ridges, and the soil was injected with a product based on mycorrhizal spores, beneficial bacteria and humus. In the second year, the project planted approximately 3000 trees and bushes according to the agreed agroforestry plan. Species planted included sweet chestnut (*Castanea sativa*), almond (*Prunus dulcis*), maritime pine (*Pinus pinaster*), and cork oak (*Quercus suber*).

In order to encourage the growth of mushrooms and truffles with commercial value, "some of the trees were inoculated with ectomycorrhizas, for example, cork oaks with *Pisolithus tinctorius*," says Professor Hernández.

"Cereal and/or legume crops were sown between the forestry rows, in order to sustainably manage the soil. The use of mouldboard ploughs was strictly avoided along with any tilling that could damage the mycelium of the mycorrhizae," he explains.

What were the results?

To assess the impact of the agroforestry trials, the project measured indicators of biomass, carbon content and biodiversity, annual yield, tree survival rates and the effect of mycorrhizal treatments.

Results showed that annual crop yields were significantly higher in the plots with the higher percentages of mycorrhizal treatment. For instance, in 2015, the barley yield at San Mateo in the zone with 100% treatment was nearly double that of the control zone. More and deeper crop roots also improved the soil's water retention capacity. Survival rates of trees varied from 79-97%, depending on the species, with, for instance, almost all almond trees surviving in Ayoó de Vidriales.

Injecting trees with ectomycorrhizas encouraged the spread of alternative crops with a high added value. Lactarius (milkcap) and Boletus (penny bun) mushrooms were found below trees in Ayoó de Vidriales, while truffles were present next to holm and kermes oaks in San Mateo de Gállego.

Levels of species richness and species abundance increased significantly thanks to the project's actions. "At San Mateo de Gállego, the increase of biodiversity on the LIFE project plot in respect of surrounding plots was spectacular," says Professor Hernández. The agroforestry systems also increased resistance to pests and diseases. Phytosanitary control is being substituted for biological control thanks to the increase in auxiliary fauna. Predators and parasites of insect crop pests, specifically aphids, live on the cover crops and help keep these pests under control. This directly benefited the landowner who reported a reduction in input costs and time spent treating the land.

Carbon analysis of the project's agricultural parcels suggests that implementing agroforestry will enable these areas to serve as a long-term carbon sink. In particular, in the previously abandoned fields of Ayoó de Vidriales, a 30.5% decrease in soil carbon was avoided.

Find out more
Website: http://operacionco2.com/

Photo: LIFE11 ENV/ES/000535/Jose Luis Marcos Robles

FARM LIFE: protecting farms from floods

FARM LIFE, which started in September 2018, is a LIFE project led by Van Hall Larenstein, University of Applied Sciences, in the Netherlands. The country's Noord-Brabant province has been particularly affected by warmer and wetter weather in recent decades, leading to a loss of biodiversity and an increased risk of flooding. Some of the farmers participating in the project will be using agroforestry to protect their livelihoods from floods and other climate change impacts.

Euridice Leyequién, a professor of forested landscapes, is the project manager for FARM LIFE. "Resilient agroforestry systems provide different mechanisms that can enhance the use of available water more effectively than monocultures and thus increase agro-ecosystem resilience against, for example, droughts and heatwaves," she says. "They contribute to water recycling and encourage changes to the farm micro-climate that reduce the evaporative demand and make more water available for transpiration."

Annual crops benefit from the presence of trees that have the ability to retain off-season rainfall and residual soil water after the cropping period. "Extending the possibility of soil moisture uptake makes soil resource utilisation more efficient than in pure monocultures," says Professor Leyequién. "The shading effects of trees can buffer temperature and reduce exposure to supra-optimal temperatures, under which physiological and developmental processes and yield become increasingly vulnerable," she adds.

"By changing land management, resilient agroforestry systems should also help prevent soil and nutrient loss and create new habitats to improve biodiversity." Numbers of some indicator species, including pollinating insects, are expected to increase by up to one-third on the FARM LIFE pilot plots.

FARMING THE FUTURE

"The project is developing inclusive sustainable rural networks in which farmers and relevant stakeholders can learn together how to transition from a landscape with conventional monoculture systems to a climate-resilient landscape with diversified agricultural production systems, i.e. agroforestry," explains Professor Leyequién.

These stakeholders include farmers' associations, entrepreneurs, knowledge institutes, government ministries, and social partners. The FARM LIFE strategy is to encourage them "to self-organise in resilient networks that can last beyond the project timeframe," she adds.

Outcomes of the project will include:

- knowledge-sharing (massive open online courses – MOOCs – and a Master's curriculum);
- farmer-driven business networks along sustainable agricultural value chains;
- tools for value creation and to make agroforestry food products more competitive; and
- tools for the development of adaptive farm plans that can be contextualised into different conditions.

"FARM LIFE is building a transition toolkit that will enable farmers, policymakers and societal partners to effectively implement the agricultural transition towards climate adaptive agroforestry," says Professor Leyequién.

She believes that the project can contribute to the successful upscaling of agroforestry in the Netherlands, Belgium and other European countries, by creating an environment in which the relevant stakeholders can "exchange practical knowledge and tools that can directly facilitate the transition from conventional monocultures to climate-resilient agroforestry."

Find out more
Website: http://farm-life.eu/

Farmlife
Farming the future

Protecting forests against ozone

A LIFE project is monitoring tree damage caused by ozone pollution, which increases in severity with rising temperatures, to develop adaptive forestry management practices.

By impairing vegetation growth and therefore an ecosystem's ability to sequester carbon, ozone (O_3) has a direct impact on how plants respond to climate change. The LIFE MOTTLES project redefined the way critical ozone levels are monitored to help forest managers adapt practices to better protect the vital mitigation role played by forests.

Ozone is currently the most toxic air pollutant for trees. When the pores on leaves (stomata) take in carbon dioxide (CO_2) they also take in ozone. Once inside the leaf, ozone causes considerable damage by oxidising (burning) plant tissue. However, plants differ in their sensitivity to ozone, "so the previous criteria of protection, established on the basis of how much ozone is in the air, is not effective," explains the project leader Elena Paoletti of the Italian National Research Council (CNR).

The project established a network of monitoring stations in three countries in different biogeographical zones – Italy, France and Romania – to compare the impact of ozone uptake on different ecosystems. "Ozone is inducing specific visible injury to the leaves and we are training specialists to recognise and define those visible injuries," says Dr Paoletti. Other measurable impacts include defoliation of the crown and reduced radial growth of stems. By comparing how ozone concentrations in the air affect these indicators, the project is able to establish critical levels. "If it is below the critical level it is not injurious, but if it's over you have to reduce that stress factor because the ecosystem is being damaged," she says.

Photo: LIFE10 ENV/FR/000208

Regulation compliance

The project is already changing the way ozone is monitored. The revised EU National Emission Ceilings Directive of 2016 listed stomata uptake of ozone as a parameter for evaluating the impact of ozone on ecosystems. The project is therefore engaging with national authorities to promote the use of its monitoring activities as a way of complying with the new reporting requirements the Directive introduces, which includes annual information on emissions for a number of pollutants. Previously, thresholds were set for the emission of a pollutant, but now Member States are required to monitor the impacts.

Rising temperatures lead to higher levels of ozone, but levels have stabilised in Europe and North America thanks to air pollution countermeasures. However, ozone pollution can transfer from one continent to another, and moreover extreme weather events such as droughts as a result of climate change can close stomata, reducing the growth of trees but also reducing the negative impact of ozone. "Evaluating the impact of ozone in a changing climate is complex," emphasises Dr Paoletti.

At the project sites, a range of management practices were demonstrated to establish criteria for determining the most effective for different forest types. For example, a very dense forest is likely to be subject to water stress, due to competition between the trees, which protects them from ozone while also restricting damage to the outer canopy. "We help forest managers with suggestions on how to cultivate effective and healthy forests in ozone-polluted areas," she says.

The project also determined the tree species that are best for planting in an urban context. It highlights that beech and ash provide a good balance of uptake and production of ozone, while willow ranks poorly in this criterion.

Find out more
Website: http://mottles.ipsp.cnr.it/

Changes in tree species composition

Climate change is expected to alter the composition of tree species in many forests, so LIFE is supporting research to maintain forest ecosystem services.

The composition of forest trees can change in response to climate change. Adaptive forest management can anticipate and support this process, for example, by promoting species with drought- or pest-resistance.

The regional Ministry of Agriculture, Livestock, Fisheries and Sustainable Development of Andalusia, for instance, is leading a project called LIFE ADAPTAMED. This is using an ecosystem approach to develop, implement, monitor, evaluate and disseminate adaptive management measures in three representative Mediterranean national protected areas of socio-economic importance.

"LIFE ADAPTAMED is very broad and involves actions on different types of forests, on formations of jujube tree, on pre-desert shrubs and on high mountain shrub ecosystems," says project director Francisco Javier Cano-Manuel León, of the regional Ministry of Environment and Spatial Planning of Andalusia.

The project's actions to improve tree species composition include thinning of pine plantations and various different management alternatives for the forest residues. "This promotes a more efficient use of resources in these environments, giving the forest a greater capacity to withstand drought processes and an increase in temperature," he explains. It will make the forest more heterogeneous and promote diversified biological communities.

In Pyrenean oak and holm oak mountain forests, LIFE ADAPTAMED has been testing out various silvicultural treatments to strengthen resilience to pests. "This involves selecting certain specimens to function as parent trees and performing actions on them to favour their sexual reproduction," says Mr Cano-Manuel León. "The treatments are focused on forests of unsuitable structure (coppice), where an excessive density does not allow a suitable vegetative vigour and hampers sexual reproduction due to the excess of competition for water, light and nutrients. That makes the trees very vulnerable to pests."

Heterogeneous forests

The natural regeneration of Mediterranean cork oak forests is often compromised by the presence of cattle and wild ungulates. To reduce this pressure, the LIFE ADAPTAMED team is controlling the impact of herbivores on vegetation and increasing the density of cork oaks and other species typical of the Mediterranean forest, such as lentisk and wild olive trees.

"The premise is that a more heterogeneous forest, in terms of structure (restoration of ecological niches) and specific diversity, with optimal densities of trees and noble thickets and a better phytosanitary status, will provide a greater variety and quality of ecosystem services," explains Mr Cano-Manuel León. These include cork, honey, aromatic plants and pastures, as well as indirect services such as soil retention, water regulation and landscape values. Biodiversity will also benefit, including prey species for the Iberian lynx and Iberian imperial eagle, pollinators and seed dispersers.

"We are currently working on some technical manuals that summarise our learnings and can be used by managers of other protected and non-protected [forest] areas. It would be interesting if adaptive management become the usual procedure for designing and executing management actions," says Mr Cano-Manuel León.

Find out more
Website: https://www.lifeadaptamed.eu

LIFE project references

***A number of LIFE publications are available on the LIFE website**: http://ec.europa.eu/environment/life/publications/lifepublications/index.htm*
Printed copies of certain LIFE publications can be ordered free of charge at:
http://ec.europa.eu/environment/life/publications/order.htm

LIFE "L'Instrument Financier pour l'Environnement" / The financial instrument for the environment

The LIFE programme is the EU's funding instrument for the environment and climate action

Period covered 2014-2020

EU funding available approximately €3.46 billion

Allocation of funds

Of the €3.46 billion allocated to LIFE, €2.59 billion are for the Environment sub-programme, and €0.86 billion are for the Climate Action sub-programme. At least €2.8 billion (81% of the total budget) are earmarked for LIFE projects financed through action grants or innovative financial instruments. About €0.7 billion will go to integrated projects. At least 55% of the budgetary resources allocated to projects supported through action grants under the sub-programme for Environment will be used for projects supporting the conservation of nature and biodiversity. A maximum of €0.62 billion will be used directly by DG Environment and DG Climate Action for policy development and operating grants.

Types of projects

Action Grants for the Environment and Climate Action sub-programmes are available for the following:

- "Traditional" projects – these may be best-practice, demonstration, pilot or information, awareness and dissemination projects in any of the following priority areas: LIFE Nature & Biodiversity; LIFE Environment & Resource Efficiency; LIFE Environmental Governance & Information; LIFE Climate Change Mitigation; LIFE Climate Change Adaptation; LIFE Climate Governance and Information.
- Preparatory projects – these address specific needs for the development and implementation of Union environmental or climate policy and legislation.
- Integrated projects – these implement on a large territorial scale environmental or climate plans or strategies required by specific Union environmental or climate legislation.
- Technical assistance projects – these provide financial support to help applicants prepare integrated projects.
- Capacity building projects – these provide financial support to activities required to build the capacity of Member States, including LIFE national or regional contact points, with a view to enabling Member States to participate more effectively in the LIFE programme.

Further information

More information on LIFE is available at http://ec.europa.eu/life.

How to apply for LIFE funding

The European Commission organises annual calls for proposals.
Full details are available at http://ec.europa.eu/environment/life/funding/life.htm

Contact

European Commission – Directorate-General for the Environment – B-1049 Brussels (env-life@ec.europa.eu).
European Commission – Directorate-General for Climate Action – B-1049 Brussels (clima-life@ec.europa.eu).
European Commission – EASME – B-1049 Brussels (easme-life@ec.europa.eu).

Internet http://ec.europa.eu/life, www.facebook.com/LIFE.programme, twitter.com/lifeprogramme

LIFE Publication / Ready, steady, green! LIFE helps farming and forestry adapt to climate change

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