MARCH 2025

MY PLANET

by The Navigator Company

From forest...

...to future


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FROM FOSSIL TO FOREST
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80 g/m²
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"The *Eucalyptus* Forum was an invitation to build bridges and to look at the future of forests with objectivity"

António Redondo, CEO of The Navigator Company, reflects on the challenges and opportunities facing the forestry sector in Portugal, stressing the importance of the *Eucalyptus* Forum as a landmark achievement in the debate and in sharing expertise.

The *Eucalyptus* Forum has proved uniquely successful in promoting dialogue about the role of the species in Portugal. What was the main aim of the initiative, and why now?

The *Eucalyptus* Forum grew out of the pressing need to address the different perceptions that exist concerning eucalyptus forests in Portugal, and to do so transparently and on the basis of scientific fact. The species has been a central pillar of the Portuguese economy and our society, but is often the target of criticisms based on information that is either outdated, or else not based on any scientific or technical knowledge.

Our main aim has been to create a space for open dialogue, involving a range of stakeholders. We are keen to continue promoting informed and collaborative discussion, based on scientific evidence, about the role of eucalyptus and planted forests in Portugal, in line with Navigator's purpose of sharing its knowledge and resources as we work towards a better future.

We know that planted eucalyptus forests are essential in the transition to a sustainable bioeconomy, that brings value for people and the planet, helping us to decarbonise, create jobs and bring development to rural areas. There's no time to lose - if we want to exploit their full potential, society needs to understand the real benefits of planted eucalyptus forests and clear up its unfounded misconceptions on the matter.

Society needs to understand the real benefits of planted eucalyptus forests and to rid itself of unscientific misconceptions.

So the *Eucalyptus* Forum was an invitation to build bridges and to look at the future of forests with objectivity. To foster understanding and encourage an objective and informed view, at a time when the global context of climate variability has brought us back to nature in our search for solutions.

How do you assess the Forum's impact and how does Navigator plan to apply what it has learned?

The *Eucalyptus* Forum was extremely productive and a very significant achievement. In the first place, we succeeded in bringing together a vast number of experts and stakeholders who contributed a variety of perspectives, which was very useful. More than 120 individuals took part, from sectors as varied

Eucalyptus is often linked to forest fires in Portugal. How do you reply to these criticisms?

The link between eucalyptus and fires is a myth that is hard to eradicate. Sadly, this is a widely held belief. It is fundamental to explain that the risk of fire is related essentially to three factors: the climate (low humidity in the air and soil, high temperatures and wind), accumulation of fine fuels on the land, and behavioural factors (accidental ignitions, negligence and even arson). In other words, the risk is related to a lack of management and abandoned land, where huge quantities of fine fuels accumulate. It is also related to land use planning, which permits housing and even industrial estates in the middle of forested areas, and vice versa. Lastly, it is related to climatic conditions and ignitions. Ample scientific research and practical experience have shown that well managed forests, irrespective of species, present a much lower fire risk, even when the climatic conditions are adverse and ignitions occur.

The numbers also bear this out: between 2000 and 2024, approximately 24% of the burned area in Portugal corresponded to scrubland and pasture. Over the same period, eucalyptus accounted for 18% of the burned area, of which it is estimated that 16% occurred on land owned by private growers (typically not managed) and only 2% in plantations managed by the industry.

At Navigator, we implement rigorous forestry management plans which include specific fire prevention measures. These include creating fuel management strips, maintaining paths and fire breaks, continuous monitoring of forest conditions and training specialist teams in prevention and firefighting. We also work to bring diversity into the forestry landscape, integrating trees of different ages and species, which helps to make forests more resilient to fires.

In addition to working on the properties we manage ourselves, we are also committed to sharing expertise with our partners in the forestry, value chain. In 2024, we invested 228 M€ in several districts of Portugal, as part of our Forestry Development strategy, through programmes designed to improve forestry practices, making the land more productive and also more resilient to risk factors.

We also invest in cutting edge technology for monitoring and early detection of fires, such as remote surveillance systems and analysis of meteorological data. We work closely with the authorities, fire brigades and local communities, in order to coordinate efforts and share knowledge.

I cannot stress enough that unmanaged, abandoned land and a depopulated countryside are factors that significantly increase the fire risk. Without maintenance work, large quantities of combustible matter accumulates on the land, enabling fires to spread. So the solution is to promote active land and forestry management, and not to stigmatise a species which, when properly managed, can help prevent fires. ●

as academe and research, local authorities, NGOs, associations of forestry producers, industry professionals and media experts. Most significantly, 70 specialists on an Editorial Board external to Navigator, and a Scientific Council comprising leading academics with experience centred on forestry and the environment. This enabled us to expand our understanding of the challenges and opportunities associated with eucalyptus forests in Portugal.

One of the most important outputs was the drafting of five thematic modules addressing eucalyptus forests from different angles: from the historical, sociological and regulatory background of the forestry sector, the environmental impacts on the soil, water and biodiversity, through to questions relating to regional planning, climate change and fires. We also explored the role of eucalyptus as a driving force for innovation and its contribution to the bioeconomy. We identified critical factors for the public's acceptance of the species, such as the need for better communication of the benefits of planted forests and the urgent need to include this topic in the school syllabus.

The highest standards were applied for the information gathered, guaranteed by an independent Scientific Council which coordinated the proceedings, and the findings will now be compiled in two books: one a scientific publication, and the other aimed at the general public, applying the same high standards, but using more reader-friendly language. Both will serve as reference works for future discussions and for sharing with society an objective and informed vision of eucalyptus forests.

A well managed forest, irrespective of species, has a much lower risk of fire.

Another major output was the perception survey conducted by ISCTE, involving 600 participants of different ages from different regions and settings. The data gathered has shown, for example, that 72.3% of respondents agree that "well-managed forests are beneficial for the country, irrespective of the species planted", and that 66.2% are favourably disposed towards the idea of a policy for expanding the forested area, in a way that conciliates production species, such as eucalyptus, with others that have conservation value. In addition, 61% of participants were in favour of a cross-party agreement being reached on a future forestry policy with no restrictions on the planting of any species. The findings also show where there are gaps in the information people have, and in the areas where people need to know more about the role of different forests.

You spoke about the importance of education and communication for improving the public's perception of eucalyptus forests. What has Navigator been doing in this area?

Education and communication are key to promoting and deeper and more balanced understanding of eucalyptus and forests in general. Our Corporate Purpose commits us to sharing our results, our knowledge, our experience and resources with society, in the search for a better future for everyone. This willingness to share is central to our role in this context.

We believe it is important to work from the bottom up. Reaching out to younger generations, awakening in them an interest in nature, in sustainability and in occupations connected to the forestry sector. Because forestry literacy is essential for a balanced vision of the role of the forest and planted species, but what is taught in schools does not always reflect reality. In particular, textbooks display a clear bias in the way they address issues relating to woodlands and eucalyptus. The concepts they highlight, such as "deforestation" and "forest fires", perpetuate a negative and distorted view, not infrequently based on propaganda and mistaken ideas, without considering the role of sustainable forestry management. Much of what is presented to students is anecdotal rather than based on scientific fact, and often out of date in relation to the current situation in the sector.

We are already working — and are keen to do more — with educational institutions, from primary schools

up to universities, helping to provide forest-related content, in the expectation that this will one day find its way into the curriculum. We also organise visits to our nurseries and mills, so that students, teachers and other interested groups can see for themselves our forest management practices and our industrial processes. This helps to clear up misconceptions and show how, in practice, it is possible to conciliate production with sustainability.
This commitment to building close community relations, based around active sharing of knowledge and designed to promote trust and dialogue, is also reflected in the different corporate social responsibility projects we are currently pursuing. These are also geared to improving forestry literacy in different sectors of the community. From Florestas.pt, a platform that provides the general public with reliable information about forest, based on technical and scientific expertise, to My Planet, a project that focuses on sustainability issues; not to mention our Forestry Producers project, aimed at forestry professionals, seeking to educate people in the sector about the value of sustainable forest management and certification, and Biodiversidade.com.pt, where we explore the topic of biological diversity in forests in general. For a younger audience, we have created Give the Forest a Hand, aimed at children, offering help at school and in leisure time, whilst raising their awareness of the importance of taking care of forests, and also the Forest of Wisdom, designed as a forest laboratory in the forest, with activities designed for the school community, and welcoming some 12 thousand visitors last year alone.

The *Eucalyptus* Forum itself is an example of this approach, in that it creates a opportunity for exchanging ideas and disseminating knowledge. Our aim is to reach a wide and diverse audience, to foster constructive dialogue, to listen to people's concerns and to reply transparently, with scientific facts.

How do you see the future of the forestry sector in Portugal, and Navigator's role in it?
I'm very confident about the future, but mindful that we face significant challenges. Unlike many other economic sectors, our problem lies neither in the demand for our products, nor in the economic situation faced by the different actors in the industry. We operate in several pulp and paper segments and in more than a hundred markets worldwide. The industry is home to an array of resilient companies, which are major international players in their markets, well capitalised and profitable. Our greatest challenge lies in the shortage of home-grown raw material.
So the starting point is the need to promote active forestry management and to combat the exodus from the countryside and into the cities. Much of Portugal's woodlands is divided into smallholdings, which need to be brought together in order to manage them properly. The combination of rural flight and fragmented ownership has a disastrous impact on yields, whilst exponentially increasing the fire risk. At Navigator, we work in partnership with forestry landowners, associations and producers' organisations to encourage sustainable management, offering technical support and promoting collaborative management models. The growth of Navigator's Forestry Producers Club — which in just over a

We are developing new bioproducts from forestry biomass.

Why is innovation such an important pillar in Navigator's strategy?

We believe that innovation will make our operations more competitive and more sustainable, while creating value for society.
One concrete example is our investment in programmes for genetic improvement of eucalyptus, seeking to develop varieties of the species that offer increased yields and greater resistance to pests and diseases, as well as being better adapted to climate change. This enables us to make our plantations more efficient, whilst simultaneously reducing our environmental impact.
Innovation also plays a crucial role in how we manage and preserve biodiversity in planted eucalyptus forests. An example of this is the environmental DNA (eDNA) marker tool we are using on our properties. Using advanced techniques for collecting traces of DNA from fauna present in the area, from samples obtained of vegetation, air and water, we are able to monitor the biodiversity in our forests, tracking a range of variables. The aim is to obtain scientifically valid quantitative data to support our sustainable management practices and to inform decision-making. This has enabled us to confirm the enormous biodiversity found in planted eucalyptus forests.
Another example is the development of new bioproducts from forestry biomass. We are exploring the production of biofuels, biochemicals and new biomaterials that can substitute fossil-based products. For example, our line of gKRAFT™ products already offers sustainable packaging solutions which are alternatives to single use plastics, in particular in the food sector.
We are also implementing digital technologies in forest management, such as geographical information systems, drones and data analysis, enabling us to monitor plantations in real time, to optimise operations and to take better informed decisions.
In our industrial operations, we have invested in modernising our mills, incorporating more efficient and sustainable technologies. This includes reducing water and energy consumption, cutting emissions and reusing waste products as sources of renewable energy. In 2024, for example, 79% of the primary energy that we consumed and 78% of the power we produced were obtained from renewable sources. ●

year grew to a total of 400 members, with the aim of reaching 500 by the end of 2025 — is a good example of these partnerships. This initiative is creating a real support network for the sector, providing financial solutions, technical training and benefits of scale for producers.
We also face regulatory and political challenges, which create uncertainties and obstacles to long-term investment. We have long called for coherent and stable public policies, which recognise not only the economic value, but also the environmental and social value of planted forests and that support the sustainable development of the sector.
Because without business and job opportunities, that keep people in rural areas and offer a livelihood, it will not be possible to encourage owners to take an interest in their land, thereby countering rural flight and the failure to manage the land, which together compromise the future of forests.
Lastly, there are the challenges of climate change and the need for continuous adaptation. Navigator is investing in research and innovation in order to develop solutions that enable us to face these challenges, making our forests more resilient, and taking advantage of the many opportunities that present themselves on the way.
An example of this commitment is our investment in the bioeconomy, exploiting the potential of eucalyptus for producing biochemicals and biomaterials (some already being piloted), not to mention biofuels and synthetic fuels. We are looking into industrial ventures for producing biomethanol and bioethanol, and we are also studying the feasibility of synthetic fuels such as e-SAF, which will be fundamental for decarbonising hard-to-abate sectors, such as aviation and shipping.
Eucalyptus globulus is naturalised in Portugal, having reached these shores some two centuries ago. The species is widely recognised for the superior

Portugal is in a prime position to take a leading role in the forest-based bioeconomy.

quality of its fibre, and is now proving exceptionally well-suited to these new biomaterials. Worldwide, eucalyptus fibre already accounts for almost half the total fibre on the market and 80% of hardwood fibre, which demonstrates the growing demand. In this context, Portugal also enjoys the competitive advantage of climate and soil conditions in which the species thrives. In Europe, only Portugal and Spain are able to grow *Eucalyptus globulus* successfully.
Indeed, it was The Navigator Company which pioneered the industrial processes for using *Eucalyptus globulus* when, in 1956 and 1957, it was the first to produce cellulose pulp from the species using the Kraft process, first in the laboratory and then on an industrial scale, and then also the first to produce printing and writing paper entirely from eucalyptus pulp. Both these products are today staple commodities on global markets.
We are committed to leading this process of transformation to a forest-based bioeconomy, built around natural and renewable resources. We are continuously exploring new opportunities in the bioproducts sector, able to replace fossil-based materials and thereby contribute to the energy transition and to reducing our environmental footprint.
But we cannot do this alone, so we work day in, day out to build stronger partnerships with forestry producers, suppliers, local communities, academe and associations, to promote sustainable forestry management practices, to

encourage active management of the landscape and to develop the future of forestry in Portugal. This is the strategic vision which recently won us recognition from Sustainalytics as one of the “2025 ESG Industry Top-Rated Companies”, positioning Navigator among the top companies worldwide for sustainability.

Considering specifically the challenges of climate change, how can eucalyptus help us to adapt and to mitigate these phenomena?
Climate change represents one of the greatest challenges of our age, and forests play a crucial role in the response. *Eucalyptus*, in particular, has characteristics that make it a valuable species in this context.
In the first place, it is fast growing, which means it is able to sequester large quantities of carbon dioxide in a short space of time - up to seven times more than cork oaks and three times more than maritime pine. This helps to reduce greenhouse gases in the atmosphere. Incidentally, the implementation of an effective forestry policy, which includes careful measures for prevent and protect against fires, is also fundamental for avoiding the emissions caused by fires.
On the other hand, eucalyptus plantations can be managed so as to increase resilience to the impacts of climate change. For instance, genetic improvements enable us to develop varieties which are more resistant to drought, pests and diseases, which are factors exacerbated by climate change. Here too, The Navigator Company has been a pioneer, producing the world’s first clones of *E. globulus.*
The use of eucalyptus wood as a renewable raw material for manufacturing bioproducts also contributes to the transition to a low-carbon economy. By substituting fossil-based materials, like plastic, with bio-based materials, we are reducing the emissions associated with extracting and using fossil fuels.
Sustainable management of eucalyptus plantations can help protect the soil, regulate the water cycle and conserve biodiversity, which are all fundamental elements in adapting to climate change.
I would like to add something on the topic of “fast-growing” species. *Eucalyptus* is a tree that offers a lot while making very few demands. Over the centuries, it has been able to evolve and adapt in order to survive, becoming a very efficient “biofactory” for photosynthesis. It has stomata on both sides of its leaves and not just on the lower side, enabling them to maximise the exchange of gases, and to start photosynthesis earlier and finish later, at the same time as regulating evapotranspiration, which is the loss of water into the atmosphere. The actual format of the leaves enables them to channel rainwater and atmospheric humidity to the base of the trunk, minimising water losses through direct evaporation of the water which would otherwise have remained in the crown of the tree. Scientists have actually proved that it uses no more water per unit of biomass produced than, for example, pine trees. Lastly, it thrives on marginal soils with thin, stony and poor soils, helping to enrich them over time by incorporating biomass - from the roots, bark, branches and leaves that it sheds. You need only travel around Portugal, to the forested uplands in southern coastal regions and to central inland areas, and speak to older people, to confirm that there are forests today occupying what was once barren or unproductive land, or pasture that has fallen into disuse. Or visit orchards and vineyards planted in recent years on land where eucalyptus was grown over two or three rotations, on what was once poor soils, unsuited to farming.

In conclusion, what message would you like to leave for our readers?
A message of optimism and confidence in the future of our forests and the role of eucalyptus as a valuable resource for Portuguese society.
Forests are a key part of our society, our economy and our environment. They provide us with renewable resources, essential environmental services and opportunities for building a more sustainable and resilient economy.
When managed responsibly, eucalyptus can make a great contribution to this future. It is important for all of us, as a society, to be properly informed, to ask questions and to take an active part in building sustainable solutions.
We have a unique industry cluster in Portugal, integrating every stage in the value chain - from R&D and innovation in forestry and bioproducts, through to the end product, with Portuguese brands enjoying success in more than 130 countries, across every continent.
This model is responsible for very considerable domestic value addition, in addition to which there is great potential for scaling it up: every year Europe imports between 6 and 7 billion euros of eucalyptus-based products (wood, cellulose and different types of paper), above all from Latin America, but also from Asia and Africa. These could be produced in Portugal and Spain, the only European countries with the ideal climatic conditions for eucalyptus. This means we could substitute these imports with locally produced materials, increasing the earnings of producers, boosting resilience and territorial cohesion, creating wealth in the country and ensuring European value chains are more resilient, with lower emissions.
With unique natural conditions for eucalyptus plantations and first-class bioindustrial facilities for pulp and paper production, Portugal is in a prime position to take a lead in the transition to a forest-based bioeconomy. This is a competitive advantage that we cannot continue to waste, above all at a time when Europe faces the challenge of reducing its dependency on fossil materials and is seeking to re-establish its strategic autonomy, in a world where the economic and geopolitical balance has shifted. ●

EUCALYPTUS FORUM

A window on to the forest

The perceptions people generally have of planted eucalyptus forests are almost always far removed from what scientists actually tell us about them today. The *Eucalyptus* Forum set out to correct this situation, by sharing information, experience and evidence, enabling people to take a fresh look at this valuable natural resource. Here we report on the methodologies and approaches applied in this initiative, and the great strides that have been made. Without denying that there is still a long way to go.

Explain, demystify, inform. Three key words when summing up the aims of the *Eucalyptus* Forum. The Navigator Company undertook this ambitious project in order to address a complex situation. On the one hand, for most people in society, the importance of forests and the challenges currently facing them are not something that impinges on their daily lives, meaning they tend to be unaware of them. At the same time, there is a worrying shortfall of human resources, especially among younger generations, interested in jobs in this area. In addition, this lack of first-hand knowledge creates fertile ground for beliefs that owe a lot to prejudice and nothing to science, and which serve to turn people away from a sector which is actually vital for Portugal.

It was in response to this context that Navigator decided to invest in a broad, and unprecedented, strategy, which actively helps to rid people of misconceptions about planted forests (and eucalyptus in particular), and to counteract the society's resistance to the species, and its unwillingness to accept plantations. Above all, the *Eucalyptus* Forum sets out to promote forest literacy, across all sectors of society, and to help ensure younger generations are better informed about the value of forests. All this is being done on the basis of scientific evidence and not forgetting the need to raise awareness of the role of planted forests as important pillars for creating value and sustainable growth.

They provide valuable raw material, from which new solutions are being developed to the environmental,

The *Eucalyptus* Forum has been organised in line with Navigator's purpose of sharing its knowledge, experience and resources with society

social and ethical challenges currently faced by our society. In other words, innovative products that make it possible to replace fossil-based materials and which hold out the promise of environmentally sustainable socio-economic development.

Planted forests also bring new life to the economies of desertified interior regions and, in contrast to other factors, therefore work in favour of territorial cohesion. But none of these benefits make their way into people's perceptions. The social license which needs to be built up in favour of forest-based industries is dependent on creating a consensus. And on an informed culture, making it possible to achieve a balanced view of well-managed eucalyptus plantations and their place in the integrated management of the landscape.

This was the great goal in view when Navigator decided to organise the *Eucalyptus* Forum. This is a project in line with Navigator's corporate purpose, in which the company accepts a commitment to share with society not just its results, but also its knowledge, experience and resources, in the quest for a better future.

Ignorance creates fertile ground for the proliferation of received ideas, devoid of any scientific basis.

"The *Eucalyptus* Forum is an excellent initiative, involving actors across the sector, and has the potential to clarify a number of misconceptions. We have to look at eucalyptus forests from an integrated perspective."

Hugo Almeida
Secretary-General of Fenafloresta – National Federation of Forestry Producers' Cooperatives

"This open debate about eucalyptus is extremely important, above all because public opinion is prey to misconceived ideas. It is important that we have the capacity to inform ourselves correctly. In schools, the syllabus is out of date, sharing messages which are out of step with reality."

Carla Leite
Forestry Officer at CAP - Confederation of Portuguese Farmers

In the panel discussion on "How are things in other countries?", four foreign guests shared their experience.

Mia Couto took part by video link, from Angola. Talking about his relationship with nature, the writer said that it is not something outside us, but as one with us. He also spoke of how, in the forest, he had the feeling of being somewhere sacred: "I visit the forest as if it were a church".

One Forum, multiple points of view
The idea of the *Eucalyptus* Forum started to take shaped in the early summer of 2023. Up to March 2024, when the first major in-person event took place, staff were busy behind the scenes gathering, analysing and systematising all the technical and scientific expertise in existence on eucalyptus forests, but also, more generally, on the importance of planted forests in constructing models of sustainable development. Throughout this process, there was a constant concern to listen to stakeholders from different areas and to bring together a variety of perspectives and complementary views, even if they sometimes might be (or seem) contradictory.

The fundamental rule was that all contributions had to be technically and scientifically sound and well founded. More than a debate between peers, the *Eucalyptus* Forum set out to be an open space for building and sharing.
At this stage, more than 120 people were involved from areas as diverse as academe (researchers and teachers), local authorities, non-governmental organisations (NGOs), associations of forestry producers, the forestry sector and the media.

The work of the Editorial Board
The contributions from this wide array of participants have been scrutinised by the *Eucalyptus* Forum Editorial Board, comprising more than 70 leading figures, invited by Navigator, from the academic world, different industrial sectors, NGOs and the media, as well as elsewhere. What they had in common was recognised in-depth knowledge of the topics in question. This structure was responsible for producing and curating the contents that will be used, in the future, as the basis for all the discussion and debate that the project seeks to foster.
The main topics explored were:
- The historical and sociological background, and the regulatory framework for the eucalyptus forestry sector in Portugal: "industrialisation of forests", challenges and factors for success;
- Perceptions and facts concerning eucalyptus - beliefs or evidence?;
- Innovation in bioproducts from eucalyptus forests: opportunities for the forest-based bioeconomy;
- Intervention in Education: knowledge- and science-based change.

More than a debate between peers, the *Eucalyptus* Forum set out to be an open space for building and sharing.

The importance of the Scientific Council
The *Eucalyptus* Forum has also benefited from expert oversight by the Scientific Council, which was set up to ensure that all the findings are strictly aligned with state-of-the-art knowledge in environmental and forestry science. Its mission also includes ensuring

that these findings are the result of independent analysis, integrating a variety of perspectives, and also the work of compiling and summarising findings in a public document aimed at a series of relevant stakeholders. The Council consists of leading academics with vast experience in environmental and forestry science. The coordinator is Helena Pereira, Emeritus Professor of the Higher Institute of Agronomy (ISA) of the University of Lisbon. The other members are: Francisco Gomes da Silva, professor at ISA; Teresa Soares David, PhD and researcher in Forestry Engineering; Maria José Roxo, Full Professor at Universidade Nova de Lisboa and Researcher at the Interdisciplinary Centre for the Social Sciences (CICS.NOVA).
The *Eucalyptus* Forum has organised two major in-person events, which were both milestones in its progress towards achieving its goals. The first was on 31 March 2024 and was a session organised as a collaborative forum. The second was a conference, which took place on 28 May 2024, offering a programme of panel discussions on topics resulting from the discussions and reflection at the previous event.

Collaborative forum: a time to listen

The venue for the first *Eucalyptus* Forum event was ISCTE (the Employment and Business Studies Institute of the University of Lisbon). It was no coincidence that the kick-off event was held at an institution dedicated to science and learning. A choice justified by the credibility that the initiative seeks to transmit, as well the high scientific standards for all existing and future content. Organised around thematic workshops, the theme for first session of the *Eucalyptus* Forum

Some of the many specialists who took part in the workshops at the Collaborative Session of the *Eucalyptus* Forum.

Paulo Canaveira, consultant and specialist in Forests and Land Use and Adaptation to Climate Change

Miguel Freitas, lecturer at the University of the Algarve

Filipe Duarte Santos, Chairman of the National Council for the Environment and Sustainable Development

Helena Freitas, Professor of the University of Coimbra, UNESCO chair for Biodiversity and Conservation for Sustainable Development

Carlos Amaral Vieira, former Director-General of Celpa

Miguel Boo, journalist and researcher

"Planted forests are extremely important in the wider context of woodlands. Without planted forests, the long-term survival of forests would not be assured in Portugal. In the world of planted forests, eucalyptus forests are an excellent example of well managed production forests, which can make a very significant contribution not just to economic value, but also to social and environmental value."

Helena Pereira
Emeritus Professor of the Higher Institute of Agronomy

"Forests are a crucial component in the context of the Green Deal."

Lídia Pereira
Member of the European Parliament

The panel on "Active forest management" reached a consensus on the need to find ways of making forests profitable, so as to interest people in managing them.

An audience of more than 250 people attended the *Eucalyptus* Forum conference on "Value, Sharing, Future", for which the media partner was Expresso, the leading Portuguese weekly.

"It's possible to have production forest and conservation forest. The most important thing is for us to have territorial planning. That will enable us to to protect wildlife. The forest is one of the divisive issues in our society. This discussion is important for us to find ways to resolving the issue."

Carlos Vila-Viçosa
Researcher at the University of Porto

"There is an idea that planting eucalyptus degrades the soil. But if that were true, the sector would have to move from place to place. In Brazil, we've been in the same areas for 60 or 70 years."

José Carlos Fonseca,
Chairman of IBÁ – Indústria Brasileira de Árvores

was "sharing ideas — planting the future", and the aim was to foster debate and listen to people with different sensibilities. The idea was to establish a participative dynamic for discussing the topics, so as to obtain different perspectives from various sectors of society.
The event attracted more than 120 participants, including figures from the academic world, researchers, opinion makers, forestry producers and landowners, business people, representatives of local authorities, forestry associations and NGOs , as well as communication and media professionals.
Divided into six thematic workshops (in two sessions, one in the morning, and then another in the afternoon), the participants at the Forum session responded to questions and challenges, helped by 18 facilitators - Navigator employees with expertise in the topics being debated, who received specific training for this task. These workshops resulted in a corpus of ideas and responses to the challenges.
The collaborative forum also offered the opportunity to learn about the results of a perception survey, conducted by ISCTE's Marketing Future Cast Lab, which sought to reveal what Portuguese people really know and think about planted eucalyptus forests.

Read more on pages 72-75

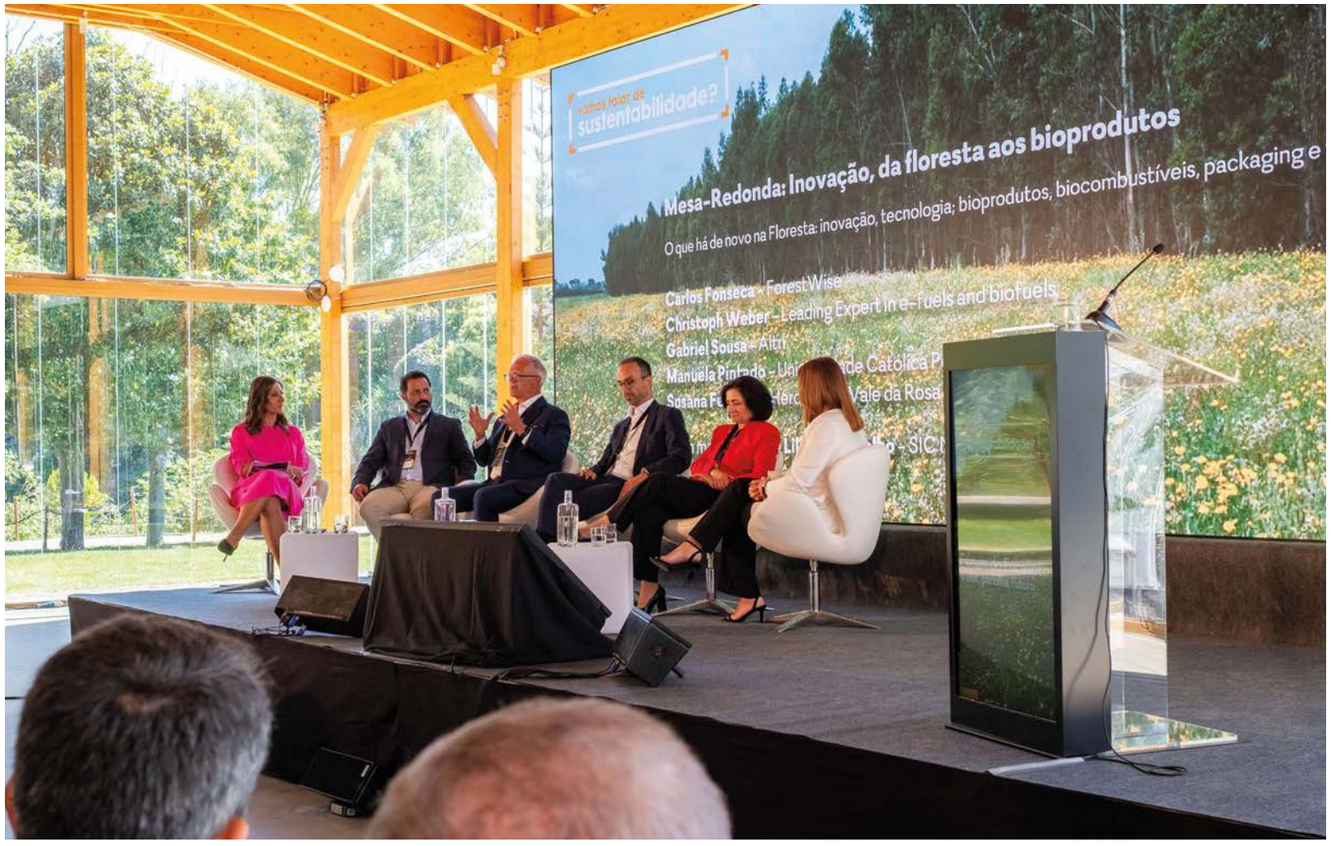
Conference: open doors to civil society

The public session of the *Eucalyptus* Forum took place on 28 May 2024, at Quinta da Pimenteira, in Lisbon, with a live audience of 250 people, as well as being live streamed for everyone who was unable to attend in person. With a wide-ranging programme and the topic of "Value, Sharing, Future", the conference media partner was the Portuguese weekly newspaper Expresso, and the event was attended by representatives of the Portuguese government and local authorities, public bodies and the business sector, academe, the media, NGOs and the educational community.

There were four panel discussions on topics identified in the course of the previous collaborative forum. The roundtable discussion on "Innovation, from forestry to bioproducts" shed light on the progress being made in processing forestry raw materials, and certain by-products from industrial processes in the pulp and paper sector, into new bioproducts. The participants were Manuela Pintado, from the Higher School of Technology at the Portuguese Catholic University; Carlos Fonseca, of CoLAB ForestWISE; Gabriel Sousa, of Altri; Christoph Weber, an expert in e-fuels; and Susana Ferreira, from Herdade do Vale da Rosa.
The panel that looked at the

"There is a need for better communication on the subject of forests, so that people can learn about their capacity for innovation and their huge potential."

Jori Ringman
Director-General of the Confederation of European Paper Industries (CEPI)



The Forum's panel discussion on "Innovation, from forests to bioproducts" showed how progress is being made in processing forestry raw materials.

The panel on "Active forest management" reached a consensus on the need to find ways of making forests profitable, so as promote their management. Jacob Keiser, researcher at the University of Aveiro, highlighted the importance of efficiency in forests. Each forest has its own purpose. But even with different purposes, both conservation and production forests have to be efficient, he told the conference.

"I'm nuts about paper."

Miguel Esteves Cardoso
Writer and journalist

topic of "Active forest management" reached a consensus on the need to find ways of making forests profitable, so as to interest people in managing them. Strategies for getting there were proposed by Carlos Lobo, Founding Partner of Lobo, Carmona & Associados; Luciano Lourenço, a retired university professor; Jacob Keiser, researcher at the University of Aveiro; and Susana Brígido, of 2B Forest.
The *Eucalyptus* Forum also sought to respond to the question of "How are things in other countries?", through a panel discussion with four foreign participants: Jori Ringman, director-general of the Confederation of European Paper Industries (CEPI); José Carlos Fonseca, chairman of IBÁ – Indústria Brasileira de Árvores; Miguel Boo, a journalist and researcher from Galicia, Spain; and Peter Holmgren, from Future Vistas Inc.. From what they had to say, it became clear that Portugal is not alone in facing popular misconceptions about planted forests and the need to be more effective in communicating their value and huge potential.

The need to update school textbooks with scientifically valid messages about forests was one of the central themes of the roundtable discussion on education.

There was also time for a panel discussion on the topic of "Education, a knowledge-based approach", which addressed the importance of education in constructing a new outlook on forests. The debate featured the points of view of Maria João Silva, lecturer at the Lisbon Higher Institute of Education; Pedro Sobral, chairman of the Portuguese Association of Publishers and Booksellers; Sílvia Castro, of the Directorate-General of Education; and Sandra Soares, from Ciência Viva. School textbooks, and the need to update them with scientifically valid messages, were one of the central topics.
But forests are also important to culture. For this reason, the *Eucalyptus* Forum also brought together the writers Mia Couto, Miguel Esteves Cardoso, José Eduardo Agualusa and Carlos Fiolhais for a lively debate about paper, forests and nature. Carlos Fiolhais summed up the common feeling of "veneration" for books as objects and for the experience of reading on paper, confessing that when he looks at a tree he sees books, and regards forests as "latent libraries".

Talking about eucalyptus, disseminating science

The knowledge generated in the work of the *Eucalyptus* Forum has started to take on a life of its own, away from the meetings, workshops and debates. After a rigorous process of review and validation by the independent Scientific Council, this knowledge is now being brought to you, the pages of this issue of My Planet.
Much of what you will find in the articles that follow represents the

"The best way of showing the public that the current wave of innovation in the eucalyptus sector is generating a range of bioproducts which are alternatives to fossil-based products, is to make them tangible. We have to find physical objects that can find their way into people's lives and show the many properties of eucalyptus pulp. We have to follow this course by communicating closely with the public."

Carlos Coelho
Chairman of Ivity Brand Corp

The *Eucalyptus* Forum also brought together the writers Mia Couto, Miguel Esteves Cardoso, José Eduardo Agualusa and Carlos Fiolhais for a lively debate about paper, forests and nature.

The knowledge generated by the *Eucalyptus* Forum will be made available in two books, both validated by the Scientific Council.

culmination of the painstaking work conducted in order to provide clear and objective information, free of myths, unfounded beliefs and misconceptions. Our aim is to provide a fuller and better informed picture of eucalyptus, forests and their impact on sustainability and the future of our planet.

This is the start of a knowledge-sharing endeavour that aims to present society with the facts, helping people to a better understanding of the role of these trees and forests in the environmental, economic and social balance. Join us on this journey through science and the truth about eucalyptus and find out how managing plantations can be part of a more sustainable future.

But this is just the tip of the iceberg. The knowledge generated by countless contributions received over the course of the *Eucalyptus* Forum project is soon to reach the public domain in two books printed on paper, both validated by the same Scientific Council. The first will be a scientific work, aimed primarily at professionals from the different sectors involved in the world of planted eucalyptus forests. The second will be aimed at the general public, maintaining the same technical and scientific standards, but in a more accessible form for the non-specialist reader. Both reflect the project's commitment to disseminating rigorous, scientifically-based knowledge, adjusted for different audiences.

But that will not be the end of the story. There are new projects already on the horizon, with different aims and involving partners from different sectors of society. My Planet magazine will continue to follow and report on these developments, keeping you informed about initiatives that share in this vision of the future for forests and eucalyptus. ●

Knowledge as the basis for sustainable and valued forests

The forests that today occupy a large part of Portugal's territory are an exceptional example of how human plans and ingenuity can work in tandem with nature, creating diversified landscapes with an active ecological and economic role. To travel around Portugal and observe its trees is to experience a varied map of colours, forms and mosaics, as well as different forms of management and use. The deciduous trees of northern Portugal, with their reds and yellows in autumn and their lush crowns, contrast with dark green and rough trunks of the pines that cover the uplands of the central region, and with the slender forms and blue green foliage of the eucalyptus forests in the regions closer to the coast. Further south, cork oak savannas are a key feature of the landscape, yielding cork for the country's industry.

Today's forests are mostly the result of human planting and cultivation. They account for the substantial increase in the area occupied by forests in Portugal, which has risen from less than 10% in the mid-nineteenth century to the current figure of more than 30% of the territory, supported by public policies and energetic planting, not always without controversy. Some of the planting was undertaken by the forestry authorities, such as on uplands and common land in the north and centre, but mostly by private landowners with financial support from national and European programmes. In addition to the environmental benefits of plantations - holding the soil in place and controlling erosion, the quality of groundwater, ecosystems for fauna and flora - these forests have brought renewable resources which are crucial for the economy, in a country that would today be significantly poorer without its planted forests.

Portugal industry has been undeniably successful in adding value to the country's forestry products, enabling it to be a major player today in the international paper and cork markets. An important feature of Portugal's forestry and industrial endeavours, and without doubt a key factor in its success, has been the technical expertise and scientific knowledge created around processes in both forestry and manufacturing. One significant development, almost fifty years ago, was the creation of a university research centre, the Forestry Studies Centre at the Higher Institute of Agronomy, and also the National Forestry Unit of the INIA; both focused on studying eucalyptus and the eucalyptus plantations that were then starting up, as well as on the quality of wood for producing pulp and paper. The business sector soon got involved in this quest for knowledge, setting up trials and conducting research, first at Celbi, and soon afterwards at Portucel and Soporcel. There is today an important independent research centre, RAIZ, which is funded primarily by The Navigator Company. Portugal has been at the forefront of international efforts to study the ecosystem and cultivation of *Eucalyptus globulus*, improving the technology and industrial processes, and many of the countries which later developed eucalyptus plantations, such as Chile and Brazil, benefited from the expertise developed by Portuguese researchers and technicians.

As a researcher, I have had the chance to take part in this scientific process and I have witnessed the international respect that exists for our knowledge in this field. It has also been very encouraging to see new discoveries being embraced by industry and by society, powering innovation in manufacturing and forestry.

I was therefore enthusiastic about the launch of The Navigator Company's *Eucalyptus* Forum, bringing together stakeholders - technicians, researchers, landowners, business operators, environmental activists, consultants, decision-makers and others - to discuss the various issues related to eucalyptus plantations (ecological, social and economic) and to challenge perceptions on the basis of scientific knowledge, thereby paving the way for joint initiatives in education, public information and action. I have the privilege of coordinating an external and independent Scientific Council, entrusted with the task of guaranteeing high scientific standards; its very existence points to the open-minded and rigorous approach take to this Forum. An important output from this process will be a comprehensive summary of what is known about eucalyptus forests in Portugal, looking at their evolution, their role in ecosystems, the environmental and sustainability risks, their economic importance and innovation. This summary will soon be available to the public. Over the course of these months, the experience of working with everyone involved in the Forum has been extremely rewarding, and, without doubt, an important milestone in my scientific career.

By Helena Pereira
Emeritus Professor of the Higher Institute of Agronomy
Chair of the Scientific Council of the Eucalyptus Forum

Portuguese eucalyptus: overdue recognition

Over the past year I have had the privilege of taking an active part in the *Eucalyptus* Forum - a timely initiative of The Navigator Company - as a member of its Scientific Council. During this year, the debate about *Eucalyptus globulus* has involved more than a hundred people from different sectors of Portuguese society, with contrasting viewpoints in relation to each of the many dimensions of this notable species. Whilst there has been no lack of disagreement, I have been a witness to the open-mindedness and fairness with which it has been possible for us to move forwards in our discussion of this species, which is so significant for our country.

In fact, it is precisely the species' centrality that has made this such a divisive issue and passionate cause in Portuguese society, to the extent that we sometimes lose sight of the facts and the knowledge that we possess in Portugal about the species and the woodlands in which it grows. In this regard, the Forum has achieved an important aim, in bringing together all the information and scientifically based knowledge that will enable people who are interested in the topic to take informed and well-founded positions on the matter.

As a forestry species used in Portugal primarily to produce raw material for industry, *Eucalyptus*, which I take the liberty of considering a Portuguese tree due to its exceptional success in adapting to different regions of the country, has proved to have uses that go beyond this original purpose. It does this, in conjunction with other species, in the category of "planted forests", which, when sustainably managed, not only produce wood, but help to remove CO_2 from the atmosphere, to regularise the hydrological regime (maximising water infiltration rates to replenish aquifers), to protect (and produce!) soils and to maintain specific levels of biodiversity.

These planted forests make a direct contribution to conserving areas of primitive forests of great natural value in various regions of the world, saving them from being felled to meet the need for timber. Indirectly, planted eucalyptus forests in Portugal also contribute to reducing greenhouse gas emissions, by providing raw materials and products that substitute other fossil-based materials. These are forests that form part of circular bio-sectors, substituting the linear sectors supported by fossil-based raw materials.

Thanks to a large store of evidence gathered by a range of bodies, we know today that, provided these planted forests are managed sustainably, they make an invaluable contribution to managing rural fires, countering certain perceptions that are nearly always based on the behaviour of fires in areas of abandoned forest, irrespective of the species present.

Lastly, whenever Portuguese eucalyptus and the respective planted forests are sustainably managed, they also play a key role in providing an irreplaceable livelihood for many families and communities that earn their living from managing and operating forests. In playing this role, eucalyptus forests make an inestimable contribution to territorial cohesion in Portugal, keeping the economy alive in areas where it can seem that everyone else has given up.

I would like to end by thanking The Navigator Company for its initiative in organising the Forum. And as a member of the Scientific Council, I extend my heartfelt thanks to all those (and there are many) who have shown such commitment in discussing the topics and drafting the contents which, in good time, will be presented as the result of their endeavours. ●

Francisco Gomes da Silva
Professor at the Higher Institute of Agronomy and Partner-Manager at Agro.Ges
Member of the Scientific Council of the Eucalyptus Forum

Challenges and opportunities in eucalyptus forests

In my view, planted eucalyptus forests play and will in future continue to play an important role in creating economic, social and environmental value. It is essential to continue investing in regional planning, at a landscape scale, and in sustainable management, with practices tailored to varying climate and soil conditions Ways need to be found to overcome the difficulties created by continued shortcomings in land registry data, and by the fragmentation of mostly private forests into smallholdings, by promoting associations and encouraging forest certification. Planted eucalyptus forests are at the start of a value chain that generates wealth and jobs for the country, offering a rapid return on investment for forest landowners. These woodlands supply pulp and paper manufacturers, who have invested heavily in implementing good practices and innovation, and which are behind new bioproducts that reduce our dependency on fossil resources and help decarbonise the economy. These forests also play an important role in sequestering carbon in the atmosphere, helping to mitigate the impact of climate change.

Despite the many different benefits generated by these forests, wider society still has difficulty in accepting them, above all from an environmental perspective, reflected in unfavourable perceptions. Some of these perceptions originate from myths, others from a lack of knowledge about the species and a failure to distinguish between the effect of the species and of silviculture practised in intensive production forests, and from observing situations of land being abandoned, of planning failures and/or mismanagement of forests. Only technical and scientific knowledge will enable us to dispel popular misconceptions and also provide the basis for forestry management practices that make it possible to mitigate the negative impacts, helping society to be more accepting of planted eucalyptus forests and enabling the sector to adapt to fresh environmental and economic challenges. It is fundamental that the knowledge generated should be disseminated, in good time and in different fora, adopting strategies tailored to each particular audience. In this context, the *Eucalyptus* Forum has set out to gather and share knowledge on Portuguese forests and planted eucalyptus forests in particular. It has brought together experts from universities, research bodies, the industry and business, and others from civil society, to reflect in different workshops on how society perceives and values the role of these forests, the importance of research, innovation and sustainable management for society and the economy, how education, culture and sharing knowledge might be able to attract people to forestry. For me, this initiative has proved highly rewarding, as well as challenging. It has enabled me to learn about the different perceptions of eucalyptus and planted forests, to gain a broader view of the constraints limiting their potential, the opportunities and solutions available for overcoming them, and to learn about the industry's excellent investment in research and innovation, and the efforts to promote responsible management. As a member of the Scientific Council, the work of analysing and validating contents prepared for dissemination by The Navigator Company's Editorial Board has proved to be an enormous challenge, but also very rewarding at a professional and personal level.

Teresa Soares David
PhD, researcher in Forestry Engineering

Eucalyptus and territorial planning: the need for sustainable management

Eucalyptus plantations play an important role today in the Portuguese economy, contributing to the production of paper pulp and other products, such as honey, oil and the new bioproducts. However, these plantations have been perceived in different ways, especially among the urban population. They have often been linked to issues such as forest fires, depletion of soils, consumption of ground water and degradation of the landscape, often in scenarios where people have abandoned the land or where territorial management is minimal.

In a country which is geographically so varied, changing dramatically from north to south, and from inland to coastal regions, it is essential that land use be planned with these local characteristics in mind. It makes more sense to locate eucalyptus plantations on soils regarded as poor or marginal, avoiding using soils with greater agricultural potential, and also the forestation of vast, unbroken areas.

Eucalyptus is a species that has adapted well to the Mediterranean climate, able to withstand extreme climate phenomena, such as drought, and poor soils. It is also outstandingly efficient in its use of water, enabling it to grow fast. However, in order to reduce the potential environmental impacts, it is fundamental to look carefully at the associated silvicultural practices and to ensure that plantations are properly managed.

This is where sustainable management practices are essential, seeking to provide ecosystem services as well as promoting protection, resilience and yields, based on measures that help to balance use of natural resources with environmental conservation.

Despite the scientific progress made, both in identifying the species best suited to the soil and climate conditions in the country, and with regard to the development of new bioproducts derived from eucalyptus, there is still a long way to go in creating an effective legal framework for forest management and territorial planning. This framework should be able bring new life to the land and boost resilience, in the face of climate change. In the future, forest management policies should be conceived on different scales, considering local factors in each region. Success stories should be used to inspire policy design, cutting away the red tape that gets in the way of implementation on the ground. To achieve these goals, it is fundamental to invest in education, involving different levels in the education system, and to improve communication with the public, so people can be more aware of sustainable forest management and engage with the issues.

The *Eucalyptus* Forum has created this opportunity for dialogue between all the parties involved and interested in planted eucalyptus forests: academe, environmental organisations, producers' associations, industry, political decision-makers and civil society, through participative workshops which enabled people to to set aside any preconceptions and to reflect on eucalyptus, focusing on the forests we have and those we aspire to have in future.

For me, it has been very rewarding to be involved in this initiative, enabling me to share ideas and learn more about the best efforts being made to find ways of minimising the environmental impacts (soil, water and biodiversity), as well as to learn about the progress in creating new bioproducts, and in other areas. It has been a huge challenge to sit on the Scientific Council for this Forum, but also a highly gratifying experience, in view of the generosity of all those involved. ●

Maria José Roxo

Full Professor, Universidade Nova de Lisboa and Researcher at the Interdisciplinary Centre for the Social Sciences (CICS.NOVA)

Member of the Scientific Council of the Eucalyptus Forum

A story of adaptation and success

More than 150 years ago, Portugal's terrain and climate were found to be ideal for eucalyptus. It was initially planted as an ornamental curiosity in parks and gardens, but it soon became one of the country's leading forestry species.

EUCALYPTUS IN PORTUGAL

The success of *Eucalyptus globulus* in Portugal was not a simple matter of chance. The country offered the species the ideal edaphoclimatic (soil and climate) conditions for it to thrive, unmatched elsewhere in the world. For instance, the tree can also be found in north-west Spain and southern Italy, but it is unable to survive in the cold climate or north and central Europe, because of its sensitivity to low temperatures, frost and snow.

A native of Australia, it arrived in Portugal more than 150 years ago, and quickly established itself in the country's woodlands. Its ability to adapt to the Portuguese climate and soil, combined with its rapid growth, has made it one of the most important, and most controversial, forestry species in the country. Initially, it was it planted as an ornamental tree, in parks and gardens, but its versatility quickly attracted the attention of private landowners and the authorities. The species gained in popularity, and was seen as a solution for

Pollination in eucalyptus blossom: a treasure for bees and a source of aromatic honey.

Did you know?

• Most of Portugal's forests are planted. In the late 19th century, forest cover was below 10%, but today it exceeds 30% of the national territory.

• With a total area of 3.2 million hectares, forests are the main form of land use in Portugal (according to the 6th National Forest Inventory, ICNF, 2019), covering more than one third of the mainland's territory.

• Savannas and woodlands of cork and holm oak are the dominant type of land use (1.07 million hectares, 34% of the forested area), followed by pine woods (907 thousand hectares, 28%) and eucalyptus (845 thousand hectares, 26%).

Eucalyptus: introduction and adaptation to Portugal

1829
The first documented planting of eucalyptus (*Eucalyptus* obliqua) at Quinta da Formiga, Vila Nova de Gaia.

1850/52
Planting of two eucalyptus trees at Quinta do Lumiar, Lisbon. By 1858, both had grown to a height of more than 10 metres. Also in Lisbon, there was at least one specimen of *Eucalyptus* robusta in the botanical gardens of the Medical and Surgical School.

1868/69
Planting of 6,000 eucalyptus trees, mostly *Eucalyptus globulus*, in the Mondego valley and close to Figueira da Foz.

1869/70
Companhia Real dos Caminhos de Ferro (the railway company) started planting eucalyptus for commercial production of railway sleepers.

1870
Records of the planting of 30,000 *Eucalyptus globulus* at Quinta de Foja, Montemor-o-Velho.

1871
Planting of 15,000 *Eucalyptus globulus* at Monte das Flores, Évora.

1871-76
Planting of 25,000 eucalyptus in Alenquer, for agricultural purposes, to protect vineyards.

1872
The first references to eucalyptus blossom for producing honey, leading to it being planted by private landowners for this purpose.

1875
The forestry authorities plant eucalyptus in the National Forest in Vale de Canas, Coimbra, which is today home to the tallest karri (*Eucalyptus* diversicolor) in Europe.

1879
Eucalyptus planted for the first time in the national pine forests of Leiria and Foja, and later in the public forests of Valverde, Gaio and Leiria.

1880
The largest eucalyptus plantation of the period (150,000 trees) was established on a property near Abrantes, known as "New Tasmania".

1907
Plans for roadside planting of eucalyptus, to demarcate and protect highways.

1920s
Eucalyptus pulp was produced using the sulphite method for the first time in Portugal, and presumably in the world, by the Caima Pulp Company, in Albergaria.

1940s
Eucalyptus becomes more important during the Second World War, for use as mine props and as fuel.

1957
Paper pulp is first produced from eucalyptus using the then innovative kraft method, at the mill belonging to Companhia Portuguesa de Celulose, in Cacia, today part of The Navigator Company.

1960s
Expansion of *Eucalyptus globulus* plantations, especially in coastal regions north of the Tagus, driven by the growing demand for paper, consolidation of the cellulose industry in Portugal and the interest of private landowners.

Important work has been conducted by researchers at the Higher Institute of Agronomy and the authorities responsible for forests over the years.

forestation, because of its rapid growth, and because it was a source of wood, firewood, charcoal and other products - the bark used in tanneries, the leaves with medicinal properties and the flowers for producing honey.
It was planted in several National Forests, along the side of roads (to mark them out), on farms and estates as a windbreak, and close to stations and guardhouses for commercial production of railway sleepers.
Eucalyptus also proved resistant to pests and diseases, which encouraged further planting. Its ability to regenerate, through shoots from stumps, means that several crop rotations are possible without the constant need for replanting. This rapid production cycle made it a prime choice for commercial forestry. Its ability to adapt meant the species was soon to be seen up and down the country.

Stump sprouting is the ability that certain trees have to regenerate through new shoots that grow from the base of the trunk, after felling.

Controversy and benefits
Despite the undeniable advantages of eucalyptus, its introduction and expansion in Portugal was not free of controversy. From the 1980s onwards, voices were raised in protest against the environmental impacts of large-scale eucalyptus monoculture, warning of issues such as biodiversity loss, soil degradation and high levels of water use.
The need to respond to these objections with facts gave rise to countless scientific studies, seeking both to understand the impacts of eucalyptus plantations on natural resources, and, for example, to develop more sustainable silviculture practices and promote genetic improvements. Over the years, research has shown that, when properly managed, eucalyptus can be grown alongside other species, without compromising natural resources.
One of the main advantages of eucalyptus is its speed of growth. In favourable conditions, it can grow to more than 30 metres in just over a decade. Its wood has been used for a variety of purposes, from shipbuilding through to furniture making, as well as for railways, as a source of charcoal for the steel industry and even as a source of essential oils for the pharmaceutical, perfume and cosmetics industries.
However, it was as a raw material for paper pulp that the species came into its own. The paper industry found that eucalyptus provided wood of superior quality, with short, strong fibres, perfect for producing printing and writing paper, enabling Portugal to assert itself as a world leader in the production of premium quality paper.
This pulp and paper sector, based on eucalyptus, has also been fundamental for the country's rural economy, creating jobs and bringing livelihoods to communities in what are often underprivileged regions.
Although the debate about the impact of eucalyptus continues, more and more has been invested in sustainable management. The combination of accumulated scientific knowledge and economic potential makes this species one of the pillars of Portuguese forestry, with an important role in the transition to a more sustainable and integrated bioeconomy. ●

It was in producing paper pulp that the species came into its own.

Did you know?

• The first mill in the world to produce paper pulp from eucalyptus wood was the Caima Pulp Company, in Albergaria-a-Velha, in the 1920s.

• In 1957, Portugal was the first country in the world to produce bleached eucalyptus pulp using the then innovative kraft process. ●

EUCALYPTUS IN PORTUGAL

Birth of a world-class industry

Public policies for the expansion of forests and encouraging forest-based industries paved the way, in previous centuries, for the development of a pioneering and internationally competitive industrial sector. The production of pulp and paper from eucalyptus not only won Portugal an international reputation, but also made it possible to support rural development and the Portuguese economy.

Since the mid-twentieth century, eucalyptus has served as the foundation for a pioneering industry and a global success story, in terms of competitiveness, product quality and international prestige - we are talking of the eucalyptus pulp and white paper sector. But the decision to develop a forestry products industry in Portugal has older roots, in public policies.
It was back in the nineteenth century, in 1886, that a fundamental shift occurred in forestry policy; expansion of forests on public estates was identified as a priority, and efforts were stepped up to distribute plants and support private ownership.
A growing area was occupied by woodlands, above all cork oak and pine. The Forestation Law of 1938 then extended forestation to coastal dunes and common land in upland regions. This resulted in the controversial "pinewoodisation" of the country, anticipating the identical "eucalyptisation" controversy twenty-five years later, due to the growing economic interest in the species.
In the nineteenth century, paper was already produced on an industrial scale in Portugal, but from cotton rags and straw. It was as a result of the industrialisation policy of Portugal's Estado Novo regime that priority was given to restructuring the sector by first encouraging the growing of eucalyptus and identifying eucalyptus species suitable for wood production.
When, in the early 1980s, the area of maritime pine started to decline (as a

As from the mid-twentieth century, eucalyptus has been the foundation of a successful pulp and paper industry in Portugal.

The start-up of the mill in Cacia operated by Companhia Portuguesa de Celulose, in 1953, and the start of operations using eucalyptus wood, in 1957, provided fresh impetus for forestation with this species.

result of forest fires without subsequent reforestation, the exodus from the countryside, the decline of the resin industry and the pressure of urban development), with the consequent loss of a rural livelihood and the neglect of previously well-tended woodlands, eucalyptus presented itself as the most viable alternative on land that continued to be used for forestry, thanks to the faster return on investment.

The start-up of the mill in Cacia operated by Companhia Portuguesa de Celulose (funded by the Marshall Plan), in 1953, and the start of operations using eucalyptus wood, in 1957, provided fresh impetus for forestation with this species. New mills were established for eucalyptus pulp (Socel, Caima and Celbi) in the 1960s, and, in the 1960s and 1970s, state support for eucalyptus ventures, through the Forest Development Fund, contributed to an expansion in the area of eucalyptus plantations.

When Portugal joined the then European Economic Community, in 1986, further changes were made in the forestry sector - including the Portuguese Forestry Project, supported by the World Bank, designed to significantly increase the domestic supply of maritime pine and eucalyptus. However, according to the Office of Planning, Policy and General Administration (2018), support was provided for forestation of more than a million hectares, of which only 3% corresponded to eucalyptus.

The growth of eucalyptus plantations was mainly due to private landowners, leading certain political groupings and environmentalists to call for legislation to restrict further expansion. Since 1985, and the great fire in Caramulo, and subsequently in the aftermath of all severe fire seasons, forestry and business operators have been faced with reactive, disorganised and increasingly restrictive legislation, which has held back private enterprise and a competitive sector, which has for decades invested in developing responsible forestry practices and been a driving force for rural development in Portugal.

€14,72 billion

the turnover of forest-based industries, forestry service providers and operators in 2022, i.e. representing 6.08% of GDP.

€6,65 billion

the turnover of the forestry sector, i.e. 49% of sales in 2022 originated in the pulp and paper industry.

101.631 people

were employed, in 2022, in the 19,541 companies involved in forestry operations, representing 2.22% of all jobs in Portugal.

13.886 people

The pulp and paper sector employed 13,886 people, in 2022, with 562 registered companies.

52.800 direct jobs

The eucalyptus sector provided direct, indirect and induced employment for 52,800 people, in 2019.

8%
of Portuguese exports
originated in forests, in 2023.

4,1%
of all Portuguese exports
were due to the pulp and paper sector in 2023, corresponding to 3.2 billion euros.

51%
was the share of the pulp and paper cluster in forestry sector exports in 2023.

€4,08 billion
was the value of sales by the pulp and paper sector in 2022, equivalent to 1.7% of Portuguese GDP that year.

5,9%
of the total energy
produced in Portugal came from the use of biomass in the pulp and paper sector, representing around 48% of all energy produced in Portugal on a co-generation basis in 2021.

(Sources: INE; Pordata; Biond – Associação das Bioindústrias de Base Florestal; PwC)

In 2017 the legal framework applicable to forestation and reforestation was reviewed, creating for the first time specific constraints on new plantations of eucalyptus.

National targets for forest species were established in 2006/2007, in the National Forests Strategy (NFS) and the Regional Forest Development Plans (RFDPs). The NFS was updated in 2015, with new targets for eucalyptus forests, and in 2017 the legal framework applicable to forestation and reforestation (LFFR) was reviewed, creating for the first time specific constraints on new plantations of eucalyptus.

***Eucalyptus* as the foundation of a pioneering industry**

Although the Estado Novo plan to foster the creation of a forest-based manufacturing sector was initially geared to pine wood, the good fortune that *Eucalyptus globulus* adapted so well to conditions in Portugal, combined with the expertise and quality of the forestry and industrial researchers at work in the country - discovering that the pulp made from this wood presented extremely useful properties, also permitting larger yields and a product of outstanding quality - meant that eucalyptus was quickly embraced as the main raw material for cellulose pulp in Portugal. This made it possible to achieve the goal of reducing Portugal's dependency on imported pulp and paper, and to create jobs and wealth for the country.

In Cacia, in 1956, in view of the difficulties experienced in producing bleached pine pulp using the original American-made plant, staff looked into the idea of using the *E. globulus* wood available in Portugal to produce chemical pulp using the sulphate process. The development work and trials resulted in success. In April 1957, Companhia Portuguesa de Celulose (CPC) started regular production of this high quality pulp, which was ideally suited to producing printing and writing paper. Their sales and exports proved highly successful and they went on to pioneer the production of bleached eucalyptus kraft pulp. It was the end of the myth, then widely believed in the industry, that only long fibres, such as pine,

Progress in the scientific study of eucalyptus

The introduction of eucalyptus, and the related forestry and industrial activities, was accompanied by technical and scientific studies of the tree, stands, the ecosystem and the technological quality of the raw material. Scientific research and technological development focused on eucalyptus and eucalyptus forests dates back a hundred years in Portugal.

The pulp and paper industry discovered favourable conditions in Portugal for development and invested at an early stage in R&D, with studies that applied science to the sector. The industry created not just research centres linked to its production units, but has consistently, and to this day, established partnerships with various scientific institutions in the country for independent research at different academic centres. Certified systems have been implemented for forest management, for reducing the water footprint, for using renewable energy and for more effective use of raw materials (for instance, by reducing waste), areas where the industry can boast of exemplary performance.

In addition to examining the environmental impacts of eucalyptus, and dispelling a number of popular misconceptions, the R&D carried out by companies, universities and national laboratories has taught us about the species' requirements and enabled operators to optimise cultivation protocols and to defend plantations against pests, diseases and other threats, such as fire and erosion.

RAIZ is today one of the top R&D centres in the industry, with the Universities of Aveiro, Coimbra and Lisbon as associate members. Recognised as belonging the National Science and Technology System and as an Interface Centre (Technology and Innovation Centre, TCI), RAIZ works on projects in collaboration with various Portuguese institutions, such as the Universities of Aveiro, Coimbra and Beira Interior, ISA and INIAV.

1920s
Experimental planting units set up for cork oak and eucalyptus (Alcobaça).

1942
Creation of the Cellulose Laboratory, the first in Portugal specifically dedicated to this field, where different species were studies with a view to industrialisation.

1960s
Creation of the Department of *Eucalyptus* Cultivation and Operation, a "non-official" department which was closed down in 1977.

1965
Start of work in selecting superior eucalyptus trees, by the Celbi Forestry Department, at Quinta do Furadouro.

1970s
The Higher Institute of Agronomy offers a "Free Course in Cellulose and Paper", organised around the use of eucalyptus for cellulose.

1972
Creation of the Forestry Products Institute (closed down in 1988), funded by taxes on forestry industries, where for the first time the forestry industry was assigned economic coordination of eucalyptus and of the cellulose pulp and paper sub-sector.

1976
Creation of the Forestry Studies Centre, at ISA, with the principal mission (at that time) of coordinating the production and transfer of scientific knowledge concerning the cultivation and industrial processing of eucalyptus.

1983
Portucel's Technology and Forestry Research Centre set up at Quinta de São Francisco, Eixo, Aveiro.o.

1986
Early plans for the design and implementation of the Soporcel Forestry R&D Centre (at Herdade da Torre Bela), in collaboration with national and international organisations.

1988
Celbi opens its new Forestry Research Centre, at Quinta do Furadouro. In 2006, this became the research centre for what is now Altri.

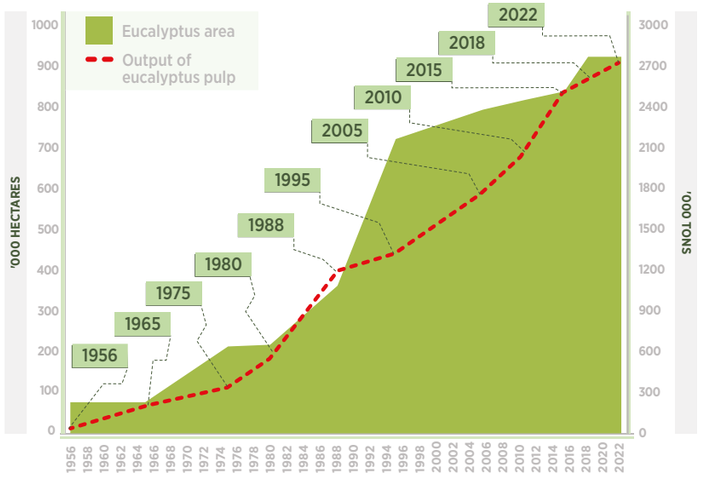
In 1989 and§ 2001
Creation of curriculum modules on Cellulose Technology and Paper Technology at the University of Coimbra, taught by Soporcel's technical team.

1996
Creation of RAIZ, the forestry and paper research institute of what were then Portucel and Soporcel, both of which are now part of The Navigator Company, with the aim of researching and providing specialist services in the fields of forestry and pulp and paper production processes. ●

Did you know?

In the 1970s, Portugal was one of the world's leading suppliers of eucalyptus essential oils for use in the pharmaceutical, perfume and cosmetics industries, exporting 400 tons a year.

Evolution of eucalyptus area in Portugal and pulp output (1956 – 2022)



were feasible for this type of paper.
As a result of this industrial success, several planning applications were made for new cellulose mills, eventually prompting the government to intervene, restricting the number of new licenses in line with the availability of forest raw materials.
This led to the building of new industrial plants such as Celulose do Guadiana (in Mourão, in 1956), SOCEL (in Setúbal, in 1964), the new Caima mill (in Constância, in 1962), Celbi (in Figueira da Foz, in 1967), Celtejo (in Vila Velha de Ródão, in 1971) and Celnorte (in Viana do Castelo, in 1974). These were joined in 1984 by the Soporcel mill in Lavos, Figueira da Foz. The worldwide prestige achieved by Soporcel paper (the first paper machine started up in 1991), and particularly by its iconic product in the world market, the Navigator brand, made a huge contribution to building up the reputation of *eucalyptus globulus* fibre for the production of printing and writing papers and other equivalent paper products.
The eucalyptus pulp mills operated by Celbi, Caima and Celtejo belong today to the Altri group.
The Cacia and Setúbal mills were nationalised in the wake of the 1974 revolution and operated by the state company Portucel E.P., merging the previously private-owned concerns.
In conjunction with the former Soporcel mill in Figueira da Foz, they are now part of The Navigator Company, which operates integrated production of printing and writing paper in Setúbal and Figueira da Foz, and a bleached pulp and tissue mill in Cacia.
The demand for wood from this growing capacity for manufacturing eucalyptus pulp did much to stimulate the growth of eucalyptus forests in mainland Portugal.
Since then, industrial output has continued to grow substantially, stimulating the forestry and industrial fabric and the provision of related services - forestry production, woodland services, energy, paper and cardboard, packaging products, industrial plant, maintenance services, logistics, etc.. All this boosts economic development and employment in rural communities. Thanks to a high rate of incorporation of raw materials, labour and services sourced in their entirety in Portugal, the exports of the pulp and paper industry are significant not just for their outstanding value, but also as the largest single source of domestic value added.
However, although forests occupy more than one third of Portuguese territory, there is still not enough home-grown wood to meet the increasing needs of the industry, meaning that imports have been rising systematically. This situation is not just a waste of Portugal's potential for forestry; the unfortunate fact is that the more eucalyptus is imported, entailing transport, the difference in quality and the higher costs and prices in relation to home-grown wood, the less able the industry is to reward Portuguese producers, as the price for which the country is able to sell pulp and paper on the external market is dictated by the competition around the world. ●

The country has failed to produce enough wood to meet industry's needs, meaning that imports have systematically increased.

Eucalyptus in Portugal: a naturalised migrant

The twentieth century marked the start of the renewables era for mankind. It was in fact during this period that Portugal developed its planted and renewable forests.
Towards the end of the previous century, a tree had migrated from Tasmania and discovered ideal soil and climate conditions in Portugal for it to naturalise and renew itself: *Eucalyptus globulus*.
It soon became clear that the species adapted well to the country and offered impressive yields. Yields were also excellent in industrial processing, which, combined with the mechanical, physical and optical characteristics of the fibre, meant that Portugal pioneered its use in the pulp industry, and later in the paper industry, with products that won international acclaim.
Growth of the Portuguese pulp and paper industry in the second half of last century increased the demand for this raw material, whilst also having a positive and growing impact on the country's trade balance and on job creation. The exports of the pulp and paper industry today feature the highest rate of domestic value added of any sector in Portugal.
Scientific research and technological development related to *Eucalyptus globulus* has kept pace with this expansion. The industry has contributed several R&D programmes, including those in response to the voices of protest raised against the tree, above all from the late 1980s onwards.
Over the years, ideological debates have exerted influence over public policies. Despite the leading position that Portugal currently occupies in the pulp and paper sector, both in Europe and worldwide, the industry's growth is hampered by regulations that constrain its sustainability and oblige the country to import raw material of inferior quality.
It is important that younger generations should learn about history, in order to plan better for the future.
After polluting the oceans, mankind has learned that it needs to replace fossil-based products with renewable, biodegradable and more sustainable products.
Portugal's pulp and paper industry is naturally well positioned to offer innovative solutions. Using *Eucalyptus globulus*, it is able to produce up to seven times more paper surface with the same area of forest compared to a pine forest in Scandinavia. What is more, after the resulting paper is used, it can be recycled up to six times more than an acacia paper from Indonesia, and even after being recycled ten times, its products offer quality superior to those produced with Brazilian eucalyptus after being recycled just once.
Without access to the facts, public opinion tends to be based simply on attitudes. It is essential to provide young people with the right information at school, as I find that certain myths about eucalyptus persist to this day, although history itself will undoubtedly take care of eliminating them in future. That way, what is an ideological debate can give way to a discussion based on rigorous technical data. ●

By Pedro Filipe Silva
Sustainability Manager at The Navigator Company

At the heart of the bioeconomy

The eucalyptus sector's contribution to the future of the economy, the environment and Portuguese society is today much more diverse and all-encompassing that in the past. Substantial investment in R&D is bringing new bioproducts, biomaterials, biochemicals and biofuels. These are innovative solutions which work within the circular economy model, offering sustainable choices. The unique properties of *Eucalyptus globulus* are at the heart of these innovation efforts and give Portugal a leading role in the new bioeconomy, thanks to the use of sustainable forest-based natural resources.

In order to ensure the sustainability of the planet, we need to make radical changes in how the modern economy works, developing innovative solutions, through new business models and promoting lifestyles better suited to these challenges.

This change entails the transition from a linear economy, based on fossil resources that generate waste, to a circular bioeconomy, founded on renewable resources, which minimises the effects on the climate, and makes full use of by-products and waste.

Initially launched in 2012, the European Union's first bioeconomy strategy was revised in 2018, with circularity and sustainability as the connecting threads, adopting the priorities of expansion and growth in scale of nature-based sectors, rapid implementation of local bioeconomies throughout Europe, and appraisal of the limits of the bioeconomy, in particular the sustainable supply of biological resources and consumer acceptance of bioprocesses and bioproducts.

In Portugal, the Action Plan for the Sustainable Bioeconomy was published in 2021, recognising that it is the only economic model able to respond to the challenges facing mankind. It is based on the need to promote the country's scientific and technological research; intelligent production and use of regionally based biological resources; circular and sustainable bioindustry, which introduces innovation in the value chain and processes; as well as knowledge and skills development through education and training.

The bioeconomy consists of producing, using, converting and regenerating biological resources, in order to find solutions that create value in a variety of economic sectors. It entails sustainably aligning the economy with renewable biological resources, working towards the substitution of fossil-based products.

THE EUCALYPTUS SECTOR AS AN ENGINE FOR INNOVATION

The biorefineries of the pulp and paper industry

Forests, and forest plantations in particular, play a central role in the bioeconomy, producing biomass that can be converted into bioproducts, substituting products obtained from petrochemicals.

With its operations based on these forest plantations, the pulp and paper industry is particularly well positioned to respond to the planet's sustainability challenges. This industry uses a natural resource as its main raw material, and tends to be neutral in terms of the balance of carbon emissions. In addition, its processes and products, which are recyclable and biodegradable, exemplify the best practices of the circular economy.

As a result, pulp and paper mills are evolving into true biorefineries, with the aim of maximising efficiency and sustainable use of biomass, minimising waste and producing a variety of products with additional value.

Biomass from forests is one of the most important raw materials for biorefineries, enabling them to produce a range of materials, such a fibrous pulps for paper, cardboard and moulded products, as well as energy and fuels, not to mention chemical compounds for multiple applications. By offering, for example, an alternative to the cereal

Forest plantations are essential to the bioeconomy, producing biomass that can be converted into bioproducts that replace those derived from fossil resources.

The Bioeconomy in numbers

According to figures from the European Commission, the European bioeconomy was worth 2.4 billion euros in 2019, generating 750 billion euros of gross value added (GVA), the equivalent of 4.7% of the EU's GDP, as well as 10 million jobs. These figures include the agriculture, silviculture, fisheries, food and pulp and paper production sectors, as well as the chemicals, biotechnology and energy industries.

Also according to the European Commission, the Portuguese bioeconomy represented turnover in 2017 of 41 billion euros, generating 11.7 billion euros in value added - which corresponds to 7% of GVA, above the European average. It also provided employment for 685 thousand people.

Further figures from the European Commission show that forests contribute 25 billion euros of value added in the bioeconomy sector, and paper and cardboard 48 billion euros of GVA, i.e. 7% of the European bioeconomy.

Worldwide, the World Bioeconomy Forum estimates that the bioeconomy has a value of approximately 4 trillion dollars, and is expected to represent one third of the world economy in 2030.

European Union (2019)

2,4 trillion euros
Turnover

750 billion euros
Gross Value Added (GVA)

18 million
Jobs

Portugal (2017)

41 billion euros
Turnover

11,7 billion euros
Gross Value Added (GVA)

685 thousand
Jobs

Forestry sector industries (Portugal, 2017)

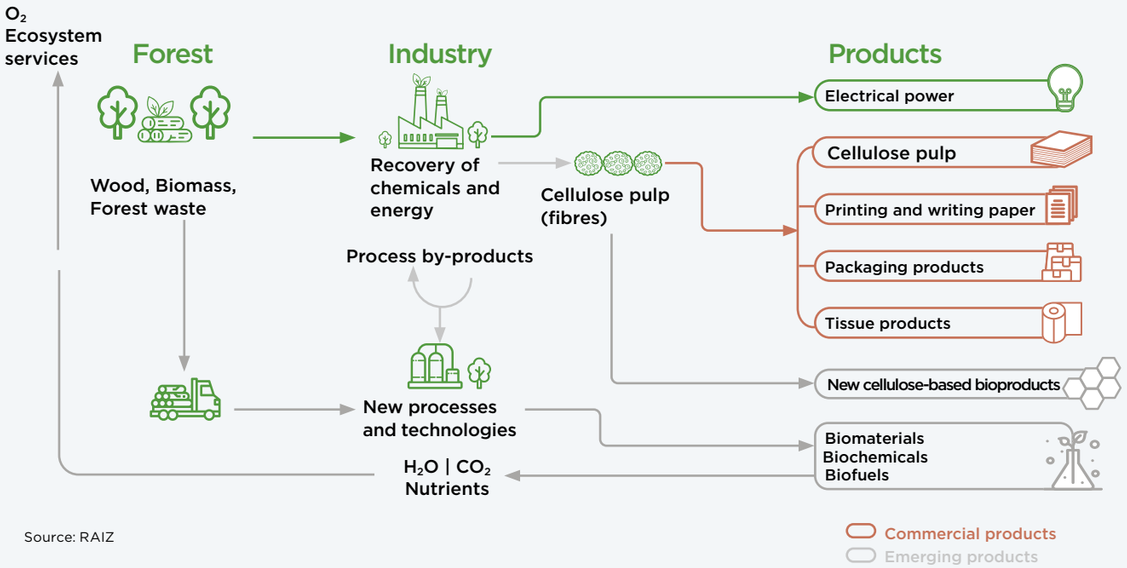
24%
of total turnover of Portuguese bioeconomy

9,8 billion euros
Turnover

76,5 thousand
Jobs

Biorefinery concept applied to the pulp and paper industry

Biorefineries, and especially pulp and paper mills, perform an important function in the bioeconomy, driving the transition to a more sustainable economy, centred primarily on renewable resources and eco-efficient processes. In these facilities, wood and forestry biomass, as well as industrial and forestry by-products, are converted, through energy-efficient and environmentally friendly processes, into cellulose fibres, paper materials, bioenergy, biofuels and bioproducts that are alternatives or equivalent to products derived from petrochemicals, making this sector a pillar of the modern circular bioeconomy.



Source: RAIZ

starches and food oils used as raw materials in bioplastics and biofuels, forest biomass can reduce the pressure on the use of agricultural soils for non-food purposes.

Innovation as a way of life

The characteristics of *Eucalyptus globulus* wood are the reason why the Portuguese pulp and paper industry has long found itself at the forefront of international developments. Going against established international practices and received ideas in the sector, the 1950s saw Portugal lead the way in production of cellulose pulp from *E. globulus* using the kraft process, as well as printing and writing papers from 100% short fibre pulp. Portugal is today the European leader in the production of bleached pulps and printing and writing papers, produced using these fibres.

More recently, the country has again been the first in the world to produce packaging papers made from 100% *E. globulus* fibre - papers with competitive advantages thanks to their mechanical properties, their capacity for recycling, and 20% faster composting at the end of their life cycle. Tissue papers produced with fibres from this species also offer excellent softness, making them competitive today on international markets.

This success story is far from running out of steam. Faced with the need to reduce the use of fossil materials, in the form of energy or raw material, the properties of *Eucalyptus globulus* are making this species one of the leading players in the new forest-based bioeconomy.

The capacity for innovation has proved unstoppable, thanks to the investment in research and development that that sector has made in order to explore the unique characteristics of wood and cellulose fibres from *E. globulus*, most notably the work carried out by RAIZ and its associates and partners in the

Did you know?

New plantations protect native woodlands

According to the United Nations Food and Agriculture Organisation (FAO), around two thirds of the wood and biomass consumed each year comes from native forests, resulting from natural regeneration. The planted forests that exist are not sufficient to meet the global demand for raw material. Global wood consumption currently stands at 2.2 billion cubic metres per annum, and an increase of 30-40% is forecast by 2050.

In order to satisfy this growing demand and to preserve native forests around the world, the FAO estimates that approximately 33 million hectares of new forest plantations will be needed.

national science system.
This investment and innovation drive is resulting in new bioproducts, biomaterials, biochemicals and biofuels, some of them on the drawing board and others already in production, with the potential to generate new business opportunities. Examples of these are the new applications of cellulose fibres in fibre/thermoplastic composites, bioactive compounds derived from eucalyptus leaves and bark, and advanced biofuels.
The results of the innovation under way, irrespective of whether the processes and bioproducts are at the development, pre-industrial trial or production stage, show that Portugal's forest plantations of

Portugal is uniquely well placed to assert itself as a global player in the new forest-based circular bioeconomy.

Eucalyptus globulus give it a huge competitive advantage for performance of the bioeconomy in the sustainable use of natural resources.
This high-performing bioeconomy adds value to the forestry sector through new products, including use of waste from forestry and industrial operations to generate additional value for the chain in the pulp and paper industry. It also offers the possibility of decarbonising other activities, for example by producing packaging to substitute plastics, or producing biofuels and e-fuels.
With its eucalyptus forests, its industrial ventures, its universities and research and development centres, and supported by the right public policies, Portugal is uniquely placed to assert itself as a world-class actor in this new forest-based circular bioeconomy. All this offers it the chance to contribute to cutting fossil carbon out of the economy and mitigating climate change, by taking a full part in the fourth industrial revolution: the bio-revolution. ●

Emerging bioproducts based on cellulose fibres and chemical compounds derived from *Eucalyptus globulus*

The innovative solutions based on *E. globulus* fit within the model of the circular economy, where the founding principle is that nothing is wasted and that everything has its purpose, providing consumers with sustainable choices, which help the world adapt to climate change.

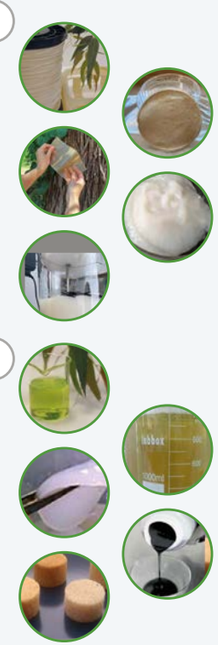
Process by-products
Fertilisers/soil conditioners, concrete, geopolymers and bituminous materials

New cellulose-based bioproducts

- **Thermoplastic biocomposites**
  Plastics industry, automotive industry, packaging, textiles, 3D
- **Cellulose-based biocomposites to substitute leather**
  Substitute for animal leather
- **Nano-and microfibrillated cellulose**
  Packaging, food additives
- **Prebiotics**
  Nutraceuticals, health

Biomaterials, Biochemicals, Biofuels

- **Essential oils and bioactive compounds**
  Cosmetics, nutraceuticals, health
- **Bioethanol and biomethanol**
  Biofuel
- **Bacterial nanocellulose**
  Food additives, cosmetics, packaging, ballistics
- **Lignin and polyols**
  Thermal insulation foams, adhesives, cements



The prominence of *Eucalyptus globulus*

Eucalyptus globulus has properties that make it an outstanding raw material, enabling Portugal to lay claim to a competitive and strategic lead in the new forest-based bioeconomy.

Lower chemical loads
The composition and chemical structure of *E. globulus* wood features a comparatively high content of cellulose and hemicellulose, and a lower lignin content, meaning that up to 20% less chemicals are needed in the industrial process. The yield of cellulose pulp is also 10% higher than for other hardwoods.

Less energy
The high hemicellulose content means that less energy is needed in the process and that the resulting paper features greater mechanical strength when compared with paper from other hardwoods.

Less water
Because the lignin content is lower and also because less chemicals are used, the industrial process also needs less water, when compared with wood from other species; and given that there are less compounds to remove when washing and bleaching the fibres, there is less effluent to recycle or treat.

Less wood
Its high density means that less wood is needed to produce the same quantity of pulp. Consumption of *E. globulus* wood can be 20% lower than for other species.

Better quality paper
E. globulus has a cell structure with thick walls, a high proportion of short fibres and also a greater number of fibres per unit of mass than other species. This makes it possible, for instance, to obtain printing and writing papers with high levels of opacity and smoothness, packaging papers that use less fibre, but feature equivalent mechanical properties, as well as softer tissue papers.

More recycling cycles
The special characteristics of *E. globulus* fibre mean paper can be recycled up to six more times than fibres from other eucalyptus species or from other hardwoods or conifers; in kraftliner packaging paper, *E. globulus* fibres withstand up to five more recycling cycles that fibres from Scots pine, giving it the edge in the circular economy.

More paper from less wood
Eucalyptus fibre makes it possible to produce the same quantity of paper, in square metres, using only half the wood that would be needed if Scandinavian conifers were used. Thanks to the superior yield from the wood, the speed of growth in the forest, and the possibility of producing lighter-weight papers, *Eucalyptus globulus* enables us to produce an area of paper or cardboard five to seven times greater from the same area of woodlands, than if it were planted with the Scandinavian pine species. ●

The bio-revolution within everyone's reach

The Navigator Company recently started up production at its new moulded cellulose unit in Aveiro, making it the first company in the world to produce this type of packaging in a vertically integrated plant, using eucalyptus fibre.

A The first moulded cellulose articles reached the food market in October last year, responding to the ever more pressing need to substitute plastic, aluminium and polystyrene packaging.
These products make up the new Bioshield range, under the gKRAFTTM brand, and are 100% recyclable and/or compostable. They are targeted at the food retail, hotel, catering and restaurant sector. They include articles such as plates, bowls and glasses, as well as takeaway packaging. In the agro-food industry, the new moulded cellulose packaging will substitute the plastic packaging and wrappings normally used for raw meat and fish, ready meals, fruit and vegetables.
Moulded cellulose products produced from eucalyptus fibre are part of the From Fossil to Forest Agenda, under the Recovery and Resilience Plan (RRP). This agenda is led by Navigator and has set out to create cellulose-based packaging and products designed to substitute fossil-based plastics.

Made in Portugal, from Portuguese raw materials
This is the first time, anywhere in the world, that a company has produced moulded cellulose packaging from eucalyptus fibre on an integrated basis. As well as being made in Portugal, these products use Portuguese raw material.
The cellulose fibre used by Navigator is produced from certified wood, sourced from sustainably and responsibly managed forests. This is in sharp contrast to other renewable raw materials which are also used in packaging, such as sugar cane bagasse, which are not subject to the same scrutiny by independent bodies, reaching the European market without any certification.

Research: onwards and upwards
The research into moulded cellulose made from 100% eucalyptus fibre started at the laboratories of RAIZ, the forestry and paper research institute. Investment in human and technical resources enabled it to conduct studies and pilot projects to check out the suitability of *Eucalyptus globulus* to new uses, including barrier properties against water, oil and fats, and oxygen - important features in food packaging.
In comparison with transparent plastic packaging, and even when it uses a plastic film to ensure barrier properties, moulded cellulose packaging makes it possible to replace 90% of the fossil-based materials with renewably sourced materials, which are also biodegradable or compostable.

100% plastic free
The same spirit which has brought the research this far is driving the quest for ever more efficient solutions for fossil-based materials offering barrier properties which can be an alternative to fossil-based plastics or chemicals.
Both through their close involvement with an array of technology start-ups and suppliers, and also through their own research, RAIZ and its academic partners are currently developing new and entirely sustainable answers, derived from renewable resources, which are also recyclable and/or compostable and which may soon find their way into our homes. ●

Navigator is the first company in the world to produce moulded cellulose packaging from eucalyptus fibre in an integrated process.

Where the new moulded cellulose packaging can be found

Tableware
Disposable articles such as plates, bowls and glasses, alternatives to those imported from Asia and made from sugar cane bagasse.

Takeaway
Packaging for food retail, hotel, catering and restaurants, an alternative to the traditional packaging made from plastic, aluminium or plastic-coated paper.

Industry
Packaging for the agro-food industry, offering an alternative to 100% plastic packaging for raw meat and fish, ready meals, fruit and vegetables.

The Bioshield range makes it possible to reduce the quantity of fossil-based materials by 90%, maintaining the possibility of recycling the plastic component when it is needed.

From eucalyptus to the tank: the next generation of sustainable fuels

At the heart of the bioeconomy, *Eucalyptus globulus* has also emerged as a key player in the energy transition, which relies on the conversion of forestry residues and industrial by-products into biofuels and synthetic fuels, alternatives to those obtained today from fossil resources. From biomethanol for shipping to e-fuels for aviation, the pulp and paper sector's bioindustries offer a sustainable response to the need for decarbonisation. And Portugal is uniquely positioned to lead this effort.

"Biofuels", "e-fuels", "bioethanol", "biomethanol", "SAF", "e-SAF"...

As the world turns increasingly to decarbonisation, our vocabulary is growing to include terms that a decade ago were rarely seen outside specialist research papers. These are all the names of different products, with one essential feature in common: they are variants in a new generation of fuels able to successfully replace those which are obtained today from petrochemicals.

Carbon neutrality is the most visible advantage they offer, combined with another which is just as important: these liquid fuels are highly compatible with existing infrastructures and technologies, including the internal combustion engine. This will ease the way of the energy transition in sectors where electrification is especially complex, such as aviation and shipping.

Biofuels for aviation, known as SAFs (Sustainable Aviation Fuels), currently represent 2% of the fuels used in aviation, but this share is set to rise to 6% as early as 2030, under the targets set by the EU. And synthetic fuels, or e-SAFs, more complicated to produce and at an earlier stage of development, will have to rise to 1.2% by the same year.

As early as 2030, it is estimated that the market for synthetic fuels for aviation and shipping could be worth double the existing European market for eucalyptus cellulose pulp.

Considering only synthetic fuels for aviation and shipping, it is estimated that in 2030 this market could be worth double the existing European market for eucalyptus cellulose pulp.

The comparison is not arbitrary: the fact is that paper sector bioindustries are especially well positioned to produce these fuels. Potential industrial projects in this field are currently being studied, taking advantage of Portugal's unique conditions for producing these new bioproducts: forestry plantations of eucalyptus, the paper industry and a climate suited to production of renewable energy, essential if the fuel is to be carbon neutral.

Recent research by The Navigator Company shows that, of the 140 pulp mills existing in Europe, only 49 are on a relevant scale and, of these, only 10 have an appropriate geographical location. In this small group, three belong to Navigator. The company is looking into the production of biofuels (biomethanol, bioethanol and biomethane) in the medium term, and is also contemplating, in the medium-to-long term, production of synthetic fuels (e-methanol and e-SAF).

But what's the difference between "biofuels" and "e-fuels"? And what makes the paper industry so well placed to produce them?

THE EUCALYPTUS SECTOR AS AN ENGINE FOR INNOVATION

Biofuels: a natural origin

Biofuels are produced from forestry waste and by-products from the industrial process for producing eucalyptus cellulose pulp.

Cellulose-based bioethanol is produced through saccharification (the process of converting complex carbohydrates into simple sugars, which can be more easily fermented) of forestry waste and then fermenting it in ethanol. It can be incorporated in gasoline, as a second generation renewable fuel, or even converted into SAF for aviation.

It is also possible to recover methanol from the liquid by-products of the production process for cellulose pulp, known as black liquor. The resulting methanol is particularly suited to use as a biofuel in shipping.

E-fuels: the "e" that makes the difference

While biofuels are obtained by processing other biological materials, e-fuels, or synthetic fuels, derive from the combination - or synthesis - of green hydrogen and biogenic CO_2.

It all starts with the electrolysis of water, which means sending an electrical current through it, separating the oxygen and hydrogen molecules. This gives us "green hydrogen", so called when the energy used in the process is wholly generated from renewable sources. The next step is to capture biogenic carbon – the CO_2 sequestered by trees during photosynthesis - and then combining it with the hydrogen.

Here too, the paper and pulp industry is favourably placed to obtain biogenic carbon, essential for producing e-fuels: this gas is generated from the combustion of forestry waste or from the production process for eucalyptus pulp.

In the European Union, the law now states that, as from 2041, the only CO_2 which can be used for synthetic fuels is biogenically sourced CO_2. In this context, *E. globulus* biorefineries will have stocks of a valuable gas they can use themselves or sell on, in carbon credit trading, in an EU which will need biogenic CO_2 to meet its target of close-to-zero emissions in 2050.

So forest plantations of *E. globulus* and the associated industry look to be one of the most eco-efficient solutions for cutting out the fossil carbon of other hard-to-abate industries and economic sectors - where decarbonisation is more difficult - through the production of biofuels and e-fuels.

It is therefore clear that production of this new generation of fuels is closely linked to the existence of competitive bioindustries in the paper sector, where a critical factor is the availability of raw material.

The soil and climate conditions in Portugal for growing eucalyptus, unrivalled in Europe, are a huge competitive advantage for the country's bioeconomy and for growth in the country's Gross Value Added (GVA), on a par with other factors, such as the total number of hours of direct sunlight in Portugal, which brings down the costs of generating solar power, and is in turn key to the competitiveness of the country's green hydrogen sector. ●

THE EUCALYPTUS SECTOR AS AN ENGINE FOR INNOVATION

Innovation and expertise in silviculture

Silviculture is being transformed by the power of innovation and knowledge sharing. From genetic improvement to digitisation of operations, forestry practices are evolving to meet the challenges of climate change, fostering forests that are more productive, healthier and more sustainable.

The forest assets of companies using improved plant material and therefore achieving higher yields, have increased in recent decades, with around 5 thousand hectares replanted each year.

THE EUCALYPTUS SECTOR AS AN ENGINE FOR INNOVATION

Silviculture has evolved significantly in recent decades, driven by innovation and dissemination of technical and scientific knowledge. This progress reflects the growing importance of sustainable practices that maximise forest yields, reduce risks and protect the environment.
In Portugal, the ability of Eucalyptus globulus to adapt to the local soil and climate has turbocharged its potential as an engine for wealth creation. However, in order to seize this opportunity, heavy investment in research and development (R&D) has been essential. From growth and genetic improvement models, through to strategies for combating pests and diseases, Portuguese silviculture has seen advances designed to bring not just efficient production, but also the central environmental goal of sustainability.
R&D work on eucalyptus - undertaken by public bodies in Portugal's science and technology system, and by companies which have set up dedicated research centres - has addressed various aspects of forest management, including genetic improvement and plant propagation, protecting forests against pests and diseases, growth and silviculture models for plantations, E. globulus' relationship with soils and water, as well as characterisation of the raw material and its variability, and optimisation of industrial conversion processes.
At present, forestry operations are evolving thanks to new technologies and digitisation, whilst the expertise acquired is shared with producers and forestry officers. This transfer of knowledge is essential in order for up-to-date and suitable practices to be implemented, ensuring responsible and resilient forestry management.
From an early stage, research in silviculture looked at growth and production models for the species, genetic improvement, its susceptibility to pests and diseases, and its relationship with soils and water, as well as land preparation practices for planting, fertilisation and operation of stands on a coppicing basis, in which the strongest shoots (after felling the tree) are selected for a new cycle of growth, without needing any intervention in the soil.
More recently, other research topics have emerged, such as the species' relationship with the environment, in the context of climate change, control of invasive species, application of new technologies in the forest and digitisation of operations.

Growth and production models

In order to learn more about the suitability of Eucalyptus globulus to forestry operations and its potential yields in different soil and climate conditions, specific methodologies have been developed, such as edaphoclimatic (soil and climate) zoning, which have made it possible to divide mainland Portugal into more than 70 regions in terms of yields, with specific recommendations for each region in terms of the type of plants and silviculture practices.
This has enabled scientists to customise the different eucalyptus silviculture models adopted in Portugal. This methodology has also been used to map soils, the climate, yields by region, and biotic and abiotic risks.
At present, more than 200 thousand hectares have been characterised in this way, providing data which improves yield estimates in forestry investment plans, cutting production costs and pointing to the most suitable practices to use in different environments.

40 years of genetic improvement

Genetic improvement of eucalyptus brings gains in yields, improved resistance to pests and diseases and increased resilience to environmental stress factors. It has therefore been a subject of interest to academe and to R&D in forest-based industries.
Improved plants can be obtained from seeds, by crossing individuals with outstanding performance, or else from clones, using vegetative propagation of selected clones. Clones maximise gains in yields

Abiotic risks refer to "non-living" factors in the environment that may harm forests. For example, extreme climate conditions (prolonged drought, heavy rain...), fire, changes in the soil (erosion, compacting, acidification...) or pollution (contamination of the air, water or soil).

Biotic risks have to do with living organisms that may cause damage to forests. For instance, insect pests such as the eucalyptus snout beetle or processionary caterpillar, and diseases caused by fungi, bacteria and viruses, such as the pine wilt nematode.

thanks to the possibility of planting copies that feature the specific genetic characteristics of the selected individuals. These clones will bring gains of various kinds, in yields, resistance to pests and diseases, tolerance of drought and also relating to the properties of the wood.
At present, the genetic gains from clones and seeded plants improved by means of controlled pollination amount to more than 40% in volume of wood output , in relation to unimproved plants.
The success achieved with the genetic improvements made over the past 40 years by companies in the sector has resulted in expansion of their assets with improved plants - figures from Biond (Association of Forest-Based Bioindustries) point to growth of 5,000 hectares a year, with replanting to substitute older plantations as their vitality declines.

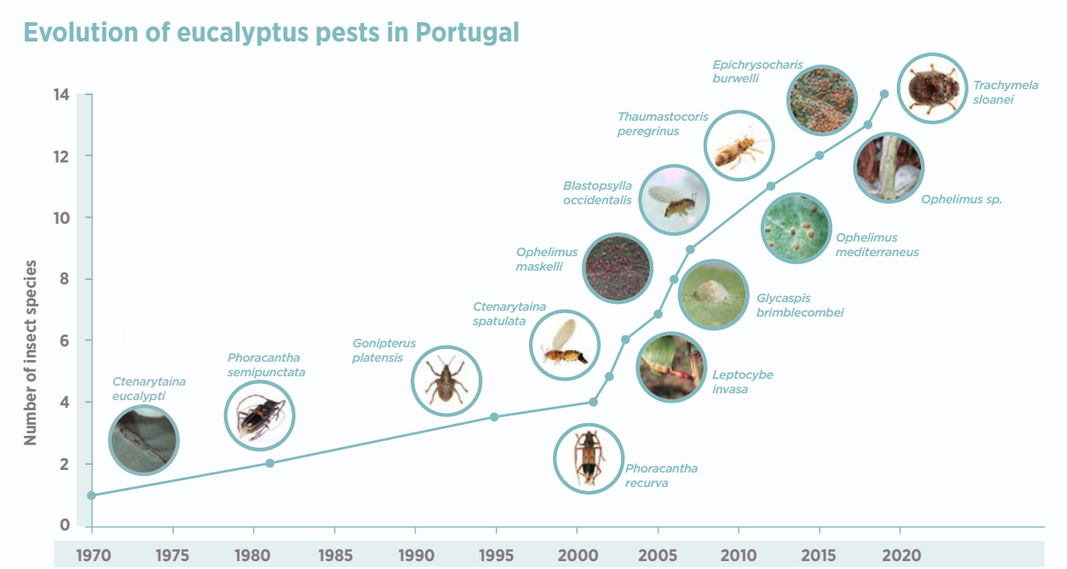
More than 200 thousand hectares have so far been mapped using the edaphoclimatic (soil and climate) zoning methodology developed by RAIZ, making it possible to characterise the local environment, provide forecasts of yields and information on the best forestry practices to adopt in each zone.

The improved plants that companies in the sector use in their forestry plantations are produced in their own nurseries, which also supply other operators.
Research into genetic improvement is today increasingly focused on the plants' tolerance of drought and of pests and diseases, in the context of climate change. In addition to genetic diversity, hybrids of various species of eucalyptus are available today, offering greater resilience, for example in the face of extreme drought or extreme rains, and also to severe attacks by the snout beetle. The use of hybrid plants makes it possible to obtain a more homogeneous forest, with lower mortality and better plant growth, more resistant to biotic and abiotic risks and with wood properties suited to industrial processing.

Control of pests and diseases
Pests and diseases have a huge impact on yields, and can compromise long terms investments in forestry. This is why forestry protection is a central area of interest to innovation and development departments in the eucalyptus sector, which look for solutions to combat these threats. What is more, there is much to be gained in this area by private and public sector research operations working together, with a view to integrated management of the pests and diseases that affect eucalyptus forests.
This research effort includes measures for biological control using parasitoids which are released into the environment. Among other solutions currently being studied, significant success has been achieved in using two natural enemies for the eucalyptus snout beetle and one for the bronze bug. One of the studies conducted in this field calculated that use of the insect Anaphes nitens, a parasite that feeds on snout beetle eggs, preventing the development of larvae, has made it possible to save at least 1,800 million euros in wood which would otherwise have been lost.
In addition to biological control, research into chemical control has pointed to the possibility of using plant protection products, already duly studied in terms of effectiveness and impact on the environment. In this case, pests can be reduced by up to 90%.

Operational advances
Huge advances have been made in eucalyptus silviculture in recent decades, thanks to research and development in different areas and at different stages of forest growth, from the installation and maintenance of plantations, through to wood extraction and the use of coppicing to achieve successive crops.

Outstanding progress has been made in land preparation operations, on the nutritional needs of plants and fertilisation practices, selection of shoots, control of undergrowth and wood harvesting processes.
For example, advances in what we know about the nutrition of eucalyptus plants and soil fertility have made it possible to accurately calibrate fertilisation recommendations in line with variations in soil and climate conditions. Depending on the nutritional needs of the plant and the availability of nutrients in the soil, fertilisation can lead to gains in wood volume of 20 to 30%.
After felling, eucalyptus stumps are able to sprout shoots, which are selected and then managed over one or two rotations (growth cycles). Research has been conducted in this field from the outset, principally on selection of shoots, where good practice can increase the wood yield by 50%. Given this fact, the age of plants, the season of felling, and the number shoots to be left to grow in this forestry operation are among the topics most widely studied by technicians and researchers.
Other areas have also seen growth, with consequences for forestry processes. The mechanisation of wood harvesting, for example, has brought increased sophistication, as well as efficiency gains. Digitisation and new technologies have also been factors in improving efficiency in managing and gathering forestry data.
For example, the new procedures and equipment have included the use of drones with sensors to quantify the volume of wood, use of technology to assess forestry biomass, and the use of practical new aids, such as smartphones, for inventories of forests and wood stacked in the field.
Important new areas of science have emerged and are being studied and developed in the industry with a view to continuous improvement of the processes and practices to be adopted in the field, such as the relationship between eucalyptus and the environment, particularly with regard to water and soil conservation, as well as, more recently, the tree's



capacity for carbon sequestration. In the context of the circular economy, growing attention has been paid to topics such as the influence of the stand management model on the productive capacity of the climate-soil-plant system, and the use of industrial waste for recycling and returning nutrients to the forest environment.

The new knowledge produced provides a strong technical and scientific rationale for the forestry practices used in eucalyptus plantations, pointing to the best procedures to be adopted in the field. This kind of responsible management, ensuring equity in economic, social and environmental value in forests, is promoted and encouraged by forest certification schemes, which the industry embraced at the start of the century.

Knowledge which has to be shared

For decades, the expertise generated by the forestry industry was hard for forestry producers and operators to access. However, growing environmental and economic demands, combined with the degradation of forest stands, have made the situation more urgent: the sharing of technical knowledge and promotion of good forestry practices have become crucial to revitalising the sector and encouraging forest management that maximises the yields of stands, reduces risks and rewards investment by forestry producers, at the same time as minimising environmental impacts.

But the work of sharing knowledge is far from straightforward. The obstacles to rapid implementation of change in the sector include a land ownership structure with thousands of smallholders, some with less than five hectares, who take a conservative view of how to manage their land.

The industry has responded with practical initiatives to speed up change in forest management, such as the Better *Eucalyptus*, Clear and Fertilise, and Better Forest programmes, implemented by Biond.

In order to establish a closer relationship with active forestry producers, the industry is investing in training for forestry officers who work in forestry producers' organisations and in certification groups. One of the projects under way is the TEC Forest Programme, which consists of transferring technical and scientific knowledge tailored to recipients, to whom, in addition to training on matters of silviculture, the industry offers support to encourage forest certification and other management initiatives.

The Premium Programme is another initiative, responding to the specific problems and issues faced by individual producers in managing their eucalyptus woodlands. It has already provided support for holdings covering more than 10 thousand hectares, promoting adoption of appropriate silviculture techniques and improving yields.

Knowledge sharing and collaboration between industry, forestry producers and forestry officers have been crucial in addressing the sector's challenges and working towards a more sustainable future. With targeted strategies, it is possible to reverse the abandonment of forests, to ensure a professional approach to woodlands management and to achieve a positive impact on yields and the environment. ●

Portugal, a key player in the European forest-based bioeconomy?

Portugal has everything it needs to be a leading player in the European forestry bioeconomy, anchored in the pulp and paper industry, alongside Scandinavian countries, contributing decisively to reducing our dependence on fossil resources and to mitigating climate change: (i) it has highly innovative companies, which are leaders on the international markets, with industrial units evolving into biorefineries, diversifying their portfolio of bioproducts, (ii) it possesses unique soil and climate conditions for producing the world's premium raw material for this sector, *Eucalyptus globulus*, and (iii) it has R&D and innovation centres, in the public and private sectors, recognised by their international peers, which are generating knowledge and transferring it to the forest and to industry.

All the same, success is not a foregone conclusion. We are living through a critical period in this journey, and if the country as a whole fails to embrace the challenge, the future of the sector could be compromised, along with Portugal's targets for carbon neutrality.

In order to assert and consolidate this leadership position, we need to assure the availability of home grown raw material, reducing imports of wood, generally or poorer quality and a larger ecological footprint.

Portugal has to embrace forestry as a strategic sector, with a long term vision supported by scientific expertise, and free of ideological bias, respecting the appropriate balance between planted forests on the one hand, and conservation woodlands and species diversity, on the other, whilst all the time preserving biodiversity. Without doubt, careful regional planning can identify space for growth, and economic and management capacity can be directed at forests. More than 30% of land is classified as scrubland and pasture, and part of this can be converted to forest, valuing and remunerating what are called ecosystem services.

In order for the country to have well planned, productive and resilient forests, we also need skilled human resources. However, courses in forestry sciences and technology in further and higher education have been losing their appeal to Portuguese young people, with a direct impact on the availability of skilled manpower. It is essential to establish a national programme, with support from companies in the sector (which have done their bit, within their particular sphere), in order to promote forestry training and to raise the status of occupations connected to forests and the forest-based bioeconomy.

In the field of R&D, innovation and technology transfer, both in forestry and in the processes and products of forest-based industries, the capacity exists for the country to do more and to do it better. It is essential to concentrate public investment in R&D&I in the areas and clusters of the greatest relevance to the country's economy, using medium-to-long term structural programmes to support stakeholders throughout the value chain.

Because of its important contribution to Portugal's exports (8%, of which 51% are from the pulp and paper cluster), the forest-based bioeconomy needs cross-party agreement to be reached on a long term vision and strategic plan, supported by appropriate public policies, expertise and science, as well as public and private funding, mobilising all the actors in the field.

Only then will Portugal be able to consolidate its position as a leader of the European forest-based bioeconomy. ●

By Carlos Pascoal Neto
Director-General of RAIZ – Forest and Paper Research Institute

Caught between preconceived ideas and the facts

A survey conducted by ISCTE set out to explore what the Portuguese know about planted eucalyptus forests. And also to discover how much of that “knowledge” is based on beliefs with no scientific foundation. Discover the main findings of this comprehensive study, which involved more than 600 participants.

The Navigator Company wanted to understand what people in Portugal believed about eucalyptus. This was why, as part of the *Eucalyptus* Forum, the Marketing Future Cast Lab at ISCTE conducted a study entitled “Beyond perceptions of the forest and eucalyptus”. The survey involved listening to more than 600 people.

Almost a third (31.8%) of the participants said they owned forestry land or had family members who did - a figures that reflects the strong ties between the Portuguese and their forests. Of this group, more than half (545) had areas of eucalyptus. However, on many of the issues addressed, their close relationship with the forest was not reflected in real knowledge.

Environmental benefits are not recognised

The role of eucalyptus in sequestering carbon dioxide is far from being common knowledge. The assertion that “*Eucalyptus* is one of the trees that captures the most carbon dioxide and releases the most oxygen per area of woodlands” left many shrugging their shoulders: 46% of participants “didn’t know/didn’t answer”.

Likewise, the contribution of eucalyptus to combating soil erosion also proved to be something people didn’t know about: 41.6% of participants agreed with the belief that the species depletes the soil, as it consumes more nutrients, whilst 34.1% “didn’t know/didn’t answer”.

As for the impact of planted eucalyptus forests on management of water resources, half of those surveyed (49.5%) believe that this species consumes more water than others, and are unaware of its efficiency or its contribution to combating hydrological imbalances.

The importance of eucalyptus to the Portuguese economy

By a large margin, people associate positive economic advantages with planted eucalyptus forests: the sector generates thousands of jobs (only 4% of participants disagreed with this assertion), and eucalyptus improves interior regions of the country (only 19% disagree).

But it was also found that little was known about the importance of eucalyptus in the transition to more sustainable development models.

Confronted with the assertion that “Portuguese eucalyptus presents excellent properties for producing products to replace others derived from petroleum”, 45.4% “didn’t know/didn’t answer”.

Likewise, although people acknowledged the importance of the species to Portuguese industry and the economy, the participants showed little awareness of the growing need to import eucalyptus wood. Only 27% were aware of this need. Of these, 51% are in favour of the idea of expanding the area of planted eucalyptus forest.

Unmanaged forests are associated with greater risks

Most respondents (72,3%), agree with the idea that forest management is beneficial, irrespective of the species planted.

And many people believe that too much forested land has been abandoned: 69% think that most forests in Portugal have been abandoned and only 5% think that most woodlands are well managed.

There is consensus on the relationship between forest management and fires: most respondents (75.8%) agree with the idea that “Properly managed forests are less at risk of fire”.

Forest certification turned out to be something few people knew about. When asked “Are you aware of what a certified forest is?”, 51% of respondents said they were not and 27% “didn’t know/didn’t answer”.

72,3%
agree that forest management is beneficial, irrespective of the species planted.

75,8%
agree that well managed forests are at less risk of fire.

Broad agreement on the need for more forest

The respondents in the survey were in favour of a “cross-party” or “long term agreement” being reached in Portugal on a future forestry policy that does not limit the planting of any species. 61% agree that this is a necessary measure, or would be useful, provided the environmental and land use rules in force are respected and those plantations are properly managed.

There was also substantial agreement on the idea of a policy for expanding the forested area in Portugal, conciliating production species with others which have conservation value. 66.2% of respondents are in favour of more forest, whilst only 6.8% were against this. ●

The Study

The study “Beyond perceptions of the forest and eucalyptus” was designed and conducted by the Marketing FutureCast Lab, at ISCTE – Instituto Universitário de Lisboa, from January to March 2024. This in-depth survey involved more than 600 people. Some of the respondents had a connection to the forest (as firemen, forestry landowners and workers in the sector), but a significant part (which includes teachers, local councillors and the general public) had no direct connection with the topics addressed.

The ISCTE team divided the project into three approaches: focus groups (conducted in Santarém, Leiria, Vila Nova de Poiares, Luso and Póvoa de Lanhoso), individual interviews, conducted by telephone, and a questionnaire sent to a sample of 604 participants (where the shares for the variables of gender, age, region and level of education corresponded to the distribution of the population of mainland Portugal). ●

“We heard people express anger at how forests have been abandoned”

How can we identify perceptions? Can they be measured or quantified? Pedro Dionísio, professor at ISCTE and coordinator of the study “Beyond perceptions of the forest and eucalyptus”, takes us behind the scenes of this survey – conducted by the FutureCast Lab at ISCTE –, and sheds light on the methodologies that ensure the findings are sound and scientifically well founded.

Pedro Dionísio presented the main findings of the study “Beyond perceptions of the forest and eucalyptus” at the first session of the *Eucalyptus* Forum, held at ISCTE, in Lisbon.

What were the main objectives behind this study?
The main objective was to identify the perceptions of different groups in relation to forests in general and eucalyptus in particular. In other words, to understand not just how people in Portugal look at forests, but to go further and understand how they see this species. Another aim entailed discovering what measures a representative sample of the Portuguese populations felt were relevant to improving forest management.

Did the topic present your team with any specific challenge?
It wasn’t a complicated survey. The greatest challenges are when there are no respondents, when it is hard to find people with the profile we are looking for. In relation to forests, the question didn’t arise. In the focus groups we had a few more heated discussions, but you couldn’t say that this constituted a difficulty.

What type of discussions?
We found that people were extremely indignant and expressed feelings of powerlessness because, the participants said, governments come and go, but the situation of the forest, as regards fires, doesn’t improve. And there are also feelings of anger, in view of the reality of woodlands which are abandoned and neglected. The people who take care of their land and comply with the legal requirements often end up being prejudiced by those who have abandoned their land. This was the main reason for a certain sense of indignation that we were able to witness.

In these focus groups, did people tend to disagree more or to reach a consensus?
I remember that all the participants were in agreement about the need to manage forests in order to reduce the risks. Firemen and representatives of the civil defence authorities showed a very clear awareness of the enormous difference that exists between forests that are well tended and those which are not, when it comes to fighting a fire.

And about what should be done?
There was a consensus that a policy or long term agreement is urgently needed so as to be able to create value for the sector. Forest land is abandoned because it’s not profitable and it’s not profitable because its been abandoned. There is a clear need to break this cycle.

Did the team notice any sharp differences between the perceptions of those with connections to the forest and those of public opinion in general?
The greatest problem is that forests only make it on to the news when there are fires. *Eucalyptus* is demonised, when people who know about forests assure us that the problem is not any one species, but rather the lack of management - and this became clear from the discussions over the course of the survey.

What did people say about this?
Poor planning and the lack of management were identified as the main problem. For example, there are areas of eucalyptus and other species which have been completely abandoned. The fire brigades are the first to point out the problem and tell us that it’s impossible to enter certain areas, because of the lack of active management. In regions with forests, people are generally very aware of the importance of management as a factor reducing the fire risk. These are people who know that large fires have to do predominantly with this issue and not with it being one species or another.

Is it this side of the survey, listening to “what should be done”, that the title refers to?
Yes, precisely. “Beyond perceptions of the forest and eucalyptus” because the aim was precisely to “go beyond” perceptions. In other words, to enumerate the strategies and measures that the participants call for as potentially beneficial for better forests. One idea that is broadly supported, for example, is that it is preferable to have well managed planted forests with several species rather than areas of unmanaged scrubland, which bring little value to the community.

What methodologies were used in the survey?
We sought to have a qualitative approach and also a quantitative approach, and for that purpose we used different tools. The first was to organise focus groups - meetings of eight to ten people, with a moderator, which follow a pre-established script. We also conducted individual interviews, also as part of the qualitative approach, talking to specialist stakeholders, such as university lecturers or environmentalists, whose perspectives enriched the study and were important for designing an appropriate questionnaire, able to respond to our objectives.

So the questionnaire was the basis for the quantitative study?
Precisely. In the quantitative approach, we sought to be representative of the whole country, from north to south.

Is it normal for these different tools to be used to complement each other in this type of survey?
Yes, if the aim, like it was here, is to arrive at an all-round view and a multifaceted perspective. Issues raised in the qualitative study were then assessed quantitatively, and this gives us significantly more comprehensive findings. ●

“Forest land is abandoned because it’s not profitable and it’s not profitable because it’s been abandoned. There is broad agreement on the urgent need to break this cycle.”

Can eucalyptus forests improve soil quality?

Given that eucalyptus plantations are located, as a rule, on relatively infertile land, unsuited to farming, if forests are then managed using good planting and maintenance practices, they can improve the fertility of the soil and avoid erosion.

Well managed planted forests, which are compatible with the terrain and the climate conditions, can play a similar role to that of natural forests in protecting the soil. This is a scientifically proven fact. *Eucalyptus* forests are no exception: plantations of this species actually present a lower risk of erosion and physical degradation of the soil than other types of plant cover and land use, and the annual nutritional needs of eucalyptus are significantly more modest than, for instance, got agricultural crops.

In Portugal, much of the soil is naturally unsuited to agricultural use, because the terrain is so rugged, and because the soil is very stony, offering naturally low levels of fertility and little depth for roots. The best alternative to farming is therefore forestry plantations. In these areas with poor soils, responsibly managed forest stands not only avoid the land going to waste but also take on the productive and ecological functions that trees perform in ecosystems, with the result that soil quality is correctly managed.

Customised management

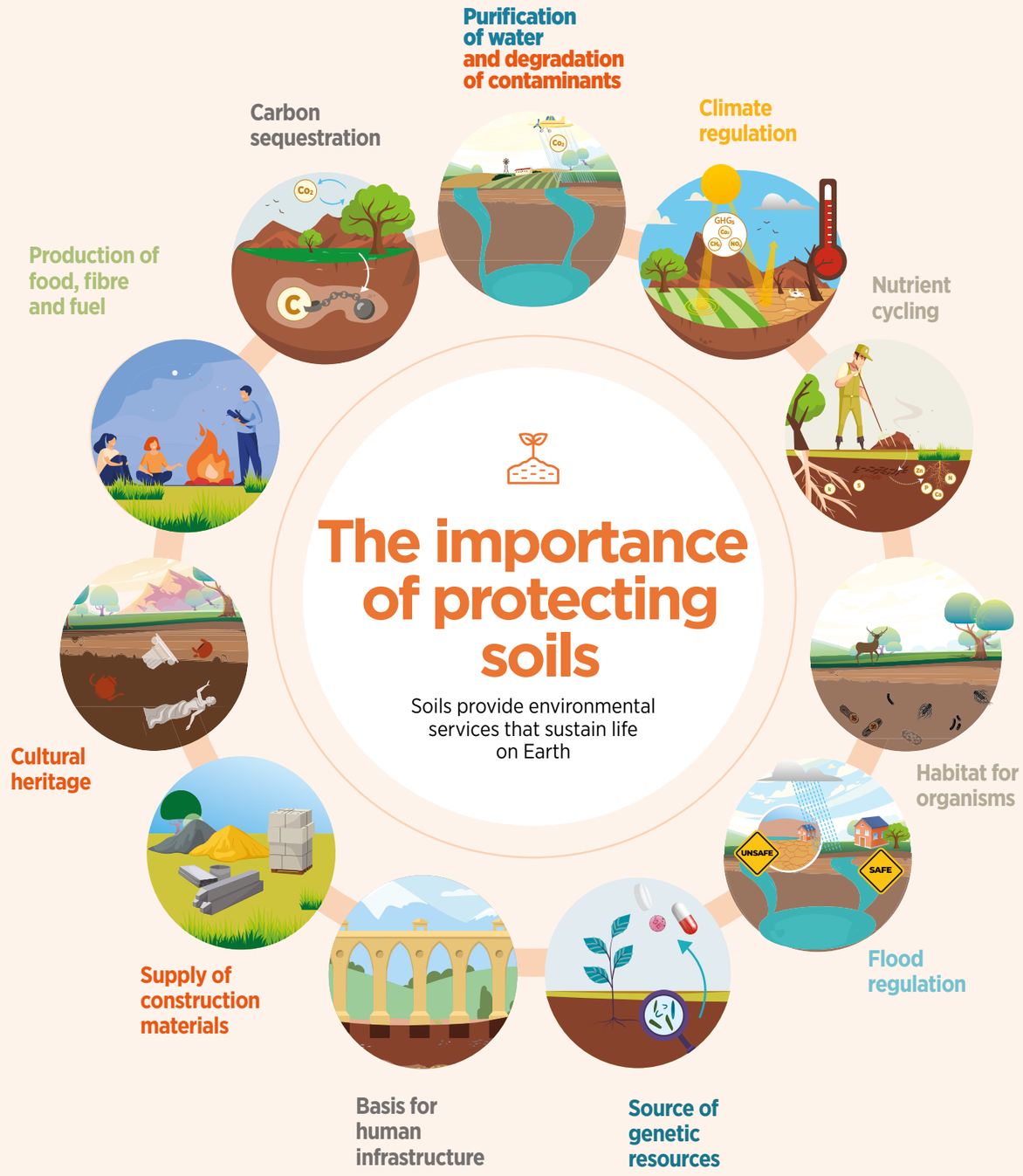
Although, as a rule, natural forests or plantations with longer growth cycles offer more protection against processes of degradation, planted forests with shorter cycles, such as eucalyptus plantations, are able to play a similar role. And, according to science (we can cite studies from 1996, 2000 and 2015), the effects of production forests on surface water run-off, which influences erosion, depend more on the climate conditions, the quantity, distribution and intensity of rainfall, the topography, how the land is prepared, and the existence of undergrowth, than on the species planted.

The key factor, of course, is that the management practices applied should be compatible with the local soil and climate conditions. Then, in the case of eucalyptus, there are also the benefits offered by the possibility of coppicing as a management technique, leaving one

By using the natural shoots from eucalyptus stumps after felling, on average for three rotations, in other words, more than 30 years, growers avoid the need to till the soil in order to plant new saplings.

Did you know...

In Portugal, it is estimated that around 50% of the total organic carbon stored in forest areas is found in the soil. Studies suggest that an even greater proportion is retained in *Eucalyptus globulus* plantations, as the amount accumulated in the soil, down to a depth of one metre, can exceed 20 kg C/m^2.



Source: FAO 2015

Source: Quideau et al. 2023

Soil conservation techniques in eucalyptus plantations

- Leave in place the litter layer (the accumulation of organic waste on the soil surface) and leftover materials from tree felling, in order to encourage the accumulation of nutrients and organic carbon.
- A fertilisation plan adjusted to the nutritional needs of the stand, which vary with the soil characteristics, and also the age of the trees.
- Minimal soil mobilisation, so as not to affect its physical properties, reducing the risk of surface run-off of rain water and the rate of evapotranspiration.
- Adjusting the forestry operation system to meteorological conditions, the topography of the land and the vulnerability of the soil to erosion and compaction. ●

Carbon from animals and plants, which is combined with other elements such as hydrogen, nitrogen and sometimes oxygen.

or two shoots from each stump, after the trees are felled, over three rotations (growth cycles). This is a traditional method which avoids radical intervention in the soil and so contributes to important ecological processes. On the one hand, it reduces the soil's direct exposure to raindrops, which causes disaggregation (the first step in the erosion process), and to sunlight, which can raise the temperature of the soil, thereby increasing evaporation, especially in hotter weather. It also reduces erosion risks because the soil is physically protected by the waste forestry biomass that remains on the ground (such as leaves and roots from previous rotations), which also increases the level of organic matter in the soil. Lastly, this type of forestry operation makes for more efficient control of spontaneous

When coppicing is used to renew eucalyptus plantations, it avoids any deep intervention in the soil, thereby contributing to important ecological processes.

vegetation and at the same time contributes to a greater diversity of plant and animal species under the trees.

Fertility and more

Although eucalyptus is highly efficient in using nutrients, because the land used for plantations of the species in Portugal generally presents naturally low levels of fertility and is acidic, growers add materials to the soil, such as lime, which neutralises acidity, and apply mineral fertilisers at the time of planting and during the first four years of growth. These are good practices and help ameliorate the quality of the soil.

At the same time, given that leaves are one of the forms of biomass with the highest nutrient content, the leftover materials from felling, such as the roots that remain the ground after wood extraction, help boost the wealth and dynamics of the micro-organisms in the soil, which are essential for the decomposition of organic matter and the recycling of nutrients.

A recently published study shows that the carbon stock in the surface layer of the soil (down to a depth of 30 cm), in Portuguese eucalyptus stands, can in some cases represent more than two thirds of the total stock in the plantation. The highest contents are in regions with the highest forestry yields, which shows that the fastest growing eucalyptus plantations make a significant contribution to carbon storage in the soil, underlining the fundamental role played by the species in mitigating climate change. ●

Perceptions versus reality

People say that eucalyptus forests deplete the soil... But the facts tells us that:

- Well managed planted forests can play a role similar to that of natural forests in protecting the soil. Forest management should opt for practices that increase levels of organic matter in the soil, boosting the sequestration of CO_2.
- Leaving the forest litter and leftover materials from felling on the ground, customised fertilisation plans, practices that involve less soil mobilisation and adjusting forestry operations to the lie of the land and the meteorological conditions: these are all important for improving the soil quality. ●

How do eucalyptus forests protect the water cycle?

Thanks to the species' efficiency in using this resource and the fundamental role of forests in completing the cycle. *Eucalyptus* has several characteristics which enable it to produce more wood with less water than other crops. And well managed plantations also help to protect water courses.

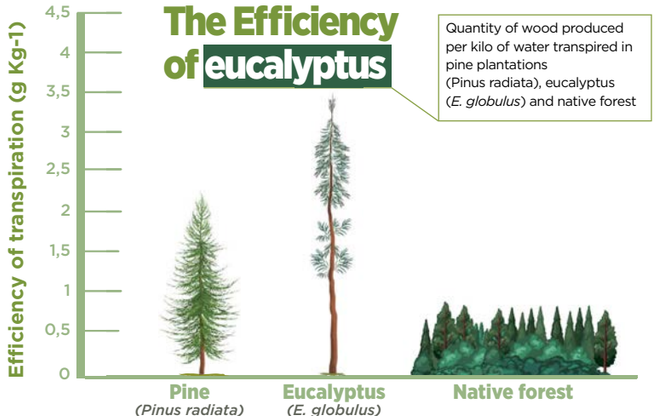
Although eucalyptus is a fast growing tree, compared to other forestry species, it does not need more water per unit of wood produced - this is a tree that uses water resources efficiently.

Studies conducted in central Portugal, as well as an analysis in 2022 of several world regions, show that water use is similar in eucalyptus forests (*E. globulus*) and pine forests (P. pinaster).

And a comparison between eucalyptus and pine plantations and native forests in Chile showed that eucalyptus was the most efficient.

So how do eucalyptus forests help protect the hydrological cycle?

Trees absorb water through their roots and convey it up the trunk and along the branches to the crown, where more than 95% of it is released into the atmosphere by means of transpiration, promoting the global water cycle. This is why we use the expression of "water use" by plants, rather than "consumption", insofar as most of the water returns to the cycle.

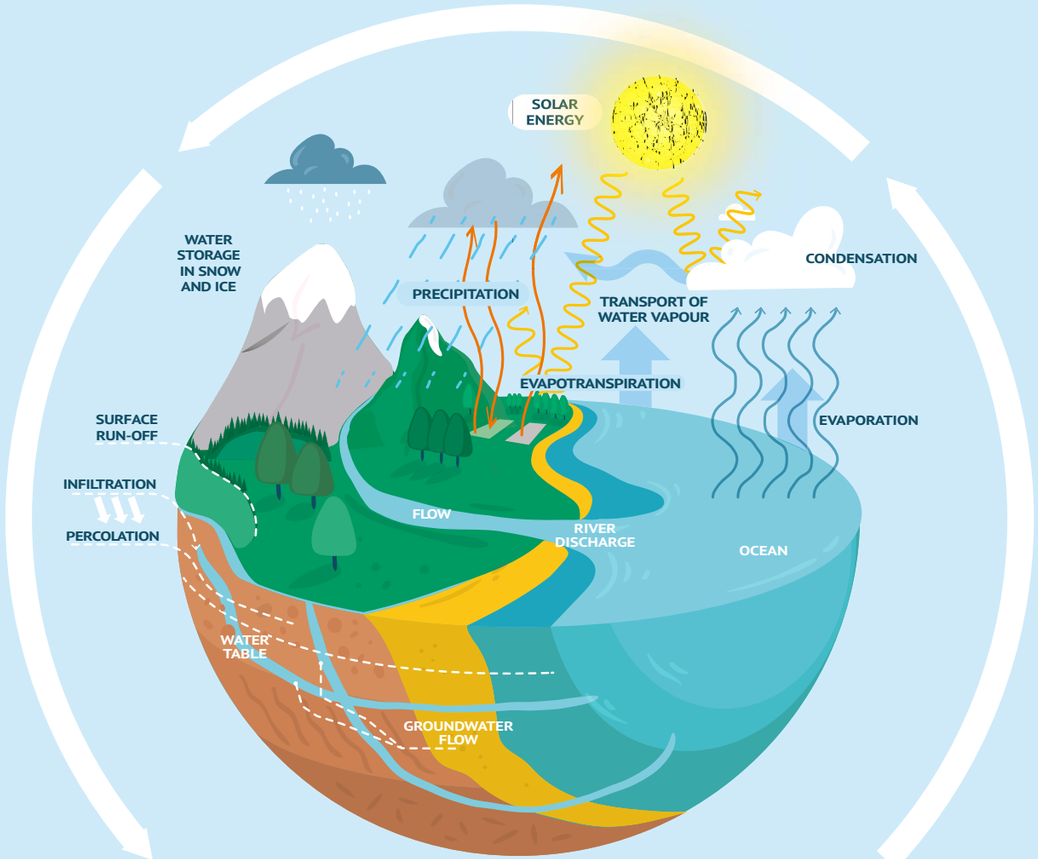


Source: Adapted from the study by White et al. (2021), Chile

The water used in transpiration is associated with photosynthesis, the process whereby plants use sunlight to transform water and carbon dioxide into food (glycose) and oxygen. In other words, the constant flow of water enables the trees to photosynthesise more efficiently, and so higher transpiration rates are associated with increased production of biomass (i.e. growth), and consequently higher rates of carbon sequestration In the case of eucalyptus, this relationship is optimised thanks to several of the species' morphological, anatomical and physiological characteristics.

More than 95% of the water absorbed by trees is then released into the atmosphere, through transpiration

WATER CYCLE



Source: adapted from www.metoffice.gov.uk

Forests and the water around us

Forests are essential for the functioning of the hydrological cycle, at a global scale. Covering around 31% of the land surface of the planet (figures from 2020), they play an important role in cooling the atmosphere and contributing to humidity in the air, the quality of water and precipitation. According to estimates, evapotranspiration in forests (water lost into the atmosphere through transpiration by plants, evaporation of water intercepted by the crowns of trees and evaporation from the soil) accounts for at least 40% of the precipitation falling on the planet's land masses.
As well as influencing climate regulation, forests also promote water infiltration in the soil and reduce the risk of small to medium scale flooding. Forested drainage basins are generally associated with higher quality water than other forms of land occupation, such as pasture or farming. ●

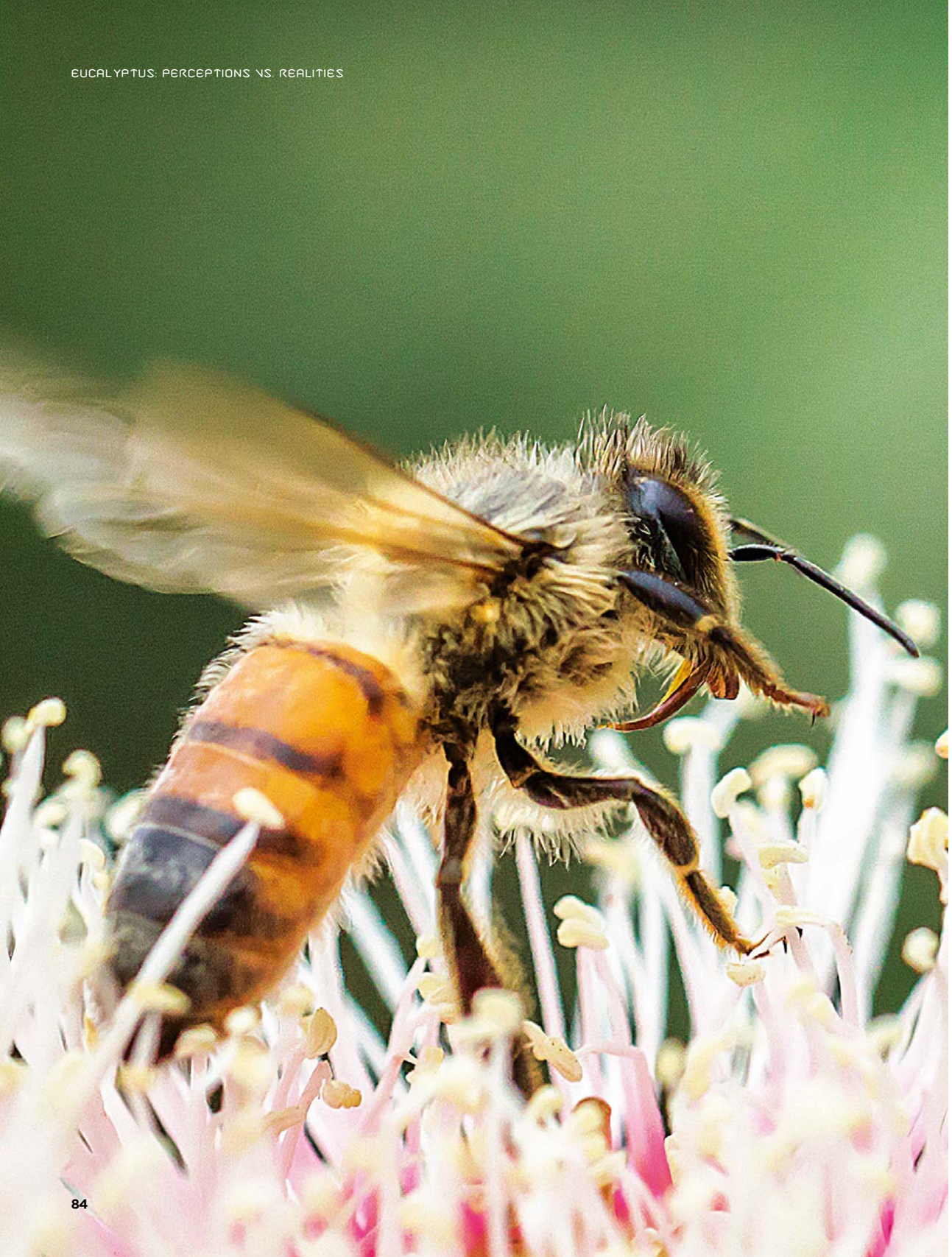
Perceptions versus reality

People say that eucalyptus forests dry out everything around them... But the facts tells us that:
- *Eucalyptus* is a fast growing species, but it tends to need less water and nutrients per unit of biomass produced than other crops, as a result of using these resources more efficiently.
- Forests, including eucalyptus plantations, are essential for the global functioning of the water, carbon and other cycles.
- *Eucalyptus* plantations release most of the water absorbed through their roots into the atmosphere, through transpiration (more than 95%).
- Forests, including eucalyptus, help reduce the frequency and extent of small to medium scale flooding and protect the soil from erosion. ●

An efficient plant
Highly efficient water use in sustainably managed eucalyptus plantations depends, obviously, on the stands being well suited to the existing water resources (see insert "Managing the quality and quantity of water resources"), but it starts with the attributes of the plants themselves. On the one hand, eucalyptus produces leaves in a short period, which increases photosynthesis. On the other hand, the leaves have a greater capacity for gas exchanges, when compared to other species such as Pinus radiata (Monterey pine), enabling them to produce more biomass from the same water.
The shape of eucalyptus leaves is another important advantage for water efficiency: it enables rainwater to flow off, meaning that the trees intercept approximately 11 to 12% of precipitation, which is less than other forestry species, such as pine. This means that more water falls on the ground, where it is needed for the plants and micro-organisms which bring fertility to the soil, and also for underground water flows.
The fact that the leaves also feature a high proportion of cuticular wax helps the water to run off, at the same time as promoting a lower level of evaporation from the crown. This means that, when water is plentiful, eucalyptus grows with less water resources than other trees, when we compare the quantity of biomass produced, but the species also has other characteristics that make it more efficient in using water when this resource is scarce. A fact observed in *Eucalyptus globulus* plantations in central Portugal and other eucalyptus stands in France: in periods of drought, eucalyptus is able to control efficiently the water lost through transpiration, by progressively closing the epidermal cells on its leaves (the stomas). And its broad pendent leaves sway easily with the breeze, which enables it to avoid overheating without using a lot of water.
The capacity of eucalyptus to adapt to adverse conditions and its efficient use of resources is especially relevant in the current context of climate change (you can read about this topic on subsequent pages of this magazine). ●

Managing the quality and quantity of water resources

In order to minimise the impact on surface run-off and water quality when timber is felled, sustainable eucalyptus growing involves preserving riverside gallery forests and maintaining protection strips and the distance of stands from water courses, springs or other water sources.
Landscape planning, using a mosaic structure, of different species, or else of plantations of different ages, means that logging is staggered, which optimises the use of water resources.
Responsibly managed eucalyptus plantations adjust the density of the forest to the local availability of water: run-off into drainage basins can be increased by reducing the density of planting.
In order to protect water resources, actively managed production forests can be located alongside areas of conservation forest. ●



Eucalyptus plantations and biodiversity: balance is possible

Although any industrial monoculture will feature less biological diversity than natural forests, the profitability of stands makes it possible to invest in creating and protecting biodiverse habitats. Ecological corridors and conservation areas are part of actively managed and certified eucalyptus forests.

Production forests help alleviate the pressure on natural forests, which are home to most of the world's biodiversity. In addition, research has proven that, with responsible management, forest plantations, and in particular those of eucalyptus, can play a complementary roles in preserving fauna and flora at the landscape scale, by offering shelter, food and breeding grounds for various species.

Why is this important? Because the development of civilisations and the growth of population, which has increased fourfold over the past century, has led to the transformation of natural ecosystems, causing a worldwide reduction in the biodiversity responsible for many of the services those ecosystems provide - what are called ecosystem services. Among other things, these include carbon sequestration and climate regulation, soil formation and conservation, air filtration, pollination, reduction of the impact of natural disasters, directly or indirectly affecting almost every area of human activity. According to a World Economic Forum estimate, more than half the wealth produced globally - 40 trillion euros - depended on biodiversity. The rapid decline in biodiversity is therefore one of the greatest challenges facing society today, and conservation is also one of the aims of the forest-based industry, which includes the eucalyptus sector.

The contribution of eucalyptus plantations

Natural forests tend to possess greater biodiversity than any type of plantation, whether of forests or agricultural crops, but, even so, production forests play an essential role in conserving it. For example, they often substitute other ecosystems degraded by man, and are able to support greater diversity than these. What is more, they help to protect natural forests from the growing demand for materials, enabling them to be conserved as refuges for biodiversity.

In Portugal, eucalyptus plantations help reduce the quantity of wood imported from elsewhere in the world, thereby also reducing the impact of

Although planted forests represent only 7% of all the world's forests, according to the FAO they satisfy approximately half the industrial demand for wood.

Eucalyptus is not an invasive species

Eucalyptus is often thought of as an invasive species in Portugal, which would be a threat to the biodiversity around it, above all because it regenerates naturally in the absence of appropriate forest management, and/or in eucalyptus woodlands when they are damaged by fire.

However, when we look at the ability of the species to spread over long distances and colonise adjacent areas (especially natural habitats), eucalyptus falls well behind native species such as the maritime pine. The species is not identified in Portuguese legislation as invasive: it is classified as cultivated and naturalised, having existed in Portugal for almost two centuries.

Did you know...

The Bonelli's eagle (Aquila fasciata), a species classified as "vulnerable", sometimes nests in tall eucalyptus trees. Nesting sites have been discovered for other birds of prey in eucalyptus trees in production forests, or in neighbouring areas. These include the goshawk (Accipiter gentilis) and the buzzard (Buteo buteo). ●

Perceptions versus reality

Production forests are less biodiverse than natural forests, but:

- Provided they are not planted on the land of natural forests, production forests help reduce the pressure for extraction of raw materials from native woodlands, enabling them to be conserved as havens for biodiversity.
- Planted forests sometimes replace other ecosystems which have been degraded by human action, and depending on how they are managed, can then sustain more biological diversity than previously on that land.
- Responsible management of production forests is compatible with wildlife conservation. Certification schemes have played a key role in promoting good practices. ●

Biodiversity is an integral part of responsible forest management, which sets out to conciliate production with wildlife conservation.

extraction and transport of species from other places of origin.
As most eucalyptus plantations have been established on abandoned or uncultivated land, or areas previously occupied by pine or eucalyptus, there has been no significant loss of biodiversity. In recent eucalyptus plantations, species such as gorse and heather can be seen, and as the crowns of the trees grow more dense, species more dependent on light give way to others more tolerant of shade or more typical of natural habitats, such as oak woodlands.
Eucalyptus forests also present significant diversity of certain groups of animals. Observation has confirmed that native fauna, particularly ants and rodents, feed on eucalyptus seeds, and many different insects prefer the bark of the species as shelter, in comparison, for example, with cork oaks. Research has also shown that eucalyptus blossom, which flowers in winter, is a source of nectar for honey production in Portugal, helping to preserve bees.
Forest plantations can also serve to link up natural habitats, enabling species to disperse and survive in landscapes dominated by pasture or arable farming. Research conducted by the University of Aveiro and the Science Faculty of the University of Lisbon has shown that, in mainland Portugal, eucalyptus forests are used by several vertebrates (deer, foxes, wild boar, hares, small mammals and others) and can play a role in conserving them, especially when wild areas are maintained inside or around the edge of plantations.
Given that biodiversity conservation is an integral part of responsible forestry management, which presupposes managing stands in a way compatible with protecting natural resources, studies show that the impacts on biological diversity depend on the silviculture model used in managing eucalyptus plantations (see insert), and not on the specific characteristics of the tree. ●

How forest management promotes biodiversity

- By establishing a landscape mosaic, with forest stands alongside areas of natural vegetation, arable land and pasture.
- Buffer zones to protect water courses, where production forests are not planted.
- Avoiding forestry operations in periods that coincide with critical stages in the life cycle of species, such as the breeding season.
- Staggered felling, so that different plots have trees at a different ages, and preserving old trees which are important for fauna.
- Maintaining areas of wild vegetation, inside and around the edge of eucalyptus plantations.
- Investing in maintenance, monitoring and restoration of areas of conservation value, and protecting valuable species and habitats.
- Preventing forest fires, by controlling undergrowth, creating fire breaks and fuel management strips. ●

Environmental DNA: genetics at the service of conservation

Environmental DNA techniques have today made it possible to identify hundreds of species of fauna from samples taken in a few days of fieldwork. This innovative approach is revolutionising the monitoring of biodiversity, including in planted eucalyptus forests.

From traces of DNA left in the environment by living creatures, such as secretions, hair or skin cells, it is possible to identify accurately the species present at a particular site. All you have to do is take samples of the soil water, vegetation or even the air, which are then sent for laboratory testing.
This technique, known as eDNA or environmental DNA, has revolutionised biodiversity monitoring programmes, making it possible to develop more effective, fact-based strategies for conservation and protection of species.
The Navigator Company is using these techniques in a range of settings, with different aims. For instance, it has used them to identify and monitor the main pollinators of eucalyptus trees - on two relatively small sites, 143 different insect species were identified, including 14 pollinators. And in order to understand how biodiversity evolves in planted eucalyptus forests, at different stages of the production cycle. Another project will shortly assess biological diversity in forest stands with different forms of land occupation.

Samples taken of the soil, water, vegetation or even the air contain traces of the DNA of the species which have been present at that site.

Biodiversity at the different life stages of production forests

Designed in partnership with 2BForest and SGS, as part of the Transform Agenda under the Recovery and Resilience Plan (RRP), this study of the different stages in the production cycles made it possible, with just a few days of fieldwork, to identify 398 distinct species or genera of organisms, including 48 vertebrates, in planted eucalyptus forests. Some of these enjoy special protection status, under the IUCN (International Union for Conservation of Nature) Red List. One example is the Iberian water shrew (Neomys anomalus), a species endemic to the Iberian Peninsula and classified as vulnerable in mainland Portugal, which has been recorded on Navigator's properties for the first time.

The Iberian wolf, the goshawk and the gold-striped salamander are other threatened species that have been identified from DNA markers.
"We conducted a survey of biodiversity on a property in Lourido, in the municipality of Arouca, by collecting samples of genetic materials from species of fauna which live on the property, or use it as a place of passage.
The DNA traces were gathered from vegetation, the air and water", explained Nuno Rico, Navigator's biodiversity conservation manager.
But that is not the end of the project. This was just a first collection of genetic material - conducted in a production forests, with the trees standing, towards the end of the cycle, and also in a conservation zone belonging to the property. "We will collect fresh samples", added Nuno Rico, "in the same areas, some time after felling. The idea is to assess how biodiversity evolves in planted eucalyptus forests, during the different stages of the production cycle, and also to gauge the role of conservation areas in this context".
Conservation areas can serve as a refuge, at certain stages of the production cycle, for species of fauna which live in eucalyptus forests.
"Using the environmental DNA, we want to obtain quantitatively and scientifically valid confirmation of our sustainable management, in which biodiversity conservation is very important. We maintain conservation areas alongside production forests and we want to assess the importance of this measure", the conservation manager explained.
Environmental DNA is a technique that "can quickly provide us with validation of what we have been doing, or else data to support changing one aspect of our operations", he concludes.
By comparing the findings from the two sets of samples, taken at two different stages of the production cycle, Navigator hopes to find ways of further improving its forestry management, so as to maintain, or even increase, the biodiversity identified on its properties. ●

Environmental DNA has revolutionised biodiversity monitoring programmes in recent years.

Natural resources soil water and biodiversity in eucalyptus plantations

Soil and water are crucial resources that enable plants to grow and produce biomass, but they also serve other essential ecological functions (or ecosystem services). These services, provided both by natural and planted forests to living beings, both animals and plants, include, for instance, the biodiversity in and above the soil, carbon sequestration and storage, and production of water for human populations.
When we talk about soil in farming or forestry, what we mean is the top layer of the earth's crust, comprising unconsolidated inorganic and organic matter, and also living organisms (soil biota). From a functional perspective, it is the principal medium in which plants grow, develop and spread, providing them with water and nutrients and aerating their roots. It also supports several other ecological functions, which I will address later.
Trees use water in the soil in order to survive and grow. This water is absorbed by the roots and conveyed through the vascular system to the crown, where more than 95% of it is released into the atmosphere through transpiration. This water used in transpiration is therefore associated with photosynthesis - transpiration is the cost of photosynthesis: higher rates of transpiration can power production of more biomass, and consequently higher rates of carbon sequestration. This process is part of the hydrological cycle.
In simple terms, biodiversity means biological variety or the diversity of species in a given place or at a given time. Mosaic forests - where areas of eucalyptus plantations are laid out alongside conservation areas, home to native species of trees and other plants, and areas of farmland - avoid creating vast, unbroken areas occupied by the same species, bringing clear benefits for biodiversity, because of the diversity of species and habitats. In addition, the mosaic layout avoids fuel building up over unbroken areas.
Well managed planted forests can play a role similar to that of natural forests in protecting the soil, in water infiltration and retention, and in promoting and maintaining biodiversity. Careful and responsible forestry management, with silviculture practices suited to the local soil and climate conditions, a forest with a more complex structure, including production forest and conservation forest, and the mosaic landscape, are all key elements in ensuring greater diversity of plant and animal species. Such a management model helps create a forest which is more resilient to climate change and results in plantations which are more sustainable - ecologically, economically and socially.
In addition, planted forests provide other ecosystem services, such as the goods, raw materials and products obtained from them. Planted forests therefore help reduce the pressure for extraction of raw materials from natural woodlands, enabling them to be conserved as havens for biodiversity. Production forests or forestry plantations make it possible to ensure supplies of renewable raw materials sought by the bioeconomy, without compromising the natural health of the planet. ●

Por Sérgio Fabres
Director of Research and Forestry Consultancy at RAIZ, Forest and Paper Research Institute

New approaches to regional planning

Innovative new ways of managing the landscape have been designed to cope with the challenges caused by vast areas of abandoned land, smallholdings and the lack of collective initiatives in rural areas. Well managed production forests, including eucalyptus plantations, are part of the solution.

In order to maintain the structural and functional balance of forest ecosystems and the resilience and supply, in quantity and quality, of the goods and services provided by forestry plantations, it is important to create diversified landscapes, on a mosaic design, which are able to conciliate production and conservation functions, contributing to the economic, social and environmental pillars of sustainability.
The rural landscape underwent a drastic transformation in a short space of time, due to people leaving the countryside for the cities and abandoning family farms which offered only a meagre livelihood. As a result, forestry enjoyed rapid expansion in the last few decades of the twentieth century. This change generated negative perceptions, above all among the urban population, sharpened by the planting of eucalyptus in coastal regions, close to major highways and centres of population. This led to calls for regional planning regulations, which currently reject the planting of eucalyptus in new areas.
However, the current forestry planning legislation has done nothing to resolve the fundamental problems of Portuguese forests, such as the need for land consolidation, abandoned land, fire risk and biodiversity loss. Instead, there are overlapping regulations, involving red tape and requiring irrelevant technical details. Perversely, this serves to cool investor enthusiasm and is a disincentive to land management. Hence the need to design and implement coherent long-term policies adapted to local conditions, which confer economic, environmental and social value on forests, while recognising and valuing the multiple services provided by woodlands, with long-term nationally based funding.

Challenges to landscape management

One of the main challenges for regional planning of forests is the fragmented ownership structure, resulting from inheritance law as it exists today. The small size of the plots, combined the lack of up-to-date rural property registers, makes it difficult for each owner to protect their land so as to generate a sustainable livelihood.

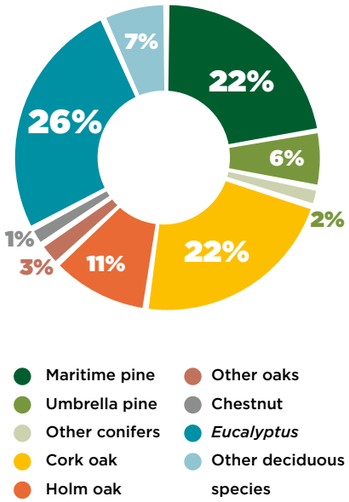
Perceptions versus reality

Although part of the population believes that eucalyptus is the dominant form of forest in Portugal:

- The territorial distribution of the main forestry species is evenly balanced: eucalyptus (26%), maritime and umbrella pine (28%), cork and holm oak (33%), with most forests consisting of native species (72%).
- There is a large number of planning regulations and procedures aimed at forests, but with unsatisfactory results, and paradoxically they often contribute to people abandoning land and to environmental imbalances. Successful landscape management requires alternatives which merit funding to incentivise shared management, as well as more realistic regulations that make it possible to support innovative models that prove successful.
- Valuing forests in line with the ecosystem services they provide requires standardised methodologies which ensure they enjoy public credibility.

A portrait of Portugal's forests

The main forestry species in Mainland Portugal in 2015



Source: ICNF, 2021

This situation also obstructs the efficient management of eucalyptus plantations, resulting in a fragmented forest landscape which is difficult to administer. This in itself often lies at the root of the misconceptions we have already mentioned concerning the risks of eucalyptus plantations, especially as regards rural fires. However, this risk can be minimised through sound forest planning and effective management, prioritising a mosaic landscape, creating breaks between forest stands, and preserving vegetation along the side of water courses. This will lead to a more diversified landscape, where planted eucalyptus forests will have their place and will bring advantages, as they will be a source of income that avoids the land being abandoned.
Although forestry holdings are individually owned (only 3% of Portugal's forests are publicly owned, while privately owned and community woodlands account for 97%) , organisational models for forestry based on associations of landowners can reap the advantages of operations on a larger scale, and these associations are today closely involved in the process of certification of forestry management. Nonetheless, these associations account for only a small proportion of owners, and it is estimated that less than 10% of landowners are members of a forestry association.

Private territorial planning initiatives

Whilst there is no lack of management and planning procedures in Portugal, producers encounter difficulty in accessing finance, in the excess of red tape and the low rate of approval of planning applications. One example

Only 3% of Portugal's woodlands are publicly owned. The rest are in private or community ownership

is the Landscape Transformation Programme, set up after 2017, which, despite the funding, has been implemented in only a small part of the Integrated Landscape Management Areas.
While the legal schemes are failing to achieve the targets set for them, innovative models are being successfully implemented on the ground, in exclusively private sector initiatives. Examples of these are schemes for aggregate areas, land consolidation through purchase and the system of joint management by forestry management entities.
The Baixo Vouga Forestry Association is just one success story. It abandoned efforts to set up Forestry Intervention Zones and instead designed a new strategy for promoting grouped forestry management, based on service contracts with members, instead of rental or purchase options. Initiatives of this type show that it is possible to increase the scale of management in areas dominated by smallholdings, provided the plans are put together to suit the owners involved.
Land consolidation through purchase has also been a successful method for landscape management: the industry has been acquiring land for forestation piecemeal and, in many regions, combining smallholdings to create larger units for forest management. Other investors have done the same, although it is no easy task, especially in regions dominated by smallholdings where the rigidity of the law prevents, in practice, a eucalyptus plantation being moved from one location to another not previously occupied by eucalyptus, which would result in more rational holdings and the advantages of scale; this has tended to deter investors and owners from efforts to consolidate ownership.
A number of original landscape management models have also been developed, for a range of purposes (wood production, rural conservation, protection against fire risks and others). We can point, for example, to the Clear and Fertilise programme, run by Biond (Association of Forest-Based Bioindustries) for eucalyptus plantations. The programme has been implemented on 75,000 hectares over five years, investing more than 13 million euros in risk reduction, positive environmental impact and improved yield, making it a model that could be extended to different forest ecosystems. Another example, also run by Biond and with RRP funding, is the Better Forest project, which has been applied over 1,500 hectares and demonstrates the potential of extending good practices to a territorial unit, irrespective of it being occupied by eucalyptus, pine or another ecosystem.

Ecosystem services and territorial management

Private investment has therefore played an important role in initiatives to promote forest management and planning. This suggests that payment for ecosystem services, applied to forest plantations, could act as a powerful incentive. What does this consist of? It means remunerating forests for the countless services they provide to mankind. The goods and materials they provide, including food, wood, medicinal compounds, natural fibres and biomass. The regulatory services, consisting of purification of water and the air, control of small to medium scale flooding, pollination and dispersal of seeds, biodiversity, and other benefits. Supporting services, which include recycling nutrients, soil formation, carbon sequestration, decomposition of organic matter and photosynthesis in plants. And lastly, the culture and leisure services provided by forests.
For the owner, the value of the ecosystem service is assessed in locally for each property, identifying which services are found on which plots, their size and, lastly, the value assigned to them. At present, there are only voluntary markets for woodlands, which are in need of yardsticks to establish the monetary value of each of the services. In addition, in most cases, forest plantations are not considered in these exercises, as they are assumed to have their own sources of income.
So looking to the future, there is a clear need for public policies that are able to promote investment in the sustainability of plantations, including of eucalyptus, insofar as well-managed forests, irrespective of the species, contribute to economic development, to retaining populations in rural areas and to better planning. ●

Private investment has played an important role in initiatives to promote forest management and planning

An ally in fighting climate change

The natural adaptability of eucalyptus and the effort put into genetic improvement and innovation in forestry and industry have combined to give us forests with additional capacity to sequester carbon and an industrial sector which is more efficient in using resources.

Climate change is clearly visible in the increased frequency of extreme weather events, the reduction in annual rainfall and higher temperatures, among other phenomena. This has added to the risks facing the countryside, such as fires, and also stress in forest stands, caused by water scarcity, pests and diseases. Could eucalyptus play a leading role in strategies to adapt to the changing climate and increase the resilience of forests? Faced with this scenario and the uncertain socio-economic future of forests, the eucalyptus sector has been investing in innovation and development projects, which confirm that the species is highly adaptable to different climate and soil conditions. Research geared to genetic improvements and technological innovation in adaptive silviculture practices has set out to make plants more resistant and productive, as well as to support strategies for retaining water and organic matter in the soil.
The work of forest-based industries has therefore taken on a fundamental role in mitigating climate change. Because, in a country like Portugal, where 97% of woodlands are in private or community ownership, the money will only be available to invest in restoring conservation areas and the recovery of native species if ways can be found for production forests to be profitable. And also because production forests contribute to sequestering carbon, which reduces the impact of greenhouse gases on global heating, as well as to protecting the soil and water resources. Forests have multiple uses, and no single forest serves only one function.
On the other hand, it is only by planting and replanting forests specifically intended to produce the raw materials needed in response to growing human demand that it is possible to avoid natural forests being destroyed to that end. Planted forests are also the starting point for developing naturally sourced bioproducts, which are recyclable, compostable and biodegradable, and which contribute to decarbonisation and to a circular economy, reducing our dependence on fossil-based raw materials. In all these regards, eucalyptus enjoys advantages in relation to other forestry species.

The role of eucalyptus

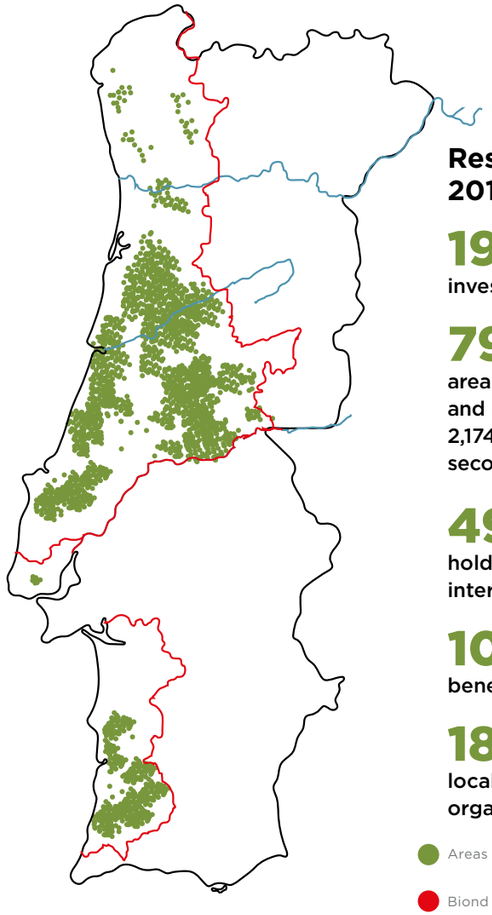
The most common eucalyptus in Portugal, *Eucalyptus globulus*, is a native of Tasmania and Australia.
In its original setting, it thrives in a relatively wide range of climate situations and geographical regions, and its native distribution is among the widest for eucalyptus species.
In Portugal, it has also found ideal soil and climate conditions for its development. Plantations of this species cover roughly 8,500 square kilometres, equivalent to approximately 9% of the country (26% of the total forested area, according to ICNF), mostly in the centre and north-west of the country, but also in the Tagus Valley and the south.
In a variety of studies, *globulus* has been found to be remarkably

Climate change is a challenge to forestry management, and so permanent monitoring is indispensable.

adaptable and flexible with regard to soil and, mainly, in relation to climate, which influences the impact of climate change on the species in Portugal. Using climate data from IPMA (Portuguese Institute for the Sea and the Atmosphere), it has been possible to make inferences concerning eucalyptus yields in the near future (20 years). For instance, productivity losses of between 1.2% and 4.7% are estimated up to 2040, using our current forestry techniques and genetic materials, but it was also found that there are positive impacts from improved potential yields for eucalyptus in areas regarded today as less suitable. This means that, in areas where other species may not survive climate change, it will be possible to maintain forest cover thanks to eucalyptus, with all the economic and social benefits that this brings.
However, in a climate change scenario, production forests face an additional challenge, which is the need to achieve a level of yields that ensures the plantations are profitable. In view of the uncertainty about the effects of the changes, eucalyptus offers an important advantage to producers and forest managers in this regard: short crop cycles, of ten to twelve years, make it easier to be sure of investment, in contrast to other trees which need a much longer timeframe.

Programmes supporting management of privately owned forests

Clear and Fertilise Programme + Replant + Recovery of Burden Areas Programme + Better Forest



Results 2019/2024

19M €
invested by Biond

79.479 ha
area receiving support and intervention (plus 2,174 ha fertilised a second time)

49.340
holdings receiving intervention

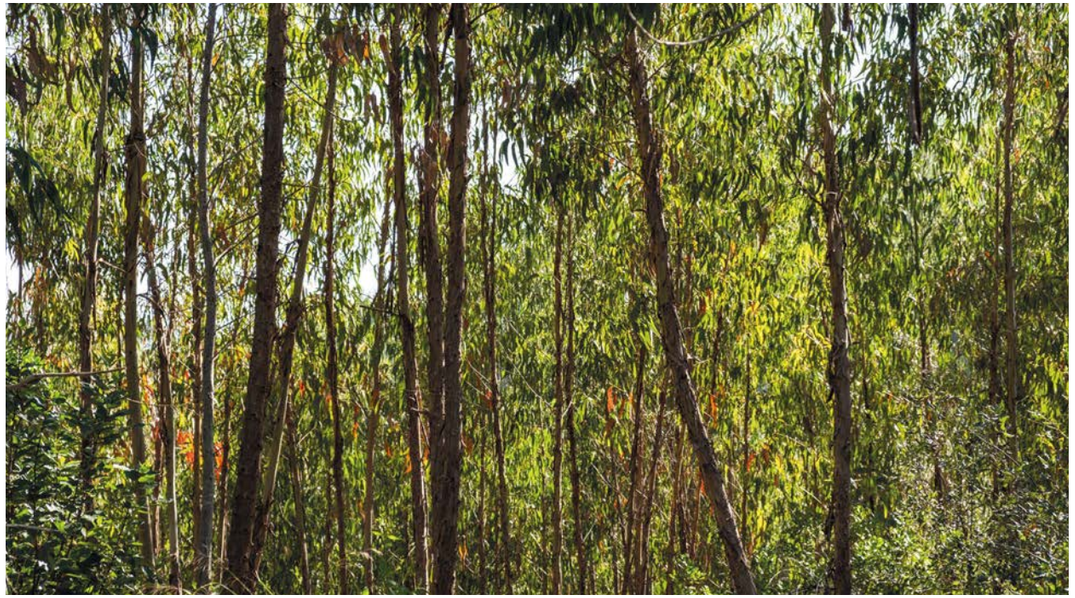
10.000
beneficiaries supported

180
local partner organisations

Source: Biond – Forest Fibers from Portugal

Forests adapted to change

The 2021-2022 interim report of the National Strategy for Climate Change Adaptation highlights a number of initiatives by Biond (Association of Forest-Based Bioindustries) as good examples. These are the "Better *Eucalyptus*" project and the "Clear and Fertilise" and "Replant" programmes, which have set out to help forests adapt and so to be more productive in the current context of climate change. They have contributed to the increase in the supply of certified wood grown in Portugal and in the certified area planted with eucalyptus, promoting responsible and professional management of the country's forests. ●



The Navigator Company's genetic improvement programme, conducted in recent decades by RAIZ, the forestry and paper research institute, has produced successive generations of E. globulus clones which offer producers guarantees of success, by raising the species' production capacity. Nonetheless, as the development of new genotypes is a slow process and takes 15 to 20 years, there are other measures that can be implemented more swiftly, such as the adoption of alternative forestry practices, to counter the adverse effects of climate change. For Portugal, the main focus of adaptive silviculture should be on promoting increased retention and more efficient use of water, either by adjusting the plantation density, or else by implementing alternative land preparation techniques, combined with the use of water-retaining materials and development of the soil biome. Another measure to be considered in connection with efficient water management has to do with reducing competition by increasing the frequency of undergrowth control, without mobilising the soil.
In view of the importance of a good survival rate and success in the post-planting period, it may also be useful to establish nursery practices to harden the plants in relation to drought, so as to make them more tolerant of water scarcity and to help in the acclimatisation process.
However, our understanding of the future impacts of a change in the climate on forestry development is limited. Climate change is a constant challenge to management, and so permanent monitoring of forest stands and ecosystems has been widely adopted.
Even so, all the knowledge generated and the innovations introduced in eucalyptus silviculture are extremely useful in optimising management and can be successfully applied to other forestry species, helping to make forests more sustainable and better adapted to future climate change scenarios. ●

Read more on pages 64-70

Perceptions versus reality

Eucalyptus has a reputation for harming the environment, but in reality:

- Climate change is shaping the distribution of forestry species in Portugal and the excellent adaptability of eucalyptus makes it possible to maintain forested areas in degraded and arid regions, where other species do not survive.
- The eucalyptus sector has invested for decades in genetic improvement and technological innovation in adaptive silviculture practices, in order to provide more resistant plants, offering greater yields, and to support strategies for retaining water in the soil.
- All the knowledge generated and the innovations introduced in eucalyptus silviculture are extremely useful in optimising operational management processes and can be successfully applied to other forestry species, helping to make forests more sustainable and better adapted to future climate change scenarios. ●

Forest fires: the protective power of management

Eucalyptus is not the most fire-prone form of land occupation in Portugal, and actively managed eucalyptus plantations can in fact serve as a barrier to the spread of fire. Fire risk prevention and mitigation are both a natural consequence of good forestry practices and an area where the industry has invested, so as to boost the resilience of the forestry landscape and protect communities.

The figures show that, in Portugal, rural fires are not related to the area of eucalyptus. According to ICNF and EFFIS (European Forest Fire Information System), between 2000 and 2024, eucalyptus accounted for 18% of the burned area, whilst 44% corresponded to scrubland and pasture, i.e. areas without planting and without management plans.

What is crucial for mitigating the risk of rural fires starting and spreading is the promotion of good silviculture practices, controlling the vegetation - what is called the fuel load. The report from the Independent Technical Commission into the 2017 fires in central Portugal clearly points to this: "... the fire in Pedrogão Grande started in the Ribeira de Frades valley, in riverside gallery woodlands dominated by oak", and "a young eucalyptus plantation [was found] in Escalos Fundeiros which did not burn and another [eucalyptus plantation] where the fire was predominantly superficial, of moderate intensity, extinguishing itself in a recently harrowed plantation". This is a clear example of propagation being boosted by the undergrowth, and not by the trees, irrespective of the species.

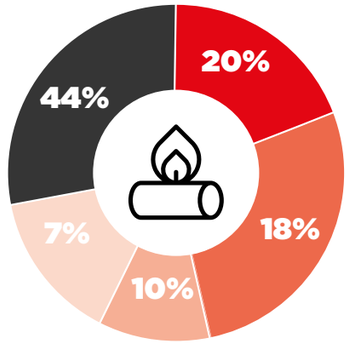
Fire prevention is moreover one of the prime concerns of any forestry producer and the industry itself, insofar as fire significantly affects the value of their business. One the one hand, the immediate economic impact can cause the land to be abandoned.

Then, in the medium to long term, this disinvestment in forestry aggravates the management risks and reduces the supply of wood and other forestry products to the market, with severe consequences for the economy and rural development.

This causes an increase in unmanaged land, which in turn means there are larger unbroken areas and a greater fuel load, as well as explaining, in most cases, why fires spreads so quickly.

What burns most in Portugal

Distribution of burned area, by land occupation and forestry species, from 2000 to September 2024



Source: ICNF/EFFIS

Where the greatest threat lies

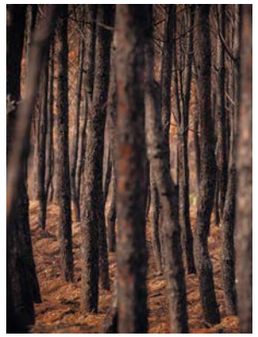
In just over a century (1902--2015), the forested area in Portugal has grown from less than two million hectares to 3.2 million, above all by occupying former farmland. But the same period has also seen a substantial increase in uncultivated land, scrubland and pasture, whilst less firewood is gathered from scrubland, adding to the fire risks in these areas. These factors are aggravated by poor access due to the rugged terrain, the shortcomings of the road network and its poor state of repair, which hinders fire-fighting operations.

The fuel load in forest stands - the quantity and the continuous nature of the vegetation, together with the density of tree crowns - also influences the danger of fire. Not least because, over time, forests produce 10 to 15 times more biomass than other terrestrial ecosystems. This is why it is so important to tackle the undergrowth through preventive silviculture, managing the land in large scale units with a diversified agro-forestry mosaic.

This was also stressed in the report of the Independent Technical Commission which looked into the Pedrogão Grande fire of 2017. "For these two species [maritime pine and eucalyptus], the rule is management of fuel in the undergrowth. Without fuel inside them, these forests cease to be a serious problem and can become part of the solution".

It is not the species that matters

Research has concluded that, even with a threefold increase in the area of eucalyptus in the past 30 years, this expansion is not linked to the increase in the total burned area. According to a scientific study in 2018, the ratio between the burned area and the number of fires is similar for the different types of forest. The most recent data shows that, in terms of forms of land occupation, most rural fires occur on scrubland and pasture. Between 2000 and 2024 (figures up to September), approximately 44% of the area burned



Did you know?

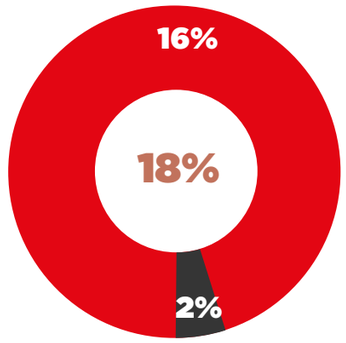
The wood affected by fires contains charcoal, principally in the outer part of the trunk, which disqualifies it as a raw material for producing cellulose pulp, as the charcoal persists throughout the manufacturing process through to the end pulp or paper product, in the form of black dots or stains.

Perceptions versus reality

- The forestry species itself is not linked to the size of major fires. It is the build-up of biomass, due to land being neglected or unmanaged, irrespective of the forestry species in question, that causes fires to propagate more easily, increasing their intensity and hindering fire-fighting efforts.
- Forest planning and active management help to reduce the severity of fires and to make firefighting more effective, so that fires have less environmental impact.

Burned area of eucalyptus in Portugal

Distribution of the burned area of eucalyptus, by segment, between 2000 and September 2024



Market areas
(typically unmanaged)

Plantations managed by the industry

Source: ICNF/EFFIS

in Portugal corresponded to areas of this types. Over the same period, eucalyptus represented 18% of the total burned area, and maritime pine 20%. Median loads of fine fuel (including the foliage of trees) are much lower in plantations of eucalyptus plantations than of maritime pine: at 15.9 and 27.5 tons per hectare respectively.
The fuel load in eucalyptus plantations is also identical to that in oak woodlands, which can be explained by a combination of factors, in particular the faster speed of decomposition of eucalyptus leaves, the scarcity of vegetation in the soil in the first years after planting, and the short crop cycles, of 10 to 12 years, which prevent fuel building up to the potential maximum levels.

The crucial factor is active management.
A study in 2009 reported that preventive management and silviculture make it possible to almost eliminate the risk of fire linked to the fuel load associated with a forestry species. Actively managed forests, where spontaneous vegetation is controlled, present a lower fire risk and also have more paths and strips with a low fuel load, created to allow fire-fighters to act quickly and effectively, preventing flames from spreading.
The benefits of forest management for mitigating fire risks are even more striking when we look more closely at the data: between 2000 and September 2024, of the 18% of the total burned area in Portugal represented by eucalyptus, it is estimated that 15.9% occurred on market areas (typically unmanaged) and only 2.4% on plantations managed by the industry.
Because the size of major fires in Portugal is determined essentially by the unbroken nature of the woodlands, and not by their composition, the simple existence of diversity within plantations, in terms of the age of plants and the felling date, improves the resilience of forests, making it possible to reduce the severity of fires and to be more effective in combating them, minimising their environmental impact.

A well-managed plantation, where vegetation is controlled and paths and fire breaks are created, can halt the spread of fire.

Building a forest for the future

To look at a photograph is to look at the past. And photographs of the Portuguese countryside a hundred years ago show us a landscape without woodlands, with the land cleared for farming and pasture by a population living in villages and uplands. Andrada e Silva wrote in 1815 that “despite a large number of Orders and Regulations which require land to be sown and planted, our forests and woodlands have been vanishing at astonishing speed”. More than a third of Portugal is today occupied by a variety of woodlands, including trees from different places of origin (European, Asian, Mediterranean, etc.), the woodlands that our parents and grandparents created. But we see forest fires, the neglect of rural land, fragmentation of woodlands into smallholdings, growing areas of scrubland and unmaintained forests, and a tree that was little known three generations ago, the eucalyptus. The result is that we are confused about how to respond to the challenge of tackling fires, of maintaining biodiversity, of ensuring that forests can provide a livelihood and attract people to the area.
Whilst there is widespread negative perception of eucalyptus forests, science shows that the fire risk is closely linked to the failure to manage woodlands, and to extreme weather events associated with climate change, and not to the species of tree. It is therefore essential to deal with the undergrowth in order to reduce the severity of fires, because as village folk say, “scrubland is the ladder for fire”; this same scrubland was formerly used to keep livestock or as farmland, cultivated through back-breaking work.
Looking at climate solutions, forests present themselves as a source of renewable goods (wood, paper, tissue, packaging, energy and new bioproducts) and as a way of regulating oxygen and storing carbon. *Eucalyptus* is part of these forests, and the owners planted it because they could see the advantages.
Political responses have been tried, in an attempt to bring professional management and consolidate smallholdings. One-size-fits-all measures have been designed for the whole country, accompanied by prohibitions and obligations that tie the hands of private landowners. Forestry Intervention Zones (FIZs), created in 2005, have mobilised people (1.98 million hectares), and more recently, after the great fire of 2017, we have had the Landscape Transformation Programme, which includes Integrated Landscape Management Areas (ILMAs), and is seeking to bring change to an area of 141 thousand hectares. But a snapshot of these programmes shows that the risk is unchanged, as little has actually been done on the ground.
An example of simplicity in action is provided by the “Clear and Fertilise” programme, set up by Biond, the association of forest-based bioindustries, providing support to landowners (already implemented on 75,000 hectares of eucalyptus). Other programmes, undertaken by forestry producer organizations, provide combined management for smallholdings grouped together, showing what is possible and what has been achieved. More needs to be done, and to be done better, aligning the action of local and regional authorities with the genuine desire that people feel to leave their small plot of land in a better state.
In these efforts to think about “Regional planning, climate change and fires”, the tools have to be simple and geared to management, promoting a collaborative approach between private enterprise and public policies, in an atmosphere of respect and shared aspirations.
Let’s try to leave a coloured photograph.

By José Luís Carvalho
Forestry Innovation and Development Officer, The Navigator Company

Taking forests into schools is the best way of encouraging young people to work in the forest.

Preparing the younger generations for a sustainable future

Forestry is a strategic pillar for the country and the world. This is therefore a field of knowledge which should be included in the educational syllabus, from primary school through to university, in order to promote forest literacy. It is also the only way to encourage young people to take an interest in the world of forests, both academically and professionally.

Forestry is a strategic pillar for the country and the world. This is therefore a field of knowledge which should be included in the educational syllabus, from primary school through to university, in order to promote forest literacy. It is also the only way to encourage young people to take an interest in the world of forests, both academically and professionally.
Bringing people into contact with forests is a mission that has to start at school, increasing awareness of the topic, but also by encouraging people to learn, on the basis of the latest scientific and research data. The educational system has a crucial role to play here, engaging with children and young people, as well as with teachers, who are pivotal in transmitting knowledge. In order to achieve these aims, we will need to work on two fronts: information and training.

Considering that much of the research and innovation is being produced by forestry operators themselves, close links between these operators and schools should be encouraged, exploring topics and approaches that reflect the science-based knowledge acquired.
It is equally important not to forget where we are starting out from: people today are largely uninterested, and often quite resistant to any anything that involves the forest and the countryside. This situation, which is due to cultural and sociological factors, but also to a widespread lack of resources, means that the chosen communication media will have to be appealing, but also that the best approach is to highlight the issues that make the forest highly relevant today - such as innovation, technology and the environment. These approaches should make it clear that woodlands and forestry can help us respond to the challenges currently faced by society. Planted forests, and especially eucalyptus forests, need therefore to feature prominently on the educational curriculum. It is necessary to show how sustainable management of these forests is a key pillar of the circular, low carbon bioeconomy; how they are becoming sources of alternative raw materials to those from fossil sources; how they mitigate climate change and promote decarbonisation of the economy; how they protect natural forests; how they provide ecosystem services; and how, as an engine of socio-economic development, they generate employment and bring new life to local economies, sustaining communities and fostering territorial cohesion.
The design of educational materials specifically dealing with eucalyptus is one way to reach the target

The right approach is to highlight topics that make forests extremely relevant today — such as innovation, technology or the environment — and show how this field offers the opportunity to tackle the great challenges that we now face as a society.

The role of industry

In order to make the courses more attractive and to adjust their content to the needs of the market, industry also needs to get involved. One way to contribute is by building a close relationship with higher education institution, making woodlands and industrial premises available for training, education and information purposes. Another path, which is in fact already being travelled, is to co-finance research into forests and forestry development, by offering study and research grants, through training programmes for teaching staff at different levels of education, and making their facilities available for media and public events.
The ISA president, António Guerreiro de Brito, stresses the importance of the educational system being open to such a close relationship, as a way of cultivating a critical spirit and curiosity about new solutions in this important bioeconomy sector: “Education needs to build closer links to industry and all the partners, actors and stakeholders in the forestry sector, enabling specialists to spend time in academe, applying new teaching practices and, very importantly, preserving the connection with research and innovation”. ●

audience, helping to shape a new generation that feels closer to the forest, better informed and less permeable to misconceptions. New ways of engaging with and reaching out to school communities also need to be considered. This could entail study visits to plantations and research centres working on forestry project.
In order to succeed in stimulating interest in the different dimensions of forests, a customised approach will be needed for each level in the education system, taking in primary and secondary schools, as well as vocational colleges and universities. These efforts will also have to be aimed at everyone involved: students, teachers, governing bodies, parents and guardians, textbook authors and publishers, educationalists and other specialists.

Higher Education seeks responses to the challenge of attracting students

In recent decades it has been much easier to talk about the problems associated with forests than about the solutions that they offer. At the same time, most the population has been concentrated in coastal cities: people have left the interior behind, and also their interest in the countryside. These are two of the main reasons why university courses in forestry engineering have seen a decline in interest from new students.
Staff at the institutions where these courses are offered - the Higher Institute of Agronomy (ISA), Coimbra Polytechnic Institute and the universities of Trás-os-Montes and the Upper Douro (UTAD) and Porto - all agree about the problem they face. And also about the urgent need to adopt or step up measures to help reverse this trend.
At ISA, the degree course in Forestry Engineering and the master’s course in Forestry Engineering and Natural Resources have been restructured to make them more attractive to students, introducing new subject areas and seeking to highlight the different issues faced by woodlands, both in the fields of production and conservation, as well as in production. In an interview with The Navigator Company’s Forestry Producers magazine, António Guerreiro de Brito, president of ISA, said that the institution is now seeking to offer a more integrated educational approach. And he gave concrete examples of new subject areas, such as “advanced management using remote detection techniques, where sensors and artificial intelligence are used to support decision-making; and the potential of biotechnology and forest-based fine chemistry”. Another example are solutions for preventing pests and fires, which are evolving towards pre-emptive action. The ISA is not limiting itself to theory: the institution is buying robotic equipment for managing woodlands and controlling invasive species in the wooded areas of its campus at Tapada da Ajuda.
UTAD is also investing in a more technological approach. The course at this institution, taught in partnership with the University of Porto, has changed its name to Forestry Engineering and Biotechnology. Domingos Lopes, head of the Department of Forestry Studies and Landscape Architecture at UTAD, explained to Forestry Producers that the change reflects the attempt to

Interest from new students in forestry engineering courses at universities has dwindled. Educational institutions have taken steps to reverse this trend, with a new tech-centred approach.

“combine knowledge of the forestry sector with technological development applied to forestry species and ecosystems”, bringing in new content, better adjusted to the reality of the sector and a new vision of the profession.
This “increased focus on technology” is more than justified, in view of the advances made in recent decades, and the head of department stressed that “there is also now a lot of work that can be done remotely”. Domingos Lopes also highlighted other initiatives designed to attract students, such as the study grants: “There are even companies which have organised themselves to pay the fees for students on this course”.
The difficulty of attracting new students has also led to changes in the course on Forestry Studies and Natural Resources at the Higher Agrarian Institute of the Coimbra Polytechnic Institute, so as to adapt the syllabus to the changing reality of forests. Joaquim Sande Silva, the course director, told Forestry Producers that they are already seeing positive results in terms of attracting new students. But he admits that it is not enough: “Despite the excellent job prospects in this area, it is difficult to fight against the growing lack of interest in the countryside and against the bad press that forestry management has received”. In his opinion, forests are associated in people’s minds with fires, and in order to attract more students “we need to diversify, invest in activities connected to ecological restoration, recovery of water courses or re-establishing natural ecosystems”. ●

Changing perceptions

Because their knowledge of forests tends to be limited, people are often permeable to ideas with no basis in science and far removed from reality. These perceptions are shared by young people, and can influence what they choose to study in higher education. In view of the difficulty of attracting students for forestry courses at university, and thereby assuring skilled professionals for sector’s future, heads of studies have warned of the need for combined efforts to clear up the misconceptions that exist about forests.
“Only with continuous and persistent efforts from academe, forestry associations and everyone involved in the sector” will we succeed in correcting current perceptions of forests, believes António Guerreiro de Brito, of the Higher Institute of Agronomy.
“It will take concerted and persistent efforts, and constant vigilance”, warns, Domingos Lopes, of UTAD, who argues that “political decision-makers and the various ministries involved need to have an integrated vision of the issues”. ●

João Lé
Executive Director of
The Navigator Company

Planting the future

Forests are one of mankind's most previous and strategic resources. They represent balance, livelihood and innovation, but above all a commitment to the future. Recognising their value is an important first step, but it is not enough, We need action - with science, strategy and common purpose. The *Eucalyptus* Forum, organised last year by The Navigator Company, was a decisive milestone in these endeavours.
Perceptions of eucalyptus forests in Portugal are often polarised. Between those who see them as a vital resource and those who see them as a threat, there is a gulf across which no one speaks. The Forum was set up to fill this gap with sound technical and scientific knowledge, able to build bridges between different groups in society.
The project was centred on systematically collecting an unprecedented body of knowledge about eucalyptus. Knowledge which is scientifically validated, which responds to myths with facts and promotes a balanced view of planted eucalyptus forests. And which confirms their key role in Portugal's socio-economic development, as well as in the fight against climate change and the urgently needed transition to a circular bioeconomy.

Profitability for the sake of sustainability
It is fundamental to regard forests as a dynamic asset, which helps to protect the soil, regulate the water cycle, protect biodiversity and sequester carbon. And which plays a crucial role in decarbonisation, in substituting fossil-based materials and developing new products which wed efficiency to sustainability However, without active and responsible management, those benefits are compromised - and management of that kind is dependent on healthy returns, which guarantee the resources need to invest in the future and preserve the environment.
Profitability and sustainability are interdependent: when one prospers, the other will thrive. Without business opportunities for forestry producers and local communities, land abandonment will continue to be a problem. It is also from the income they generate that producers are able to invest in managing the land, in adopting good practice and working to conserve and restore ecosystems, habitats and species. If we want forests to be a driving force for progress, we need to see them as an integrated system that combines economic, environmental and social dimensions.
Looking at the prospects for forestry development in Portugal, eucalyptus forests stand out as offering a unique opportunity, as well as a multifaceted challenge. This is a resource with vast potential for generating economic, social and environmental value, but strategic and concerted action is needed to achieve this. Hence the urgent need to face down the misconceptions and to take an assertive approach to the real obstacles limiting sustainability in this sector.

A firm grounding in knowledge
One of the greatest obstacles lies in disinformation. *Eucalyptus* forests are frequently reduced to myths, such as that directly linking them to forest fires or the idea that they are an excessive drain on water resources. These perceptions, as widespread as the lack of knowledge which enables them to take root, are far removed from reality: when properly managed, these forests are highly efficient in using water, help to reduce the risk of fire and serve to protect soils. Combating these preconceived ideas, devoid of any factual or scientific basis, entails investing in education and communication. We need to equip younger generations with scientific knowledge, by including the role of forests in the school curriculum, raising public awareness through information campaigns, which are both easy to understand and transparent.
Another critical challenge is active management. Many areas of eucalyptus forest in Portugal are degraded or abandoned, which compromises their potential yields and increases the environmental risks. Reversing this situation will mean adopting sustainable and economically feasible practices.
The fragmented structure of landownership aggravates the problems, making it difficult to create the scale needed for efficient management.
Decarbonisation and the transition to a circular bioeconomy have put planted forests, and eucalyptus in particular, at the centre of the solutions to climate challenges. This species features outstanding yields and the ability to provide natural and renewable raw material to substitute fossil-based materials. But the road to a truly sustainable sector requires technological and scientific advances. Genetic Improvement, and innovations in forest management and industrial processes are essential for maximising yields and minimising the environmental impacts.
Legislative issues should also not be overlooked. Existing forestry policies are often perceived (and experienced) as an obstacle to efficient management, because they are too complex and fail to offer clear incentives for good practice.
Simplifying the framework and creating financial stimuli for restoring degraded areas are key steps to unblocking the potential of Portugal's forests.

***Eucalyptus* Forum: the legacy**
The future of forests depends above all on concerted action. In order to create a cohesive and resilient sector, it is essential to coordinate the efforts of landowners, producers, industry, academe, civil society and the authorities.
Science should be the bedrock on which this alliance is built, guiding decisions on the basis of concrete data and fresh solutions. Without this cooperation, forests risk remaining hostage to fragmented interests and policy failures.
The *Eucalyptus* Forum has shown that this conversation is possible. By including different perspectives and prioritising technical and scientific knowledge, we have laid the foundations for a shared and inclusive vision of forests.
We now need to seize the moment and carry this movement forward.
Joint management models, public-private partnerships and incentives for good forestry practices are routes we should explore in our collective efforts to achieve better forests.
The Navigator Company has embraced its key role in this mission, not just by leading by example, but also by sharing knowledge and creating opportunities for everyone involved to reap the benefits of well-managed forests.
By laying the foundations for concerted action on forests, the *Eucalyptus* Forum has succeeded in one of its main objectives. Cooperation between city dwellers and rural communities, between producers and consumers, between scientists and society,
Is essential for creating a consensus which makes for sound and sustainable forestry policies.
This is the legacy we want to build.
Let be conclude with a call to action: let us all - whether citizens, legislators, researchers, producers or managers - look on forests not just as a resource, but as a commitment.
A commitment to the planet, to future generations and to sustainable progress.
The future of our forests will be as strong as our collective commitment to protecting them, valuing them and helping them thrive.


How many animals and plants can you see through your window?
Through ours, we can see 268 species of fauna and 1195 species and sub-species of flora
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