B I O I S L E - N E W S L E T T E R

Resumo

O CIBIO-Açores, Centro de investigação em Biodiversidade e Recursos Genéticos – Açores, tem sede na Universidade dos Açores, constituindo-se como um grupo de investigação do InBIO, a Rede de Investigação em Biodiversidade e Biologia Evolutiva. Em 2018 o centro contou com 63 investigadores: 20 doutorados (9 professores, 1 investigador principal, e 10 investigadores doutorados), 12 doutorandos, 8 mestrandos e 23 colaboradores de projeto. O centro publicou 31 artigos em 2018 e conseguiu obter financiamento a nível nacional e internacional. Desde a sua formação em 2006, a sua atividade centra-se no desenvolvimento de investigação de elevado nível na área da biodiversidade, utilizando os Açores e outros sistemas insulares como modelo. As suas áreas de ação estendem-se dos biótopos costeiros até às florestas naturais e de exóticas, incluindo também a ecologia das águas interiores, a paleoecologia e a paleontologia.

Summary

CIBIO-Açores, the Research Center in Biodiversity and Genetic Resources – Azores, is based at the University of the Azores while constituting a research group of InBIO, the Research Network in Biodiversity and Evolutionary Biology. In 2018 it included 63 researchers: 20 PhDs (9 professors, 1 principal researcher, and 10 post-doc fellows), 12 PhD students, 8 MSc students and 23 research fellows. The center published 31 papers in 2018 and managed to obtain funding at national and international levels. Since its establishment in 2006, the center is devoted to the development of high level research in biodiversity using the Azores and other island systems as models. Its areas of activity span from coastal biotopes to natural and exotic forests but also include freshwater ecology, paleoecology and paleontology.

Editorial

Depois de mais de dez anos de atividade científica, o nosso centro inclui áreas de investigação que se foram gradualmente desenvolvendo e amadurecendo, e que atualmente atingiram uma coesão e relevância suficientes para, eventualmente, dar origem a linhas de investigação mais específicas, e independentes. No entanto, o grupo continua a possuir uma elevada interligação entre essas diferentes áreas, com a participação de vários membros nas atividades desses campos diversos, mas complementares. Embora essa análise estratégica tenha servido, basicamente, como um exercício interno, consideramos que a definição de linhas de investigação que daí resultou merece ser aqui apresentada, como forma de caracterizar mais completamente a diversidade do nosso centro.

Como nos organismos e populações biológicas, a diversidade pode ser uma vantagem para sobreviver e proliferar quando as condições ambientais (e.g., financiamento, oportunidades de carreira científica) mudam rapidamente, e quando um considerável grau de incerteza paira sobre o papel da biodiversidade como área focal de investigação.

De facto, a necessidade de ligar a investigação, ao nível dos organismos e dos ecossistemas, a abordagens mais orientadas para a produção, é um desafio contínuo, que também dependerá de um tipo de formação científica menos dependente da aquisição de conhecimentos e mais focada no desenvolvimento de competência mais integradoras, no uso de disciplinas transversais como sejam um desenho estatístico e uma análise de dados sólida, o uso de ferramentas tecnológicas (e.g., metagenómica, sequenciação de DNA de terceira geração) e de áreas emergentes, incluindo a inteligência artificial e aprendizagem de máquinas.

Com uma parcela considerável do processo científico a tornar-se cada vez mais tecnológica e, portanto, cada vez mais automatizada, o papel do investigador tornar-se-á cada vez mais o de um analista de sistemas, ligando questões de investigação e desafios societais através de abordagens holísticas. Entretanto, a atualização tecnológica das instituições de investigação é atualmente muito heterogénea, devido a claras desigualdades de financiamento. Esperamos que a nossa instituição de investigação, como um todo, consiga vencer os importantes desafios do futuro. De nossa parte, continuaremos a apoiar o desenvolvimento de investigação e de formação avançada e, assim o esperamos, a usar os nossos laboratórios insulares como lançadores de ideias científicas, mesmo que outro tipo de lançadores ganhe mais relevância num futuro próximo.

Editorial

After more than ten years of scientific activity, our center includes research areas that have been gradually developing and maturating, and that presently gained enough cohesion and relevance to eventually give rise to more specific, independent research lines. Nevertheless, the group continues to include a high level of overlap and interconnection between those different areas, with several members participating in the activities of these diverse but complementary fields. Although this strategic analysis served basically as an internal exercise, we think that the resulting definition of research lines fully merits to be presented here, as a way to more completely characterize the diversity of our center.

As in biological organisms and populations, diversity can be an advantage to survive and still drive when environmental conditions (e.g., funding, scientific career opportunities) change rapidly, and when a considerable degree of uncertainty rests upon the role of biodiversity as a research area to focus on.

In fact, the need to join organismal and ecosystem research to more production-oriented approaches is a continuous challenge, which will also depend on a type of scientific training less dependent on knowledge acquisition, and more focused on the development of highly integrative skills, as well as on the use of cross-section disciplines such as sound statistical design and data analysis, the use of technological tools (e.g. metagenomics, third generation DNA sequencing), and of rapidly emerging areas, including artificial intelligence and machine learning.

With a considerable portion of the scientific process becoming more technological, and therefore more and more automated, the role of the researcher will become more one of a systems' analyst, linking research questions and societal needs through holistic approaches. Meanwhile, the technological upgrade of research institutions is presently very heterogeneous, due to clear funding inequalities. We do hope that our research institution, as a whole, will manage to win important future challenges. On our part, we will continue to support research and advanced training, hopefully using our island laboratories as launchers of scientific ideas, even if other types of launchers will gain more relevance in the near future.

Produção científica *Scientific production*

A produtividade científica do CIBIO-Açores tem-se mantido desde 2012, atingindo no decurso do presente ano um total de 31 artigos publicados, com um fator de impacto acumulado de 73 (Figura 1). Relativamente aos projetos de investigação e às prestações de serviço aprovadas, tem sido possível obter financiamento de entidades diversas (ver lista de projetos).

The scientific productivity of CIBIO-Açores has been maintained since 2012, reaching a total of 31 published articles during the current year, with a cumulative impact factor of 73 (Figure 1). With regard to research projects and approved services, it has been possible to obtain financing from various entities (see list of projects).

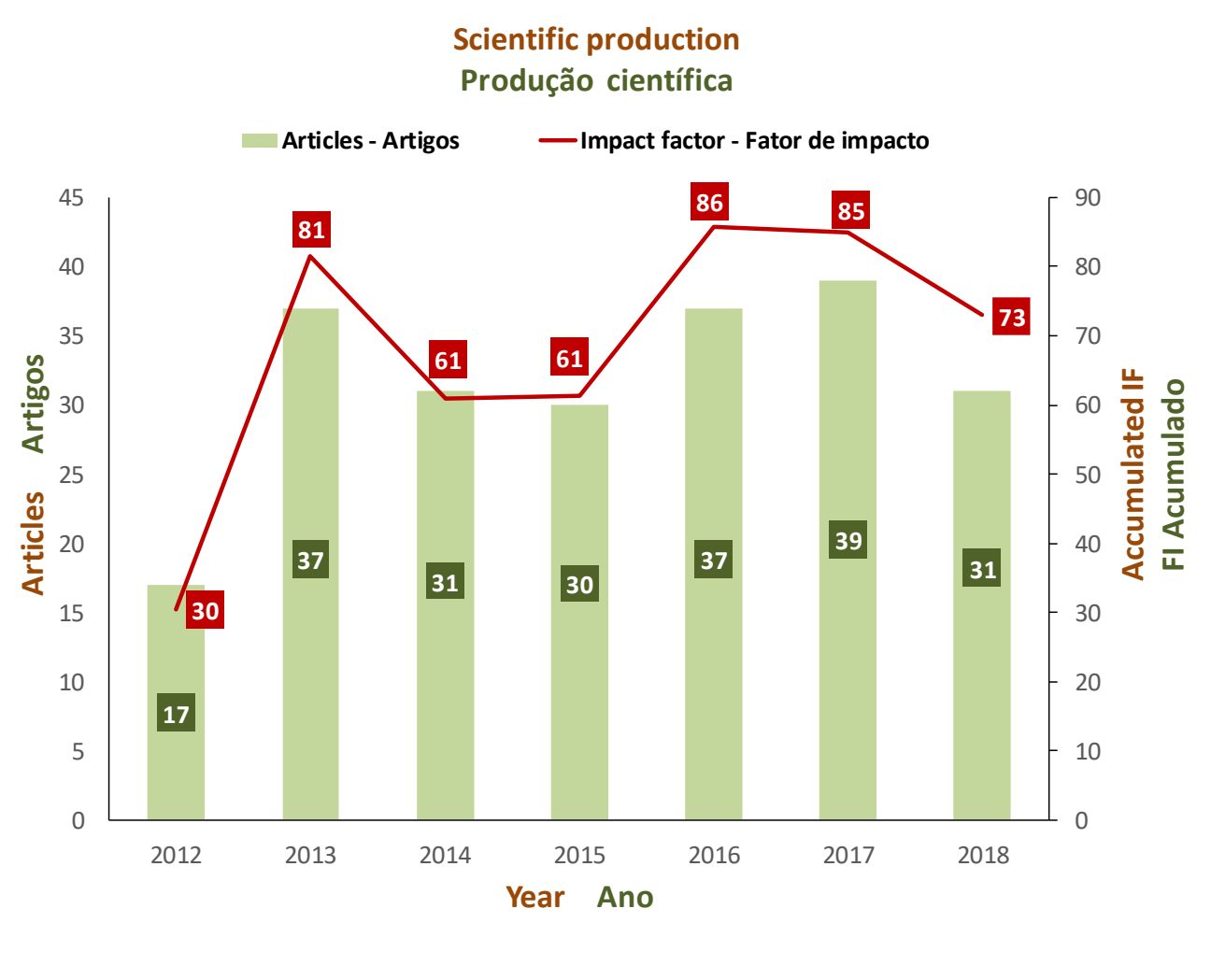


Figura 1. Resumo da produção científica do CIBIO-Açores desde 2012.
Figure 1. Summary of the scientific production of CIBIO-Açores since 2012.

Principais áreas de investigação

Embora o centro tenha como principais áreas de investigação a Evolução em Ilhas, a Ecologia Insular e a Conservação e Gestão em Ilhas, realizámos uma análise interna dessas áreas, de forma mais detalhada e precisa. Identificámos oito unidades de investigação, com um grau considerável de interconexão.

Main research areas

Although the center's main research areas are Island Evolution, Island Ecology as well as Island Conservation and Management, we undertook an internal analysis of those areas in a more detailed and precise way. Eight research units were identified, with a considerable degree of interconnection.

Aquatic Systems	**MARBE** **Marine Biodiversity and Environment * Biodiversidade e Ambiente Marinhos** **Coordinator * Ana Cristina Costa**
	MPB **Marine PalaeoBiogeography * PaleoBiogeografia Marinha** **Coordinator * Sérgio Ávila**
	PALEO **Palaeolimnology * Paleolimnologia** **Coordinator * Pedro Raposeiro**
	FRESCO **Freshwater Ecology * Ecologia das Águas Doces** **Coordinator * Vítor Gonçalves**
Terrestrial and Aquatic Systems	**DIVERGE** **Systematics and Evolution of Insular Lineages * Sistemática e Evolução de Linhagens Insulares** **Coordinator * Mónica Moura**
	GBM **Madeira Biodiversity Group * Grupo de Biodiversidade da Madeira** **Coordinator * Miguel Sequeira**
	MODELANDIS **Modelling and Land Management on Island Systems * Modelação e Gestão do Território em Sistemas insulares** **Coordinator * Luís Silva**
Tourism	**NaTour** **Planning and management of tourism in natural areas * Planeamento e gestão do turismo em áreas naturais** **Coordinator * Maria Anunciação Ventura**

MARBE
Marine Biodiversity and Environment * Biodiversidade e Ambiente Marinhos
Coordinator * Ana Cristina Costa

The main goal of this research line is to describe marine biodiversity, understand the dynamics and the functioning of marine littoral ecosystems, analyse human-induced pressures and their impacts on these ecosystems, and to reconcile exploitation (fishing, aquaculture and bio prospection) and conservation, meeting societal expectations on marine issues including awareness, assessment, innovation and renovation. In particular, we intend to improve the understanding of processes that control marine biodiversity at local scales, in the Atlantic and in a global context, addressing natural and anthropogenic induced connectivity of marine systems (e.g. insular, oceanic and with marginal seas). More specifically, we address the following aspects.

Community dynamics and functioning: Study of the drivers of structure and communities' functions; assessment of biotic interactions across spatial and temporal scales; assessment of effects of human activities on coastal biodiversity including the impacts of global change (e.g. invasive species and climate change) on the structure and functioning of communities. The importance of accurate and reliable taxonomy to studies of biodiversity cannot be overemphasized to meet the needs of the newly emerging and rapidly developing marine biotechnology to evaluate resource organisms for applied research. However, not only taxonomic inventories but also species' relative abundances, genetic diversity, and apportionment in higher taxa are important to properly evaluate the natural marine patrimony. Patterns' data are critical to understand the processes affecting biodiversity and to detect biodiversity changes. Thus, besides traditional taxonomic inventories updates in marine flora and fauna, some other approaches are considered:

Comparison of fossil biota with living ones from some habitats and regions to provide clues on favourable conditions for the formation and proliferation of species; identification of natural processes historically generating biodiversity patterns.

Evolutionary ecology and adaptation: linking geographic distribution and evolutionary history of marine organisms by using molecular techniques for quantifying the phylogenetic relatedness between species and higher taxa in order to recognize intraspecific genetic variability, and to quantify difficult-to-identify species and larval forms in natural samples.

Multiple uses of coastal systems: analysis of coastal ecosystems statuses, development of their uses within reconciliation boundaries with biodiversity and habitat conservation (e.g. MPAs, Marine Reserves); measuring and minimizing human impacts (e.g. fishing, tourism) by developing guidelines enabling nature protection and management; develop scientific-based biodiversity arguments for management and decision for MSP; develop strategies to meet societal challenges of littoral populations by promoting a sustainable exploitation of marine biodiversity, and development of innovative and profitable uses of marine environment and biodiversity.

MPB

Marine PalaeoBiogeography * PaleoBiogeografia Marinha

Coordinator * Sérgio Ávila

The MPB team studies a wide range of marine phyla (e.g., molluscs, echinoderms, bryozoans, crustacean decapods, crustacean balanids, crustacean ostracods, foraminifers, corals, selaceans, whales, bony fishes, calcareous algae), both Recent and fossil, from a palaeontological, (palaeo)biogeographical, (palaeo)ecological, and (palaeo)climatic perspective.

Our research is focused on the Atlantic Ocean insular systems, and include the following areas: Marine Island Biogeography Theory; Geological processes in volcanic oceanic islands; Island ontogeny and sea-level changes; Spatial-temporal biogeography and biodiversity patterns; Local/global climate changes; Evolution of marine species in oceanic islands; Taxonomy and systematics of selected marine invertebrate groups.

We use several research tools: Geochronology; Isotopic analysis; Big Data Analysis; Modelling; Statistics, and quantitative tools; Tourism and socioeconomic tools; GIS-based tools; Unmanned observation drones; Professional video and photography.

Besides the fundamental research in Marine PalaeoBiogeography, we also promote the sustainable use of insular geoheritage for tourism purposes.

The specific objectives of MPB areas of research aim to: Understand the marine (palaeo)biogeographic and evolutionary patterns and processes occurring in oceanic islands throughout geological time; Understand the marine insular (palaeo)biodiversity and (palaeo)ecological patterns and processes; Understand the marine phylogeographical patterns of selected taxa from the Atlantic archipelagos; Evaluate and promote insular natural resources for (geo)tourism; Develop management tools that will contribute to improve the islands' natural-resource sustainability and (palaeo)biodiversity conservation.

For a long time, we have been highly committed to outreach activities, which include: the writing of books, TV documentaries, the "Route of the Fossils" trails and the "House of the Fossils' Museum" on the island of Santa Maria, support for the "PalaeoBiology Database".



PALEO
Paleolimnology * Paleolimnologia
Coordinator * Pedro Raposeiro

The paleolimnology group aims to study past climate and environmental changes and their causes, with a focus on human impact, by the analysis of paleo environmental archives. These natural environmental archives include lake sediments and peat bogs sampled and analysed using a multiproxy approach (e.g., classical as well as cutting-edge proxies) allowing the reconstruction of past environmental changes (e.g., climatic, volcanic and anthropogenic change) and ecosystem processes (e.g., food web changes following the introduction of top predators, methane cycling in lakes). The classical methods used are based on several biological (pollen, charcoal, diatoms, cladocera and chironomids), chemical (organic and inorganic chemical composition of the sediments, stable isotopes in organic matter), sedimentological (lithological description of the sediments) and mineralogical indicators and cutting edge methods, based on molecular markers (e.g., aDNA, leaf waxes) that are used to reconstruct and interpret past environmental and climate conditions. The group expects to understand the links between changing climate and their impact on past human populations and societies to predict incoming climatic and ecological events and to envisage adaptive responses. The Paleolimnology group includes three senior researchers, one Ph.D. student, two M.Sc. students and one research grant holder, and has several international collaborators on several projects.

Our research covers two areas:

- Terrestrial systems: landscape and climate histories;

- Aquatic systems: freshwater and brackish systems' ecology and diversity influenced by humans and climate.




FRESCO

Freshwater Ecology * Ecologia das Águas Doces
Coordinator * Vítor Gonçalves

Aquatic ecosystems of oceanic islands are unique due to their volcanic origin, geomorphological environment, climate situation and biogeographic isolation, which originate structural and functional patterns and ecosystem processes different from those observed in continental regions. Taking the advantage of being in a 'natural laboratory', the Azores islands, our main goal is to describe and understand the structure and function of insular aquatic ecosystems,

and to develop methodologies and strategies for their environmental assessment, rehabilitation and conservation.

Our research aims to determine the impacts of local and global environmental changes on aquatic biota, namely lakes, streams and coastal waters. We want to describe the biological community's structure and its interactions with environmental drivers, and determine the indicative value of biological quality elements for ecological quality assessment of these ecosystems. On ecosystem function, focus is given on litter processing to understand how this process occurs in the absence or low abundance of detritivores (natural situation in many oceanic freshwaters), which is expected to occur more frequently and in wider areas in the future given their sensitivity to warming and pollution.

To address these topics, we use a combination of classical ecological approaches and new methodologies such as environmental DNA (eDNA) and modelling.

The major goals of FRESCO are to:

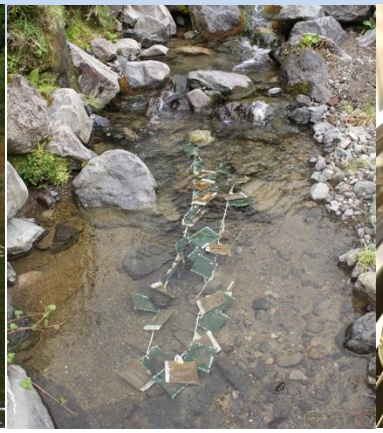
1. assess the biodiversity of Macaronesian freshwater ecosystems and their distribution patterns;

2. understand the functioning of aquatic ecosystems in remote oceanic islands and how they are affected by local and global environmental changes;

3. assess the response of aquatic biota to environmental changes, particularly those arising from eutrophication and/or organic pollution, allowing the development of biological metrics for ecological quality assessment of inland surface waters;

4. develop molecular tools for the assessment of cyanotoxin production potential in Azorean lakes and thermal waters to implement in monitoring programs;

5. maintain a culture collection of Azorean microalgae and cyanobacteria and evaluate their potential use for biotechnological applications (e.g., nutrition, pharmaceutical, cosmetics).


DIVERGE

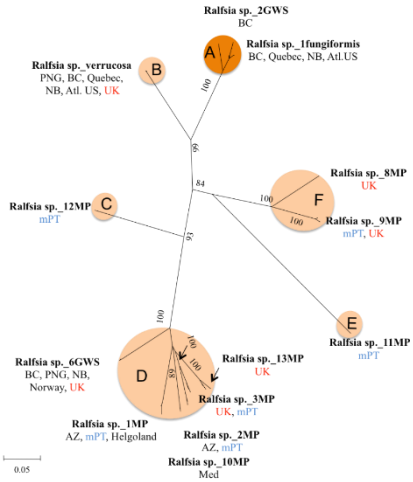
Systematics and Evolution of Insular Lineages * Sistemática e Evolução de Linhagens Insulares

Coordinator * Mónica Moura

Islands are perfect spots to comprehend how evolution takes place. It is thus the primary aim of DIVERGE to study the mechanisms that drive speciation in insular settings such as those that occur in the Macaronesian Region. Molecular genetics, morphology and bioinformatics are our main tools to detect diversity patterns at several levels, from straightforward morphologically distinct lineages to cryptic speciation.

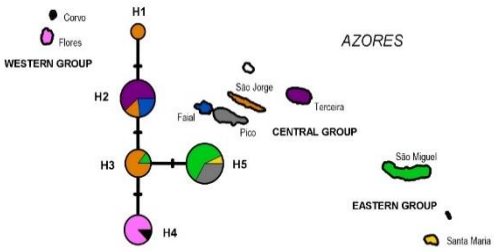
Molecular genetics methods, encompassing population genetics, phylogenetics and phylogeography, are used to determine the relationships between and within insular lineages and their associated evolutionary patterns. Because systematics is basic to conservation planning, the group also deals with fundamental issues such as revision of taxonomic inaccuracies, detection of barriers to gene flow and population structure.

The group is composed of researchers that are united by a common passion for broadening the existing knowledge base on insular biodiversity and evolutionary forces, through the study of such diverse groups as marine algae and terrestrial vascular plants, frequently in collaboration with other research groups at national and international institutions. The group has been focussing its work on Azorean lineages and on related Macaronesian and continental taxa, with several projects currently underway dealing with the systematics of Azorean endemic plants and wild crop relatives.



Cofinanciado pelo Programa Operacional AÇORES 2020
(85% pelo FEDER e 15% pelo ORAA)

Azorina vidalii



Wide phylogenies and phylogeographical analyses contribute to better understand the evolutionary processes and biogeographical patterns in several insular lineages such the Campanulaceae and the Scytosiphonaceae.

Climatic changes and plant genetic resources: the overlooked potential of Cabo Verde's endemic flora

AKDN

AGA KHAN DEVELOPMENT NETWORK

Current projects are dealing with the systematics of Azorean endemic and native plants and wild crop relatives.

GBM
Madeira Biodiversity Group * Grupo de Biodiversidade da Madeira
Coordinator * Miguel Sequeira

We investigate the past, present and future of the flora and fauna of Madeira and the Macaronesian islands. Our research activities include: Study of the fauna, flora and vegetation of the past; The history of zoological and botanical knowledge in Macaronesia; Study of the current fauna, flora and vegetation; Description of new species, subspecies and new combinations; Genetic diversity; Island ecology, Ecology - plant landscape, tree growth rings and invasive plants, invasive animals. Phylogenetic relationships and colonization patterns of several taxa, essentially the endangered and endemic/native taxa.

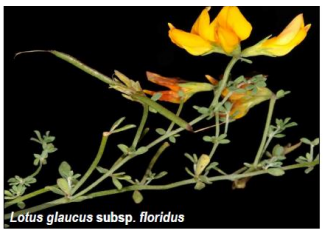
The main goals of this research group are:

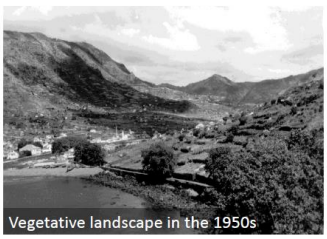
- To contribute to a better paleobotanical and paleozoological knowledge of Macaronesia;

- To better understand vegetation types and dynamics, including recent landscape changes, and human-driven changes in the Macaronesian Landscape;

- To contribute to a better floristic knowledge of Madeira and to taxonomical knowledge of critical taxa including their conservation status (e.g., *Andryala* L., *Sinapidendron* Lowe, *Musschia* Dum., *Carlina* L., *Aeonium* Webb & Berthel., *Tolpis* Adans., *Myrica faya* Aiton, *Dracaena draco* L.);

- To contribute to a better faunal knowledge of Madeira and to taxonomical knowledge of several taxa (e.g. bats, reptiles, birds, land-snails), including their conservation status.





MODELANDIS

Modelling and Land Management on Island Systems * Modelação e Gestão do Território em Sistemas insulares

Coordinator * Luís Silva

Globally, and particularly on islands, anthropogenic activities have led to considerable change in soil cover and biodiversity patterns. Therefore, a holistic approach to research and management presently requires the integration of studies devoted to indigenous and non-indigenous species, natural and artificial habitats, ecologic and economic services. Our strategy is to use diverse modelling, statistical, sociodemographic and geographic information tools to research and evaluate a wide range of species, from endemic to invasive, and a broad array of ecosystems, including forest resources, pastureland, and natural habitats. Besides fundamental research dedicated to the study of ecological and biodiversity patterns on islands, using diverse modelling tools (e.g., species distribution modelling, community modeling), our group also uses dendrometric and dendrochronological approaches, evaluation of economic resources (e.g., tourism), and land management tools (e.g., management plans) in more applied research.

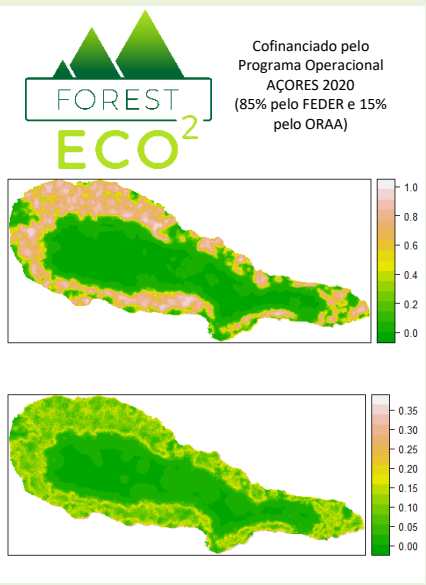
The specific objectives of the group are:

- To understand the biodiversity, ecological and genetic patterns in island systems, as derived from natural and anthropogenic factors;

- To evaluate ecological services, economic services and diversity patterns in pastureland and forests, particularly along gradients of anthropogenic disturbance;

- To evaluate natural resources for tourism and its potential impact on, for example, walking trails;

- To devise land management tools that will contribute to improve natural resource sustainability and biodiversity conservation.



NaTour

Planning and management of tourism in natural areas * Planeamento e gestão do turismo em áreas naturais
Coordinator * Maria Anunciação Ventura

In the last decade, the Azores archipelago turned from an almost unknown region to a highly awarded tourist destination. Furthermore, in April 2015 the local air space was opened to low cost flights, leading to an increase in the number of national and international arrivals. Cruise ships carrying thousands of tourists also arrive more frequently, mainly to Ponta Delgada harbour. The observed boom of tourists is recent in these islands but is already a fact in other neighbouring archipelagos. Thus, our research interests extend to the entire Macaronesian biogeographic region, which includes the EU's outermost regions of the Azores, Madeira and the Canaries, as well as the African country of Cape Verde. In this context, we have already established recent contacts with Cape Verdean colleagues that might help develop joint research, within the frame of an ongoing H2020 project.

In general, we are dealing with small oceanic islands, dispersed throughout the North Atlantic Ocean, that need a particular care when it comes to planning and managing activities that take place within their natural habitats, in order to preserve local natural resources while promoting ecotourism, nature-based tourism and a high quality touristic offer. Islands are mostly wanted for their natural beauties, and tourism is quite important for the economy of small island states. For instance, in the Azores, the beautiful landscape and seascape are the main reasons for most of the tourists to visit the archipelago.

Thus, this group is built under the need to properly plan and manage tourist activities that take place within natural areas, both on land and at sea, harmonizing recreation and conservation, while minimizing possible impacts.

Our main goals are to:
- Study and value the nature-based tourism as a cultural service provided by the Macaronesian natural ecosystems;
- Analyse and explore the existing natural resources that form our biological and geological heritage, in order to promote them for sustainable tourist uses;
- Determine tourist carrying capacities in natural areas (e.g., in the existing trails) and help plan and develop new activities, routes and trails;
- Plan the design of sub-aquatic trails for a sustainable use of the maritime resources (e.g., seascape, biodiversity assets), by the local maritime-tourism enterprises;
- Study the potential to develop new forms of nature-based tourism to be implemented in the regions and analyse their economic revenue, without compromising the ecosystems' conservation;
- Promote certification schemes that can help preserve the natural capital;
- Identify and develop management plans for certain terrestrial/marine species with conservation interests (e.g., umbrella or key species), that can in turn be used to promote local tourism;
- Analyse cultural ecosystem services to support decision-making.





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