

Concurso de Projetos de I&D em Todos os Domínios Científicos - 2022
2022.09185.PTDC

Estado
A Conceder

Fecha a
11.03.2022 17h00 GMT

Dados gerais

Investigador responsável

Ana Cristina Machado Russo

Título do projeto em português

Análise de eventos secos, quentes e fogos combinados ou consecutivos e dos seus impactos na qualidade do ar ao nível Europeu numa perspetiva de alterações climáticas

Título do projeto em inglês

Droughts, heatwaves, and fires: Exploring compound and cascading hazards and their impacts in air quality at the European scale under a climate change perspective

Acrónimo do projeto

Dhefeus

Palavras-chave em português

Eventos compostos qualidade do ar fogos florestais eventos secos e quentes

Palavras-chave em inglês

Compound events air quality wildfires dry and hot events

Tipologia do projeto

Projetos de Investigação Científica e Desenvolvimento Tecnológico

Área científica principal

Domínio científico

Ciências Naturais

Área científica

Ciências da Terra e do Ambiente

Subárea científica

Meteorologia e Ciências da Atmosfera

Painel de avaliação

Earth Sciences and Engineering

Fundamentação da seleção da área científica

The overarching goal of **DHEFEUS** is to enhance the knowledge on compound or cascading weather/climate events, namely droughts and heatwaves, and further associate them to the occurrence of wildfires and pollution events in Europe. **DHEFEUS** will address the potential weather–air pollution interaction during wildfires and dust storms, taking into consideration that concurrent droughts and extreme temperatures can potentiate fires and the occurrence of air pollution episodes. Apart from addressing weather and climate-driven events, **DHEFEUS** will also focus on 1) wildfires’, which are very sensitive to weather, climate variability and particularly, to weather extremes such as heatwaves and droughts; 2) wildfires’ pollutants emissions. Based on these, we think that **DHEFEUS** will be best evaluated under the subsection Meteorologia e Ciências da atmosfera.

Calendarização

Data de início

01.01.2023

Duração (meses)

Instituição proponente

Instituição	Unidade de I&D
FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências	→ Universidade de Lisboa (UL) - Faculdade de Ciências da Universidade de Lisboa - Instituto Dom Luíz

Descrição da instituição e respetivas competências para o desenvolvimento do projeto

FCiências.ID - a Non Profit Private Association, created as a joint initiative of the Faculty of Sciences of the University of Lisbon (FCUL) and 6 private companies, in order to support, potentiate and develop Research and Development of its associates - is the SNCT representative of 19 FCUL hosted research centers, thus assuring the overall scientific framework and logistic support to research activities.

Instituto Dom Luiz (IDL) is an Associated Laboratory that focuses on the use of quantitative science to unravel our Planet's Dynamics and to respond to major societal challenges posed by Climate Change, a sustainable use of Earth and Energy Resources, and exposure to Natural Hazards. As a fully-integrated Earth System Science Institute – with over 100 integrated members – IDL produces internationally-relevant science that directly contributes to a vast range of public policies and initiatives, or that is upstream to numerous applications at national and European level. IDL manages state-of-the-art laboratories and research in Geophysics, Geochemistry, Geology, Renewable Energy, High Performance Computing facilities and hosts doctoral programs in Earth System Science and Sustainable Energy. IDL research lines combines analytical studies, data analysis, observational activities and modelling.

Instituições participantes

País	Instituição	Unidade de I&D
PORTUGAL	Instituto Português do Mar e da Atmosfera, I. P.	→ Instituto Português do Mar e da Atmosfera, I. P.

Descrição da instituição e respetivas competências para o desenvolvimento do projeto

The Portuguese Institute for Sea and Atmosphere, I.P. (IPMA), is a public institution, part of the indirect administration of State, endowed with administrative and financial autonomy and its own assets.

IPMA follows the responsibility of the Ministry of Sea, under supervision and guardianship of the respective minister. The strategic guidelines and goals for IPMA, as well as the monitoring of their implementation, are articulated between members of the Government responsible for the sea and science. IPMA has responsibilities at national territory level in the areas of the sea and atmosphere. Focusing its research efforts on projects that accrue to direct applications for use in operating activities, pursuing continuous improvement in the information made available to its users whether for commercial use or public service and in particular directed to the safeguard of people and property.

In particular, IPMA is the leading entity for the EUMETSAT Satellite Applications Facility on Land Surface Analysis (LSA SAF). IPMA has a long experience in evaluating fire risk and in monitoring fire events. Within projects, such as the LSA-SAF, Copernicus Global Land, CAMS, and ARISTOTLE-2, such activities are maintained at different scales, ranging from regional to global.

As part of the LSA SAF and Copernicus-related initiatives, IPMA implemented and maintains a set of chains for processing, archiving and near-real time/off-line dissemination of remote sensing products.

Instituições de colaboração

País	Instituição
NORUEGA	Oslo Metropolitan University

Descrição da instituição e respetivas competências para o desenvolvimento do projeto

OsloMet aspires to play a leading role as a provider of research-based knowledge related to the welfare state, in Norway and abroad.

Our goal is to be inquisitive and open in our dealings with society, employers and businesses, and we will produce new knowledge that provides solutions to the challenges of tomorrow.

OsloMet established five Centres of Research Excellence in 2020. These centres reflect the diversity of research conducted at Norway’s third-largest university. The centres provide a framework for high-quality research whose impact will be felt both nationally and internationally.

Nordic Centre for Sustainable and Trustworthy Artificial Intelligence Research (NordSTAR) is a Centre of Research Excellence in modern Artificial Intelligence (AI). The centre aims to establish a new paradigm in AI basic research, so-called sustainable and trustworthy AI.

NordSTAR team has extensive knowledge in the development of quantitative tools, modelling & analysis, complex systems and sectoral applications (e.g. intelligent health, climate, energy, finance).

País	Instituição
ESPANHA	Environmental Physics Laboratory

Descrição da instituição e respectivas competências para o desenvolvimento do projeto

EPhysLab is a multidisciplinary research group of the University of Vigo, established in 2002. The group is formed of researchers in both Atmospheric and Oceanic Physics, and Computer Engineering that belong to the Faculty of Science and the School of Aerospace Engineering in Ourense.

Our research aims are within the scope of Environmental Science, considering many different aspects. These research aims have been funded by Europe, the Spanish Government, Xunta de Galicia and in a small part by private bodies.

In our work we always strive for excellence; and we have published around 30 scientific journal papers in the last five years in peer-reviewed international journals (SCI), a majority to the level of Q1.

Since 2006, we have been a “Competitive Reference Group of the Xunta de Galicia” and have been part of the “Marine Research Centre (CIM-UVigo)”, one of the five Singular Research Centres of Galicia, since 2016. In addition, we are an Associated Research Unit of the Higher Council for Scientific Research (CSIC).

EPhysLab has several collaboration agreements with more than twenty Universities and Research Centres both nationally and internationally, as well as with private bodies. These collaborations are based on the transfer of knowledge. With the aim of joining research, transfer and teaching, we are actively linked to two strategic initiatives of the University of Vigo: the Campus del Mar and the Campus del Agua.



Investigador responsável

Ana Cristina Machado Russo

Nuclear

IR

40% de dedicação

Ciência ID

FA1D-32CB-7626

Instituição à qual está associado no âmbito do projeto de investigação

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV

Obtido em 13-02-2022 at 15:44:14 GMT

Sinopse do CV

Ana Russo (hereafter ARusso) completed a **degree and MSc in Meteorology** at Faculdade de Ciências da Universidade de Lisboa (FCUL) in 2001 and 2005, followed by a **PhD focusing on air quality modelling** at Instituto Superior Técnico (2011).

ARusso continued her scientific path at Instituto Dom Luiz (IDL, FCUL) as a research fellow in 2012. In 2015, ARusso was **awarded a competitive FCT post-doctoral grant** which she conducted at IDL until 2019, when she started a fixed term contract at FCUL.

ARusso has developed skills and several state-of-the-art tools on broad scientific aspects (e.g., data mining, geostatistics, artificial intelligence, air quality modelling, climate change, compound events) as well as on team management, coordination and leadership, student mentoring, fund acquisition and budgeting. These skills helped to **consolidate ARusso’s research path on the interplay between different climate and weather extreme events and their sectoral impacts** (e.g., agriculture, vegetation, and human health), and she published several articles within this proposal thematic (e.g., Russo et al. 2014, *doi:10.1016/j.atmosenv.2014.02.010* on air quality and weather interaction; Russo et al. 2019, *doi:10.1088/1748-9326/aaf09e* on compound dry and hot events; Hertig et al., 2020, *doi:10.3390/atmos11121271* on compound pollution and heatwaves in health impacts; Russo et al. 2017, *doi:10.1016/j.agrformet.2017.01.021* on compound droughts and fires; Libonati et al., 2021, on compound drought, heatwaves and fires, *doi:10.1088/1748-9326/ac462e*.

ARusso scientific production includes **53 articles** in international peer-reviewed journals, 10 of them as 1st author, accounting for more than 830 citations and a h-index of 19 (Scopus). **17 of these papers were led by** post-doctoral **researchers**, PhD, and MSc candidates **under her supervision**. ARusso has participated in several national and international conferences, authoring 85 communications. In the last 5 years, she **participated in three international projects** (IMDROFLOOD, ROADMAP, FioCruz-74102235403615), **two FCT projects** (QSECA, IMPECAF) **and** on an **EEA grant project** (1003RNA2100.1.1). She **coordinates both ROADMAP (CO-PI) and IMPECAF (PI)**.

She is a **member of the COST Action DAMOCLES** and proposed the COST Action OC-2021-1-25610. Participation and coordination of international projects and COST actions fomented **collaborations with international institutions** (e.g., MPI-Germany; LOCEAN-France; UBeijing-China; UFRJ-Brazil). Additionally, ARusso is a **founding member of the Iberoamerican Women network for Climate Action (IBWoClima)**.

During the last 5 years, ARusso has **supervised 5 undergraduate students, 6 MSc students, 4 PhD students and 1 Erasmus+ student**.

She was invited to **evaluate 2 MSc thesis, the applications to the IDL PhD program (2021) and post-doctoral scientific projects (The Dutch Research Council, 2021)**.

The increasing level of responsibilities led to the invitation in 2019 to become the **Co-Lead of the IDL/RG1 group**.

Custo total (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Membros

Alexandre Miguel Ramos

Membro

15% de dedicação

Associação

Confirmada

Ciência ID

B113-3F07-8DA1

Instituição à qual está associado no âmbito do projeto de investigação
FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV
Obtido em 13-02-2022 at 15:14:25 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Andreia Filipa Silva Ribeiro Membro 15% de dedicação



Associação
Confirmada

Ciência ID
1D1A-DF5C-E3B6

Instituição à qual está associado no âmbito do projeto de investigação
FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV
Obtido em 10-03-2022 at 10:52:34 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Carlos do Carmo de Portugal e Castro da Camara Membro 20% de dedicação



Associação
Confirmada

Ciência ID
611E-5F03-C163

Instituição à qual está associado no âmbito do projeto de investigação
FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV
Obtido em 07-03-2022 at 13:04:04 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Célia Marina Pedroso Gouveia Nuclear Co-investigador responsável 30% de dedicação



Associação
Confirmada

Ciência ID
571A-5CC8-78F3

Instituição à qual está associado no âmbito do projeto de investigação
Instituto Português do Mar e da Atmosfera, I. P.

CV
Obtido em 10-03-2022 at 11:07:44 GMT

Custo envolvido (em euros)					
	2023	2024	2025	2026	Total
	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Coral Salvador

Membro

15% de dedicação

^

Associação

Confirmada

Ciência ID

6212-E2CB-8630

Instituição à qual está associado no âmbito do projeto de investigação

Environmental Physics Laboratory

CV

Obtido em 08-03-2022 at 18:09:31 GMT

Daniela Lima

Membro

20% de dedicação

^

Associação

Confirmada

Ciência ID

311C-9DF0-F29A

Instituição à qual está associado no âmbito do projeto de investigação

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV

Obtido em 04-03-2022 at 13:36:57 GMT

Custo envolvido (em euros)					
	2023	2024	2025	2026	Total
	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

João Lucas Marcelino Geirinhas

Membro

15% de dedicação

^

Associação

Confirmada

Ciência ID

EE1C-2C05-9D01

Instituição à qual está associado no âmbito do projeto de investigação

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV

Obtido em 07-03-2022 at 10:13:14 GMT

Custo envolvido (em euros)					
	2023	2024	2025	2026	Total
	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Joao Paulo Afonso Martins

Membro

20% de dedicação

^

Associação

Confirmada

Ciência ID
CF18-48BA-69BF

Instituição à qual está associado no âmbito do projeto de investigação
Instituto Português do Mar e da Atmosfera, I. P.

CV
Obtido em 08-03-2022 at 14:37:14 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Pedro Goncalves LindMembro15% de dedicação



Associação
Confirmada

Ciência ID
EA1A-9C9F-D37E

Instituição à qual está associado no âmbito do projeto de investigação
Oslo Metropolitan University

CV
Obtido em 08-03-2022 at 08:51:58 GMT

Pedro SoaresNuclearMembro15% de dedicação



Associação
Confirmada

Ciência ID
E716-7D48-A637

Instituição à qual está associado no âmbito do projeto de investigação
FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV
Obtido em 09-03-2022 at 18:45:08 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Pedro Miguel Ribeiro de SousaMembro15% de dedicação



Associação
Confirmada

Ciência ID
921F-0F1B-85B6

Instituição à qual está associado no âmbito do projeto de investigação
Instituto Português do Mar e da Atmosfera, I. P.

CV
Obtido em 13-02-2022 at 08:27:50 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Raquel Olalla Nieto Muñiz Membro 15% de dedicação



Associação

Confirmada

Ciência ID

D116-82C7-65A1

Instituição à qual está associado no âmbito do projeto de investigação

Environmental Physics Laboratory

CV

Obtido em 07-03-2022 at 15:30:50 GMT

Renata LIBONATI DOS SANTOS Membro 15% de dedicação



Associação

Confirmada

Ciência ID

C615-0D17-E71A

Instituição à qual está associado no âmbito do projeto de investigação

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV

Obtido em 06-03-2022 at 20:35:54 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Ricardo Machado Trigo Nuclear Membro 15% de dedicação



Associação

Confirmada

Ciência ID

1A15-AEFF-B55E

Instituição à qual está associado no âmbito do projeto de investigação

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV

Obtido em 02-03-2022 at 10:00:24 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Rita de Melo Durão Membro 15% de dedicação



Associação

Confirmada

Ciência ID

Instituição à qual está associado no âmbito do projeto de investigação

Instituto Português do Mar e da Atmosfera, I. P.

CV

Obtido em 09-03-2022 at 10:34:55 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Rita Margarida Cardoso Tavares Membro 20% de dedicação



Associação

Confirmada

Ciência ID

C611-FBF3-2B93

Instituição à qual está associado no âmbito do projeto de investigação

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

CV

Obtido em 09-03-2022 at 11:58:54 GMT

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	0,00 €	0,00 €	0,00 €	0,00 €

Novas contratações

(DL57-RDE - 02) DL 57/2016 - Regime de dedicação exclusiva 100 % de dedicação



Instituição

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

Tarefas

- T1 – Data · 2.4 pessoa * mês
- T2- Extreme weather events · 4.8 pessoa * mês
- T7 – Climate Change assessment · 3.6 pessoa * mês
- T5 - Compound approach to extreme weather, forest fires and air pollution events · 8.4 pessoa * mês
- T3 - Forest fires · 4.8 pessoa * mês

Custo envolvido (em euros)

2023	2024	2025	2026	Total
43 323,69 €	43 323,69 €	0,00 €	0,00 €	86 647,38 €

(BI-b - 04) Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG 100 % de dedicação



Instituição

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

Tarefas

- T1 – Data · 1.2 pessoa * mês
- T2- Extreme weather events · 6 pessoa * mês
- T7 – Climate Change assessment · 4.8 pessoa * mês

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	12 433,84 €	0,00 €	0,00 €	12 433,84 €

(BI-b - 06) Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG 100 % de dedicação

Instituição

Instituto Português do Mar e da Atmosfera, I. P.

Tarefas

- T1 – Data · 1.2 pessoa * mês
- T4 – Air pollution · 7.2 pessoa * mês
- T6 - Carbon balance · 3.6 pessoa * mês

Custo envolvido (em euros)

2023	2024	2025	2026	Total
12 433,84 €	0,00 €	0,00 €	0,00 €	12 433,84 €

(BI-b - 07) Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG 100 % de dedicação

Instituição

Instituto Português do Mar e da Atmosfera, I. P.

Tarefas

- T1 – Data · 1.8 pessoa * mês
- T6 - Carbon balance · 8.1 pessoa * mês
- T5 - Compound approach to extreme weather, forest fires and air pollution events · 8.1 pessoa * mês

Custo envolvido (em euros)

2023	2024	2025	2026	Total
0,00 €	12 433,84 €	6 216,92 €	0,00 €	18 650,76 €

Consultores

Francesca Di Giuseppe

Associação

Confirmada

Ciência ID

0912-ACA7-8AD2

Email

francesca.digiuseppe@ecmwf.int

CV

Obtido em 07-03-2022 at 15:24:54 GMT

Enquadramento da sua participação no projeto

Francesca leads the development of the Fire Forecasting system at ECMWF. The system provides operational predictions to the European Forest Fire Information System (EFFIS) under the umbrella of the European Copernicus Emergency Management Services. EFFIS is also being expanded into the Global Wildfire Information System to create an integrated system that provides access to all fire related available information on a global scale. Since joining ECMWF in 2011, Francesca has worked extensively on seasonal and sub-seasonal forecasting for sectoral application related to drought, fire and health, with a focus over Europe and Africa. Francesca Di Giuseppe will contribute to Tasks 3 and 5.

Ana Bastos

Associação

Confirmada

Ciência ID

291A-52B4-AA5A

Email

anafibastos@gmail.com

CV

Obtido em 08-03-2022 at 12:12:55 GMT

Enquadramento da sua participação no projeto

Ana Bastos is the Leader of the Climate-ecosystem-disturbance interactions group at the Department Biogeochemical Integration at the Max Planck Institute for Biogeochemistry. Ana Bastos aims to better understand inter-annual to long-term variability in the global carbon-cycle. To do this, my research bridges the disciplines of atmospheric science, ecology and biogeochemistry, from both observation-based and modelling perspectives. Specific topics include land-atmosphere interactions, the role of internal climate variability and ocean-atmosphere-land teleconnections in controlling carbon-cycle dynamics, the impacts of climate extremes on ecosystem functioning and ecosystem disturbance regimes. Within the aim of DHEFEUS Ana Bastos will contribute to Task 6 on the analysis of feedbacks between fire, ozone, vegetation and to the assessment of carbon budget.

Jakob Zscheischler

Associação

Confirmada

Ciência ID

A111-9FC2-6ABC

Email

jakob.zscheischler@ufz.de

CV

Obtido em 10-03-2022 at 09:06:21 GMT

Enquadramento da sua participação no projeto

Jakob Zscheischler is an Earth system scientist with a background in mathematics, biogeochemistry and climate science. His research focus are compound weather and climate events, that is, combinations of climatic drivers that contribute to environmental and societal risk. He is the Chair of the European COST Action DAMOCLES (Understanding and modeling compound climate and weather events), which brings together climate scientists, engineers, social scientists, impact modellers and decision-makers and coordinates national research projects on compound events. In a recent review he proposed four different types of compound events, with the goal to aid in compound event analysis. He leads the group on Compound weather and climate events at UFZ. Jakob Zscheischler will contribute to Tasks 2 and 5.

Sinopse do cv da equipa

The work plan will benefit from the multi- and interdisciplinary scientific expertise of the research team, including partners from the institutions involved (IDL, IPMA, EphysLab and OsloMet), and consultants from different renowned institutions (ECMWF; Max Planck Institute for Biogeochemistry, Germany; Helmholtz Centre for Environmental Research – UFZ, Germany).

The **DHEFEUS** team has a vast experience and is internationally recognized on all the core sub-areas of this proposal, namely multivariable analysis of extreme events [P1-P5,7,19,37], fire behavior and impacts [4-5,22,31,35], air quality [10,27,38-39], and environmental impacts [P5,7,19], compound approaches [P2,19] and climate change impacts [30,40]. The team is also responsible for setting up operational environments which provide real time information for fire management (ARISTOTLE–eENSHP, CeaseFire, LSA-SAF/IPMA). The present proposal will also build upon the expertise obtained from previous projects on the subject areas (e.g. ECV Fire Disturbance (ESA), FUME (FP7), IMDROFLOOD (JPI), Firecast and IMPECAF (FCT)). DHEFEUS will be articulated with 2 ongoing projects focused on natural hazards and impacts on the environment (ROADMAP/JPI, Firerisk/H2020). Additionally, several of the team members already worked together in previous projects.

The project will be coordinated by the IDL, a group with research activity and large professional experience in meteorology and atmospheric sciences. The **great expertise** of the IDL team members **Ana Russo, Ricardo Trigo, Carlos da Camara, Pedro Soares, Rita Cardoso in climatological-related issues, and in compound events under a climate change perspective** in particular (e.g., [P1-P5,7,10,40]) will be pivotal for the compound approach proposed here, in order to better understand compound events and its impacts on air quality.

These skills will be complemented by the IPMA's team experience on air quality modelling and on setting up operational environments which provide real time information for fire management.

The researchers with nuclear CVs all have strong skills on the core areas of the project. Namely, they all have a background on climatology and are experienced on extreme events modelling.

Ana Russo has a vast scientific record on the interplay between different climate and weather extreme events and their sectoral impacts (see PI synopsis).

Célia Gouveia research is focused in the climate impacts on vegetation status, namely in the case of extreme events. She coordinates de Forest Fire Hazard Group on European Natural Hazards Scientific Partnership for Early-warning ARISTOTLE eENHSP (EU-ERCC) and coordinates the IPMA’s team on the FirEURisk (H2020-LC-CLA-2018-2019-2020-project 101003890). She coordinated a national (FCT) project and participated in 11 international and 18 National projects. At the moment she is a consultant on the Agrometeorological Risk Management expert team, as a part of the Standing Committee on Services for Agriculture (SC-AGR) of the Services Commission (SERCOM) at WMO and she is the national delegate at Scientific Working Group from EUMETSAT.

Ricardo Trigo is a Senior Researcher and Group leader at IDL. He has published extensively focusing on the evaluation of weather driven natural hazards, with particular emphasis to floods, droughts, landslides, heatwaves and wildfires. He is a member of the Drought Interest Group (DIG) run jointly by the Climate Variability and Predictability (CLIVAR) and Global Energy and Water Cycle Experiment (GEWEX). He has participated as PI in several EU funded projects (e.g. CIRCE, FUME, ERA-CLIM). In 2008 he was awarded with the International Journal of Climatology Prize endorsed by the Royal Meteorological Society (UK) and in 2017 with The Earth Sciences Prize (2017) awarded by the University of Lisbon/Caixa Geral de Depósitos Prize.

Pedro Soares is the coordinator of the Portuguese team of CORDEX (Coordinated Regional Climate Downscaling Experiment) effort and an active member of the GCSS (GEWEX Cloud System Studies) Boundary Layer Cloud Working Group. He has been PI or CO-PI of several projects (e.g. REWRITE, SOLAR, LEADING) with a strong climate change component.

The participation of **EPhysLab** will ensure the presence of a highly specialized team, constituted by Coral Salvador and Raquel Nieto, who have a strong profile in the fields of climate variability, compound modelling, extreme events and their impacts on human and the environment, which are pivotal for the multi-analytical approach to be implemented in the DEFHEUS project. **Raquel Nieto** has a long list of publications in their field of work accompanied by multiple international scientific collaborations, and their knowledge and experience will be a great asset in successfully achieving the objectives of the proposal. **Coral Salvador** is a young post-doc researcher which have a interesting record of publications on the core areas of the project.

The participation of **OsloMet** will ensure the participation of **Pedro Lind**, who is an experienced researcher in statistical and mathematical models and their implementation and applications to health, engineering and society. Pedro Lind has also experience in air quality modelling through artificial intelligence techniques, on complex networks and critical phenomena. He authored and co-authored more than 70 publications indexed in WOS with over 1100 citations, and counts more than 200 talks and seminars in international conferences and in universities around the world.

The team will be assisted by **three consultants** with solid backgrounds on climate and global carbon-cycle (**Ana Bastos**, MPI), compound modelling (Ana Bastos and **Jakob Zscheischler**) and fires (**Francesca Di Giuseppe**). The consultants will assist the PI and CO-PI, providing a fresh perspective and knowledge based on their expertise. They will act as steering committee, identifying weak and strong efforts during the project duration.

Resumo

Resumo em português

Secas e ondas de calor são eventos naturais extremos que ocorrem frequentemente em todo o mundo [1]. Na Europa, os impactos dos referidos extremos têm vindo a ser exacerbados nas últimas décadas em virtude do aumento da sua frequência e intensidade [2-6]. Consequentemente, e por força do agravamento progressivo e projetado devido às alterações climáticas [2-3,6-7], antecipa-se uma intensificação dos respetivos impactos na vida humana e nos ecossistemas [8,9].

Os eventos naturais extremos podem resultar da interação de processos físicos que atuam a escalas espaciais e temporais variadas [P1-P4,6,9-14], ou seja eventos compostos ou em cascata. Tal como os eventos individuais, os eventos compostos quentes e secos (a partir de agora, CQS) têm vindo a apresentar tendências positivas na frequência e gravidade, com impactos a vários níveis, nomeadamente na mortalidade [15-16], nos fogos [17], na poluição do ar [16,18], e nas perdas agrícolas [19]. Tendo em conta os impactos dos eventos CQS, diversos estudos dedicaram-se a avaliar os custos e benefícios da aplicação de medidas de redução do risco, tanto estruturais quanto baseadas na natureza. No entanto, a maioria das abordagens não incorpora a interação entre múltiplos eventos ao abordar os impactos setoriais e ambientais, o que pode levar à subestimação do risco [12]. O Quadro de Sendai para a Redução do Risco de Catástrofes destaca a necessidade de desenvolver e operacionalizar sistemas de alerta precoce considerando várias tipologias de risco, dando preferência a abordagens holísticas em detrimento de abordagens mais tradicionais univariadas ao avaliar situações de perigo meteorológico. Assim, vários investigadores começaram a dirigir a sua atenção para a aplicação de abordagens compostas, tendo sido identificadas relações claras no Sul da Europa entre extremos quentes e secos [e.g., P1], com impactos setoriais [e.g., P2,P4,11,18].

O objetivo geral do **DHEFEUS** é analisar eventos CQS e associá-los à ocorrência de incêndios e eventos de poluição na Europa Mediterrânica (EU), que finalmente serão avaliados quanto aos seus impactos na qualidade do ar (. O **DHEFEUS** focará: 1) os mecanismos forçadores de extremos individuais e compostos; 2) a avaliação das interações entre secas e ondas de calor, e entre os referidos extremos e a) fogos e b) eventos de poluição de uma perspetiva multidisciplinar, considerando as condições climáticas passadas, presentes e futuras.

A natureza inovadora do **DHEFEUS** resulta da adoção de uma linha de investigação emergente e desafiadora que assenta na utilização de métodos inovadores (e.g., abordagens compostas orientadas para eventos [P1-P4,1,9-12-14,20,23-24,32], Cópulas [19] e métodos sensíveis às mudanças climáticas [30,32]), suportados pela utilização complementar de novos conjuntos de dados de satélite [23-24,27] e de outputs de modelos de alta-resolução (saídas regionais de modelos climáticos e simulações regionais do WRF-Chem) que permitem avaliar os mecanismos de interação entre os fenómenos intervenientes [30,32]. Ao estudar em conjunto o clima, a atividade do fogo e a poluição do ar, o **DEFHEUS** terá em consideração o Acordo de Paris e os Objetivos de Desenvolvimento Sustentável da ONU para melhorar a vida no presente e nas condições futuras de aquecimento global. Essa abordagem integrativa permite explicar as sinergias entre diferentes eventos, o que constitui uma linha de investigação emergente e crucial no âmbito das alterações climáticas. A análise de vulnerabilidade proposta a partir de uma análise «ascendente» caracteriza as múltiplas causas (baixa precipitação, temperaturas extremas) de resultados únicos (incêndios, alta poluição), em vez de análises «descendentes» que avaliam vários impactos resultantes de apenas uma causa [10,12,18,20].

A equipa tem vasta experiência em todas as sub-áreas desta proposta, i.e., análise multivariável [P1-P5,4-6,19,22], fogos [4-5,22,31,35], qualidade do ar [10,27,38-39], impactos ambientais [P4-P5,7,19], abordagens compostas [P2,7,19] e alterações climáticas [30,40]. A equipa do projeto também possui sólida experiência na criação de ambientes operacionais que fornecem informações e alertas em tempo real (e.g., LSA-SAF e CeaseFire) e em projetos internacionais/nacionais nas áreas temáticas (e.g., FIREURISK, ARISTOTLE 2-ENHSP, ECV Fire Disturbance (ESA), FUME (FP7), QSECA, FIRECAST e IMPECAF (FCT)).

O **DHEFEUS** propõe uma estrutura de abordagem inovadora que permitirá fornecer informações vitais para o planeamento e implementação de medidas de adaptação e mitigação eficazes ao nível Europeu. Será seguida uma abordagem de baixo para cima para garantir o envolvimento das partes interessadas desde o início do projeto e também após sua conclusão, o que será assegurado pela conexão entre os parceiros e as autoridades responsáveis (e.g., APA, Autoridade Nacional de Emergência e Proteção Civil).

Resumo em inglês

A variety of weather-driven natural hazards, such as droughts and heatwaves, often occur throughout the world [1]. The resultant impacts of the occurrence of these extremes have been exacerbated by an increase in their frequency and intensity over the past few decades in Europe [2-6]. Due to the projected increase of these extreme events [2-3,6-7], combined with larger exposure, exceptional risk to humans and ecosystems is expected [8]. Therefore, progressive intensification of these hazards represents one of the most challenging impacts of climate change on society [8,9].

Natural hazards often result from interacting physical processes across a wide range of spatial and temporal scales [P1-P4,6,9-14]. These types of interacting events are commonly referred as compound or cascading. Similarly to individual extremes, positive trends in the frequency and severity of compound hot and dry events (hereafter CHD) have also been reported [6,9,12], being responsible for wide-ranging impacts, namely morbidity and mortality [15-16], wildfires [17], air pollution [16,18], and agricultural losses [19]. Several studies have addressed individual and CHD events in order to assess the costs and benefits of disaster risk reduction measures, both structural and nature-based. However, most of the approaches do not account for the interplay between multiple hazards when addressing the impacts on natural and socioeconomic sectors, although that might lead to the underestimation of risk [12]. Following the considerations formulated under the Sendai Framework for Disaster Risk Reduction, which highlights the need for multi-hazard early warning systems, an urgent call has been issued to assess compound disasters and the associated risks rather than focusing on single hazards. Therefore, several researchers started to focus their attention to the application of multi-hazards and compound approaches to tackle the caveats resulting from centering on single hazards. Consequently, clear relationships were identified in Southern Europe between hot and dry extremes [e.g. P1], which resulted in sectoral impacts [e.g. P2, P4,11,18].

DHEFEUS overarching goal is to improve the understanding on CHD and further associate them to the occurrence of fires and pollution events in Mediterranean Europe (EU), by focusing on their intricate chain of events through a compound-oriented framework. Therefore, DHEFEUS will focus on 1) the driving mechanisms of individual and extreme events; 2) the assessment of the interaction between CHD events and furthermore, between a) CHD and fires and b) CHD and pollution events from a multidisciplinary perspective, including past, present and future climate conditions. This will be accomplished based on innovative methods (e.g., compound event-oriented approaches [P1-P4,1,9-12-14,20,23-24,32], copula analyses [19] and climate-change sensitive methods [30,32], supported by satellite-based datasets [23-24,27] and high-resolution regional modelling (Regional Climate Models’ outputs and regional simulations from WRF-Chem) of surface-atmosphere feedbacks [30,32]. By studying on weather, fire activity and air pollution together, **DEFHEUS** will take into consideration the Paris

Agreement and the UN Sustainable Development Goals to improve lives in the present and under future climate warming conditions. This integrative approach enables to account for synergies between different hazards, which constitutes an emerging and crucial line of research within the scope of climate change. The proposed approach characterizes the multiple causes (low precipitation, extreme temperatures) of single or compound outcomes (fires, high pollution), instead of tracing the impact of a single hazard to a certain outcome [10,12,18,20].

DEPHEUS' team has a vast experience on all the core sub-areas of this proposal, namely multivariable analysis of extreme events [P1-P5,4-6,19,22], fire behavior and impacts [4-5,22,31,35], air quality [10,27,38-39], environmental impacts [P4-P5,7,19], compound approaches [P2,7,19] and climate change impacts [30,40]. The team has also sound experience in setting up operational environments providing real-time information and alerts (e.g., ARISTOTLE-eENHSP, IPMA portals and CeaseFire platform) and on international/national projects on the subject areas (e.g., FIREURISK, ECV Fire Disturbance (ESA), FUME (FP7), QSECA, IMDROFLOOD (JPI-Water), FIRECAST and IMPECAF (FCT)).

Overall, **DHEFEUS** proposes a groundbreaking compound framework, based on complementary databases and robust statistical tools and models' outputs to provide critical information for planning and implementation of effective adaptation and mitigation measures over Europe. A bottom-up approach will be followed to guarantee stakeholder involvement from the start of the project and also after its completion, which will be ensured by the connection between the partners and responsible authorities (e.g. APA, Autoridade Nacional de Emergência e Proteção Civil).

Resumo para publicação

Resumo para publicação em português

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Resumo para publicação em inglês

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Revisão da literatura

During the last 3 decades, record-breaking natural hazards occurrence has increased throughout the world [1-4], having led to over 1.6 million fatalities globally and estimated yearly economic losses of ~260–310 billion USD [21]. A large set of other sectoral, societal and environmental impacts have been reported [e.g., P4-P5, 2, 5, 8, 15, 19].

Europe has been struck, in particular since the begin of XXI century, by several extreme events, namely the mega-heatwaves of 2003, 2010 and 2017 [3-4], the large droughts in southwestern Europe in 2005 [2] and 2012, and the devastating fire-seasons of 2003, 2007 and 2017 in the Mediterranean [P4, 5, 22]. Heatwaves and droughts were also linked to the most extreme ozone pollution episodes in Europe [41]. With likely increased wildfire activity and frequency and intensity of climate extremes due to global warming, surface ozone (O3) will be further enhanced [23-24,33], leading to more severe O3 damage on vegetation [33]. The Intergovernmental Panel on Climate Change (IPCC, <https://www.ipcc.ch/reports/>) has stressed systematically that a warming climate is leading to significant increments in the frequency, intensity, spatial extent and duration of extreme events [2-3,14], that, combined with larger exposure, can result in an exceptional risk to humans and ecosystems [2,8-9]. Projected changes are partly attributed to changes in anthropogenic emissions and land cover and use [15], which will result in more intense and longer lasting heatwaves in Southwestern Europe (SWE) [3,15] compound by a decrease in mean precipitation. The occurrence of concurrent or lagging heatwaves and droughts increases the risk of wildfires around the Mediterranean basin [P4, 22], which is the European region with the largest total burned area [5, 22] and therefore with recurrent extensive human, ecological and economic losses [22]. In some regions, air quality (AQ) is expected to further worsen due to the increased frequency of fires, which causes the release of gaseous and particulate pollutants into the atmosphere [23-24]. Moreover, the release to the atmosphere of carbon related pollutants is mainly driven by the increase of fire emissions resulted from large and intense fire seasons frequently exacerbated by long dry periods [25-26]. Still, it is difficult to discriminate if a certain pollutant is emitted by wildfires or by other natural or anthropogenic sources.

Although nowadays there is strong evidence that natural hazards are at times synergetic [P1-P4,10-14,17-20] and that their combined occurrence has aggravated impacts [10-12,14,16-19], conventional risk assessment approaches only contemplate single hazards [11]. Thus, and in line with the Sendai Framework for Disaster Risk Reduction, it is urgent to assess compound disasters and their associated risks rather than focusing on single hazards [11]. Moreover, as climate change progresses, there is a need for additional knowledge and understanding of the interactions and interdependence of natural hazards because some of the key drivers are changing rapidly [12]. One of the interactions which is still a challenge is the potential weather–air pollution interaction during wildfires and dust storms. [P1] show the higher probability of droughts in the spring and early summer being associated with extreme temperatures in the summer over several areas of the Iberian Peninsula, which can potentiate fires and the occurrence of air pollution episodes. [27] highlighted the influence of synoptic conditions on air quality in the case of long-range transport and of fire-driven pollution events, which were powered by the advection of very warm and dry air masses that allowed the fires to spread rapidly. However, the underlying mechanisms of all these interactions, i.e. between droughts, heatwaves, pollution and fires, are not completely understood. Furthermore, several health and environmental consequences [e.g., P5,16-18,23] are foreseen, namely on vegetation dynamics and carbon balance [33]. These multidimensional climate–pollution effects need to be considered in estimating both climate and air pollution effects, in order to set up adequate policy and public health actions to face both the current and future climate and pollution challenges.

Recent studies have characterized CHD events based on distinct statistical approaches, including event coincidence analysis [e.g., 28], frequency of simultaneous occurrences of multiple extremes [e.g., 29], or copula analyses [e.g., P2,12,19]. Despite the scientific progress to date, the full comprehension of the mechanistic links associated to CHD events is in its early stages [P2]. Conceptual and technical barriers remain, such as the ambiguity in drought and heatwave definitions, limitations of data products, and challenges in the characterization of causal links across the land–atmosphere interplay [P2,9]. Additionally to statistical approaches, General and Regional Circulation Models (GCMs and RCMs, respectively) emerged as a powerful tool to evaluate recent trends in a broader temporal context and to investigate the underlying mechanisms associated with the occurrence of extreme events [2,7, 13-15, 18, 24, 30]. In particular, WRF-Chem [32] models simulate meteorological conditions along with pollutants' concentrations, namely high concentrations that are more strongly related to heatwaves and fire events.

Therefore, **DHEFEUS** intends to develop a holistic assessment of CHD events and their impacts on air quality on EU, based on the most updated dynamical and statistical methods and climate-change sensitive indices and approaches [6], supported by satellite-based datasets and high-resolution regional modelling of

surface-atmosphere feedbacks [30]. By acting on climate and air pollution together, **DHEFEUS** will take into consideration the Paris Agreement climate goals and the UN Sustainable Development Goals to improve lives now and limit future climate warming.

Plano de investigação e métodos

RATIONALE

Concurrent and amplified drought and heatwave events can strongly affect vegetation health, prompting tree mortality and favoring fires [P4,14,20], with the later, in turn, being an important source of air pollution [25,27] which can cause wide-ranging health problems [16,18,23]. Nevertheless, the underlying mechanisms associated to the chain of events encompassing droughts, heatwaves, fires and air pollution is still not fully understood. Multidimensional effects need to be considered in estimating both climate and air pollution effects to deliver public administrators with effective early warning tools. DHEFEUS constitutes a first attempt of analyzing compound extremes in the IP aiming at the minimization of air quality impacts.

MAIN GOAL

DHEFEUS intends to improve the knowledge on the impacts of CHD events on air quality at European scale by: 1) exploring appropriate high-resolution datasets and remote sensing tools to understand the role of the feedbacks and interactions between different hazards, and 2) applying robust statistical and dynamical techniques ensuring a better understanding of the different hazards’ feedbacks and interactions; and lastly 3) merging impact data towards establishing a comprehensive compound framework to better assess the impacts of CHD events. Therefore, **DHEFEUS** will expand the current knowledge on CHD events, its main drivers and their environmental impacts now and under future climates, while enlarging current national and international collaborations.

DHEFEUS intends to answer several emerging and still unanswered target questions (TQ):

TQ1: How do CHD events contribute do exacerbate the impacts on air quality in different sectors of Europe?

TQ2: What is the role of climate forcing factors (e.g., anomalous Sea Surface Temperature in the Atlantic, or predominant phases of the main modes of atmospheric circulation like the North Atlantic Oscillation or Eastern Atlantic Oscillation) to the occurrence of CHD events?

TQ3: How much the synergetic effect of CHD events and wildfires affect the terrestrial carbon budget?

TQ4: What are the main impacts of the CHF events, under future climate change conditions, in terms of extreme pollution events in different sectors of the Europe?

PLAN

DHEFEUS proposes an integrated approach which will be carried out in 7 tasks (**T#**, see DHEFEUS_cronograma.pdf). **T1** will be devoted to data acquisition and validation. **T2** will address single and compound heatwaves and droughts, identifying synergies, driving mechanisms and dominant atmospheric modes controlling single and combined events. **T3** will analyze fires and their association to single and compound events as identified in **T2**. **T4** will examine air pollution events, especially those associated with wildfires and from long range transport. **T2-T4** will allow resolving **TQ1** and **TQ2**. **T5** and **T6** rely on **T1-T4**, focusing on more than two hazards (e.g., droughts, heatwaves and wildfires), providing an overview of the likely impacts of fire emissions on terrestrial carbon cycle and of climate feedbacks in presence of single and combined hazards, answering to **TQ3**. **T7** is devoted to climate change and proposes to analyze how extreme events will evolve in the future, answering to **TQ4**.

DATA

DHEFEUS relies on the several relevant datasets over EU, which include meteorological, climate projections, fire occurrence, air quality and regional simulations from WRF-Chem (see description on **T1**). All data to be used is freely available and was previously used by the team members, thus minimizing the risk regarding data accessibility and representativeness.

METHODS

To answer to the proposed **TQ** following a multi-hazard and multidisciplinary perspective, we propose to implement the following dedicated methodologies:

- A) Drought and heatwaves** will be identified using multi-indicator approaches [P1-P3,10]. The indicators will use long meteorological datasets (1979 to present), integrating recent gridded high-resolution data together with high spatial-resolution satellite information (e.g., MTG and Sentinel) with shorter duration, although allowing a good characterization of droughts and heatwaves. In particular, multi-scalar drought indices like the Standardized Precipitation and Evapotranspiration Index (SPEI) [6], will be used to quantify the severity of the hazard. Exposure analysis and return periods will be identified over EU to assist stakeholders’ decision-making process and the implementation of mitigation strategies.
- B) Fires** over Europe (since 2001) will be analyzed and characterized regarding its duration, intensity, and total burned area based on national statistics available on EFFIS and from high temporal resolution remotely sensed products (c.f. **T1**, **DS8** dataset). The meteorological and surface forcing mechanisms responsible for triggering large fires will be assessed [5]. Case studies of extreme events (e.g., the 2017 and 2020 events in Portugal, 2021 in Greece and Turkey and 2022 in Ukraine) will be identified and characterized using ERA-5 reanalysis datasets, WRF-Chem outputs and remote sensing data (c.f. **T1**, **DS1**, **DS7**, **DS8** datasets).
- C) The identification of synergies, driving mechanisms and dominant atmospheric modes** controlling single and CHD events will be attempted, considering a wide spatial Europe-Atlantic region, using multivariate statistical analysis [P1,P3-P4,5,9] and compound approaches [P2,10-14]. Synergies will be identified,

together with their main drivers [P3,9], allowing the characterization of the dependence structure between droughts and heatwaves. The probabilities of one hazard becoming extreme given the occurrence of another hazard will be estimated, which constitute a valuable and attractive tool in risk assessment [P2].

D) The links between fire activity and pollutants’ concentrations, namely contribution of biomass smoke to records of air pollution and the importance of long-range transport, will be assessed over the EU, namely for case studies using *in-situ* data from air quality monitoring stations and from Copernicus Atmosphere Monitoring System (CAMS). Carbon emissions will be derived from the Fire radiative power (FRP) [25] obtained from SEVIRI, MODIS/VIIRS and SENTINEL and Ozone will be obtained from CAMS, allowing to assess the impact of the recent extreme fires on ozone and terrestrial carbon budget and therefore evaluate the impact of single or CHD events on nowadays carbon budget. This will rely on **DS5, DS7, DS8** datasets (cf. **T1**).

E) CHD, forest fires and pollution events over Europe will be addressed based on twofold approach: 1) focusing on the involved mechanisms, based on trend and extreme analysis, together with coupling metrics [e.g., P3, 9] and 2) focusing on the characterization of the joint behavior of multiple hazards and the consequent risks based on statistical (Copulas) and dynamical (WRF-Chem) approaches [P2,12,19,32]. A full characterization of the linear and nonlinear dependences between variables allows for the characterization of the dependence structure between variables and the estimation of conditional probabilities of one event given the occurrence of another event, constituting a valuable and attractive tool in risk analysis [P2]. This twofold approach will permit to assess the role played by preceding and simultaneous dry and/or hot conditions in the exacerbation of forest fires and resultant air pollution [23], and the identification of the key moments (months, seasons) and timescales of dry and/or hot conditions involved in the reinforcement and triggering both fires and air pollution events [23]. The use of both dynaical and statistical approaches relates to the fact that both have advantages and caveats. WRF-Chem can predict meteorological conditions along with pollution level [32], although having limitations on the parametrizations (e.g., terrain). Conversely, statistical approaches require much less computational power allowing for similar results, but large training data sets are usually required to improve outputs’ accuracy and minimize uncertainty [39]. This two-fold approach will be complementary and secure the proposed outcomes.

F) The evaluation of the impacts on the vegetation productivity of the synergetic effects of carbon and ozone extremes associated with fires and CHD extremes will be performed using satellite derived information of vegetation gross primary productivity. The disturbances on vegetation productivity will be analyzed using vegetation parameters available from the LSA-SAF (LAI, FAPAR) and the NPP MODIS datasets (**DS4** and **DS5**). Statistical approaches, such as correlation and logistic regression, will be used to evaluate the effect of ozone extremes (**DS9**) associated with severe fires (**DS8**) on the exacerbation of vegetation productivity losses (**DS5**), namely in water stress conditions (**DS1**).

G) Climate change assessment will be performed based on the ability of GCMs and RCMs to represent extremes, relying preferentially on the CMIP6 and WRF-Chem runs. At the regional scale, climate change assessment will be performed based on the full EURO-CORDEX regional climate simulations from CMIP6 [30] to feed the WRF-Chem model [32]. These will be validated and ranked, aiming to build a multi-model ensemble based on the RCMs individual qualities to represent the actual main drivers of CHD extremes in the IP, and their impacts on fires and mortality/morbidity outcomes. The statistical comparison of the multi-model ensembles, future and present climates, will permit the quantification of future changes on the drivers and properties of the hazards, and to characterize the uncertainty of the projections. Result will be used to support the construction of the warning system, having in mind the amplitude of the uncertainty of future hazards.

DHEFEUS will have access to a High-Performance Computing (HPC) System from IDL, where the numerical simulations will be executed.

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Tarefas

1 T0 – Coordination

36 meses

De 01.01.2023 a 31.12.2025

⬆

Membros

Pessoas / Mês	Alocados
0.72	Ana Cristina Machado Russo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.54	Célia Marina Pedroso Gouveia Instituto Português do Mar e da Atmosfera, I. P.

Descrição

Coordination will involve all the administrative work related to the Project as well as the management, dissemination and outreach activities. Management activities will include, among others, the drafting of administrative documents, the organization of project meetings, the organization of a kick-off meeting at the beginning of the project, the organization of a final workshop and the control of deadlines and milestones.

This task will entail the following:

- Organize the kick-off meeting;
- Monitor the progress of the individual tasks;
- Ensure the achievement of established objectives and deadlines;
- Promote corrective actions when considered necessary;
- Organize regular project meetings;
- Ensure the timely delivery of technical and financial reports;
- Promote the dissemination of results;
- Establish contacts with potential end-users;

- Organize a workshop with the end-user community to discuss and promote results.

Membros

Pessoas / Mês	Alocados
0.54	Coral Salvador Environmental Physics Laboratory
1.2	BI-b - 04 Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.72	Daniela Lima FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
2.4	DL57-RDE - 02 DL 57/2016 - Regime de dedicação exclusiva FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.54	João Lucas Marcelino Geirinhas FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.54	Pedro Soares FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.72	Rita Margarida Cardoso Tavares FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.2	BI-b - 06 Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG Instituto Português do Mar e da Atmosfera, I. P.
1.8	BI-b - 07 Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG Instituto Português do Mar e da Atmosfera, I. P.
0.54	Célia Marina Pedroso Gouveia Instituto Português do Mar e da Atmosfera, I. P.
1.44	Joao Paulo Afonso Martins Instituto Português do Mar e da Atmosfera, I. P.
0.54	Rita de Melo Durão Instituto Português do Mar e da Atmosfera, I. P.

Descrição

The aim of this task is to select, store and retrieve the data needed for the successful completion of **DHEFEUS**. The complexity inherent to the chain of processes involved entails the need of retrieving a variety of datasets (DS#). The following datasets will be extracted for the study area and then analyzed in terms of consistency, data representativeness and temporal and spatial cover:

- DS1:** The high-resolution long-term ERA-5 reanalysis from ECMWF with a spatial resolution of 30km from 1979 to present.
- DS2:** The European Climate Assessment & Database (ECA&D) E-Obs gridded observational dataset at 0.1° resolution from 1950 to present (including temperature, precipitation, wind, extreme weather indices and other relevant variables).
- DS3:** Iberia01 gridded daily temperature and precipitation dataset covering the IP at 0.1° resolution over the 1979-2015 period (or longer if possible).
- DS4:** The Satellite Application Facility on Land Surface Analysis (LSA-SAF) skin temperature dataset (LST), and evapotranspiration (ET and ETref) datasets with a resolution of 4km over the Meteosat Second Generation (MSG) disk from 2004 to present.
- DS5:** The GPP/NPP MODIS (MOD17A3, <https://modis.gsfc.nasa.gov/data/dataproduct/mod17.php>) annual global Gross Primary Production (GPP)/Net Primary Production (NPP) dataset.
- DS6:** Climate change scenarios from GCMs for the North Atlantic and European regions will be used with different emission concentration scenarios and 20th century control simulation from the Coupled Model Intercomparison Project Phase 6, if available at the project start, otherwise CMIP5 (<http://cmip-pcmdi.llnl.gov/cmip5/>) will be used.
- DS7:** For regional climate change assessment, two high resolution WRF simulations, and WRF-Chem at 9km and 27km horizontal resolutions, covering the full IP, forced by EC-EARTH for present (1971-2000) and future climate (2041-2100) will be used.

DS8: Information on fire events, recorded since 2001, will be extracted from ESA Fire Climate Change Initiative version 5.1 satellite product (FireCCI51, https://geogra.uah.es/fire_cci/firecci51.php) at 250 m spatial resolution. Data from high temporal resolution (15 min.) remotely sensed products, namely the Fire Radiative Power (FRP), the FRPPIXEL product from SEVIRI (<https://landsaf.ipma.pt/en/>), similar MODIS and VIIRS products (<https://feer.gsfc.nasa.gov/data/frp>) and recent data from Copernicus Sentinel 3, (<https://www.eumetsat.int/website/home/Satellites/CurrentSatellites/Sentinel3/AtmosphericComposition/index.html>) will also be extracted.

DS9: Observations and forecasts from Copernicus Atmospheric Composition System (CAMS) available from IPMA.

DS10: Carbon (and other pollutants) emissions will be derived from Fire radiative power (FRP) [25] obtained from LSA-SAF and also obtained from other remote sensed sensors (OMI, TOMS, etc.)

The relevance of other datasets will be explored, namely the European Space Agency Climate Change Initiative (ESA-CCI), the Copernicus Climate Change Service, and the Moderate Resolution Image Spectroradiometer datasets.

Membros

Pessoas / Mês	Alocados
1.08	Coral Salvador Environmental Physics Laboratory
2.16	Raquel Olalla Nieto Muñiz Environmental Physics Laboratory
2.7	Alexandre Miguel Ramos FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
2.88	Ana Cristina Machado Russo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.62	Andreia Filipa Silva Ribeiro FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
6	BI-b - 04 Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
4.8	DL57-RDE - 02 DL 57/2016 - Regime de dedicação exclusiva FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.81	João Lucas Marcelino Geirinhas FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.81	Pedro Soares FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.54	Renata LIBONATI DOS SANTOS FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.54	Ricardo Machado Trigo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.44	Rita Margarida Cardoso Tavares FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Célia Marina Pedroso Gouveia Instituto Português do Mar e da Atmosfera, I. P.
2.16	Joao Paulo Afonso Martins Instituto Português do Mar e da Atmosfera, I. P.
0.81	Pedro Miguel Ribeiro de Sousa Instituto Português do Mar e da Atmosfera, I. P.
0.54	Rita de Melo Durão Instituto Português do Mar e da Atmosfera, I. P.
0.54	Pedro Goncalves Lind Oslo Metropolitan University

Descrição

Despite the intense emphasis devoted to droughts and heatwaves during the last decades, the quantitative assessment of these hazards continues to be very challenging, namely because of a global need to observe and implement in an improved manner land-atmosphere processes in climate and forecast models. Nevertheless, the use of methodologies that account for different variables, time scales and associate different feedbacks is not yet a standard procedure. Despite the notable advances on addressing compound or cascading events, past studies mainly focused on one hazard and, at most, its corresponding feedback mechanisms. Moreover, compounding or cascading events are expected to have cumulative impacts superior to the hazards alone [10-12] and are expected to become more common in a warming climate. These makes the study of compound events even more vital for preparing for future climate extremes [13-15]. Therefore, it is very important to address CHD events properly, identifying synergies and driving mechanisms and dominant atmospheric modes controlling single and combined hazards.

This task proposes to:

1. Identify drought and heatwave events affecting EU, since 1979 to present. These will be accomplished by using **DS1** to **DS4** datasets to obtain a detailed historical characterization of droughts and heatwaves as well as the concurrence of both events, assessing the underlying soil moisture-temperature coupling mechanisms.
- 2.Characterize droughts and heatwaves events that occurred regarding its duration and intensity. This will rely on multi-scale indicators [P1, P3, 6, 19] and on statistical analysis to compute extreme events of temperature considering the tails of the distributions (e.g. 95% and 99% percentile). This will allow understanding how the observed average temperatures of the past decades might be linked with the occurrence and properties of individual hazards.
- 3.Assess the meteorological and surface forcing mechanisms responsible for triggering droughts, heatwaves episodes in which concurrence exists. Special extreme case studies will be analyzed and characterized using high-resolution regular gridded datasets (**DS1** to **DS4**). Heatwave and drought anomaly composites will be computed to analyze at different spatial (large; meso; regional) and temporal (long-term; seasonal; short-term) scales the ocean and atmospheric circulation mechanisms responsible for the development and amplification of droughts and heatwaves [P3,9].
4. Explore, from a large-scale teleconnection perspective, the role played by atmospheric oscillation modes (e.g., NAO, EA). This will allow to explore how such perturbations influence the large- and mesoscale atmospheric settings over the EU and the multivariate statistical downscaling of CHD events, following similar approaches [34].
5. Evaluate the link between droughts and heatwaves through the modelling of statistical dependencies based on e.g. copulas and lagged correlation analysis [P2,10,12,19].
6. Data from WRF-Chem (**DB7**) will be used for specific case studies, namely in Portugal and Greece, and results compared with the ones obtained using copulas assessment [32]. This will support the work developed on **T4** and **T5**.

The output of T2 will consist of:

- Individual and compound hazard maps and temporal datasets based on heatwave and drought indicators calculated using high-resolution and satellite datasets.
- Identification of the circulation mechanisms responsible for the development and amplification of droughts and heatwaves.
- Identification of potential higher risk of occurrence of compound heatwaves to droughts.
- Maps of hotspots of compound dry and hot events based on large-scale patterns.

We would like to highlight the participation of Jakob Zscheischler as consultant, which will be a valuable asset due to his expertise in extreme events.

4 T3 - Forest fires		21 meses	De 01.01.2023 a 30.09.2024	
Membros				
Pessoas / Mês	Alocados			
3.6	Carlos do Carmo de Portugal e Castro da Camara FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências			
4.8	DL57-RDE - 02 DL 57/2016 - Regime de dedicação exclusiva FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências			
0.54	Pedro Soares FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências			
1.62	Renata LIBONATI DOS SANTOS FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências			
1.62	Ricardo Machado Trigo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências			

Pessoas / Mês	Alocados
3.24	Célia Marina Pedroso Gouveia Instituto Português do Mar e da Atmosfera, I. P.
2.16	Joao Paulo Afonso Martins Instituto Português do Mar e da Atmosfera, I. P.
0.54	Rita de Melo Durão Instituto Português do Mar e da Atmosfera, I. P.

Descrição

The Mediterranean region is characterized by the frequent occurrence of summer wildfires [P4, 5, 22], posing both an environmental and socioeconomic burden. Nevertheless, due to climate change conditions, northern European regions have been increasingly affected by fires. According to the EM-DAT International Disaster Database (<https://www.emdat.be/>), between 2001 and 2020, 109 major fires occurred in Europe, causing about 740 deaths and major economics losses (over 14 billion USD).

Wildfires are very sensitive to weather, climate variability [5] and particularly, to weather extremes such as heatwaves and droughts [P4, 5, 22]. In temperate mid-latitude ecosystems, a wide range of meteorological fields (precipitation, temperature, relative humidity and wind speed) influence the spread of wildfires on multiple timescales [35]. Most of the largest wildfires occur when certain extreme weather events overlap with appropriate anomalous climate conditions, e.g., the combination of extreme drought with extreme wind or heatwaves have both been identified as crucial factors in wood-fueled crown wildfires in Mediterranean forests and shrublands [P4, 5, 22]. Therefore, T3 task proposes to:

- 1.List and characterize fire events occurred in Europe, regarding its duration, intensity, fire scar size, spread, total burned area.. These will be accomplished using:
- a) Information on each fire event recorded between 1980 and present taken from national statistics available at EFFIS platform (**DS8**).

b) FRP from LSA-SAF recorded with a temporal scale of 15 minutes (since 2004) and daily FRP from MODIS and VIIRS (since 2000) (**DS8**); FRP provides valuable information about the rate at which a fire is generating energy and has been directly correlated with its aerosol emissions, providing an alternative approach to calculating wildfire fuel consumption through methods that rely on the mapping of burned area and assuming, measuring or modelling the supposed fuel consumption per unit area.

c) MODIS-derived fire characteristics datasets, namely Fire Atlas and FRP.
- These databases are relevant to a broad spectrum of fire-related applications such as local to global functional pyrodiversity, fire emissions quantification, and the benchmarking of fire modules embedded in dynamic global vegetation models. Moreover, these datasets allow to evaluate the intensity and severity of fires with high resolution on a gridded form.
2. Produce historical statistics of fires events at local, regional and national scales, based on the information produced in 1.
- 3.Assess the meteorological and surface forcing mechanisms responsible for triggering large fires. Special extreme case studies will be identified and characterized using ERA-5 reanalysis datasets (**DS1**) and WRF and WRF-Chem outputs (**DS7**), namely i) the 2017 and 2020 events in Portugal; ii) the 2021 events in Greece and Turkey and iii) the war-related fires from explosions in 2022 in Ukraine.

The output of this task will consist of:

- Maps of historical fire occurrence and behavior.
- Hazard maps and temporal datasets based on fire occurrence calculated using in-situ datasets and satellite databases.
- Fire vulnerability maps which allow identifying areas prone to severe/extreme fire events and the dependence regarding vegetation type.

We would like to highlight the participation of Francesca Di Giuseppe from the European Centre for Medium-Range Weather Forecasts (ECMWF) as consultant (see Consultants), which will be a valuable asset due to her expertise in sectoral applications related to drought, fire and health. This liaison will allow a direct connection with the ECMWF which will facilitate the access to the operational forecast data, namely fire related forecast. ECMWF is both a research institute and a 24/7 operational service, producing global numerical weather predictions and other data for our Member and Co-operating States and the broader community.

Membros

Pessoas / Mês	Alocados
1.62	Coral Salvador Environmental Physics Laboratory

Pessoas / Mês	Alocados
2.88	Ana Cristina Machado Russo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Andreia Filipa Silva Ribeiro FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.54	João Lucas Marcelino Geirinhas FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Renata LIBONATI DOS SANTOS FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
7.2	BI-b - 06 Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG Instituto Português do Mar e da Atmosfera, I. P.
1.62	Célia Marina Pedroso Gouveia Instituto Português do Mar e da Atmosfera, I. P.
1.08	Pedro Miguel Ribeiro de Sousa Instituto Português do Mar e da Atmosfera, I. P.
1.08	Rita de Melo Durão Instituto Português do Mar e da Atmosfera, I. P.
2.16	Pedro Goncalves Lind Oslo Metropolitan University

Descrição

Air pollution causes 7 million preventable deaths per year, with more than 90% of people breathing polluted air. Pollution from anthropogenic and natural sources is often created in one place and transported through the air, transgressing international boundaries and affecting far away countries [5, 27].

Rural fires release large amounts of particulate matter and toxic gases into the atmosphere [14], extending beyond the burned and immediate surrounding area and impacting distant populations. Wildfires’ smoke represents a health risk [16, 18, 23-24], which is expected to worsen as wildfires are expected to increase due to climate change [14]. Wildfire activity is expected to increase due to global warming and surface ozone (O3) will also be further enhanced [23-24,33], leading to more severe O3 damage on vegetation and further disturbances on carbon budget [33].

One way for tracking smoke from wildfires is based on atmospheric dispersion models, which rely on heavy computing and require extensive parametrization procedures and data. Although models allow having an image of the behavior of the dispersion paths and dilution in the atmosphere, they present differences between predicted and actual pollution concentrations and pathways. Alternatively, the use of monitoring stations and remote sensing-based approaches have been successfully used. Near-real time observations and forecasts available at Copernicus Atmosphere Monitoring Service (CAMS) [27] and the energy released by fires (Fire Radiative Energy, FRE) [36], obtained through satellite measures of FRP from the Moderate Resolution Imaging Spectro-radiometer (MODIS) [25], and or SEVIRI/MSG (**FRPPIXEL**-LSA-SAF) products (**DS8, DS9**). The **FRPPIXEL** product records information on the location, timing and FRP output of wildfires detected every 15 minutes across the full METEOSAT disk at the native spatial resolution of the SEVIRI sensor. The performance of the operational FRPPIXEL product has been assessed via comparisons to both other geostationary fire products derived from Meteosat data, and to near-simultaneous detections made from MODIS. The product was found to both meet its performance requirements with respect to MODIS, and to be the best performing geostationary fire product currently available at testing. Recently developed FRP from SENTINEL-A is also available on EUMETSAT (**DS8**). FRE and FRP measures can potentially provide detailed information on the amount and rate of biomass consumption over large areas [36].

Estimates of wildfire aerosol and trace gas emissions, primarily in the form of CO2, CO and CH4, are commonly derived from assessments of biomass burning. Carbon emissions from the major wildfires in the IP, namely the from the Megafires of 2017 and 2020 in Portugal, 2021 in Greece and Turkey and 2022 in Ukraine will be estimated (**DS10**). This task will rely on the outputs produced on **T2**.

DHEFEUS proposes to investigate the relationship between pollution levels and the fire activity in the EU. Specifically, T4 will focus on:

1. the links between fire activity as measured by FRP and FRE and pollutants concentrations.
2. the spatial and temporal zone of influence of wildfire activity.
3. the use of FRP and FRE as a tool to filter the contribution of biomass smoke to records of air pollution in urban airsheds, namely the carbon emissions resulted from severe wildfire events.
4. the capability of WRF-Chem, CAMS and in-situ measurements to characterize dust intrusions or wildfire plume episodes.

The output of this task will consist of:

- Pollutants’ concentrations maps from CAMS, WRF-Chem, FRP/FRE and monitoring sites data.
- Extreme pollution event maps.

Membros

Pessoas / Mês	Alocados
1.62	Coral Salvador Environmental Physics Laboratory
2.16	Raquel Olalla Nieto Muñiz Environmental Physics Laboratory
2.7	Alexandre Miguel Ramos FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
5.04	Ana Cristina Machado Russo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
2.16	Andreia Filipa Silva Ribeiro FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.44	Carlos do Carmo de Portugal e Castro da Camara FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
2.88	Daniela Lima FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
8.4	DL57-RDE - 02 DL 57/2016 - Regime de dedicação exclusiva FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.89	João Lucas Marcelino Geirinhas FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.81	Pedro Soares FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Renata LIBONATI DOS SANTOS FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Ricardo Machado Trigo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.44	Rita Margarida Cardoso Tavares FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
8.1	BI-b - 07 Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG Instituto Português do Mar e da Atmosfera, I. P.
2.7	Célia Marina Pedroso Gouveia Instituto Português do Mar e da Atmosfera, I. P.
1.44	Joao Paulo Afonso Martins Instituto Português do Mar e da Atmosfera, I. P.
1.89	Pedro Miguel Ribeiro de Sousa Instituto Português do Mar e da Atmosfera, I. P.
1.08	Rita de Melo Durão Instituto Português do Mar e da Atmosfera, I. P.
2.7	Pedro Goncalves Lind Oslo Metropolitan University

Descrição

The assessment of the adverse social, economic and environmental impacts associated with a combination of multiple climate hazards have recently become a focus of high interest [e.g., P2-P4, 10-14, 16-20]. Such compound events often lead to larger impacts compared to individual hazards [12].

The assessment of compound events requires a joint analysis of multiple contributing variables, such as maximum temperature and precipitation to characterize multiple hazards (e.g., droughts and heatwaves) and the associated impacts (e.g., air quality).

One way of addressing this is based on statistical approaches. Among probabilistic models, the use of Copulas has been recently applied for multivariate dependence modelling in climate studies [P2, 12, 19]. A major advantage of Copulas is the generation of joint distributions aside from the shape of their original marginal distributions. Moreover, Copula functions show a great flexibility for modelling non-linear dependencies and tailed events (extremes) in multivariate distributions [P2 ,12, 19]. Conversely, dynamical models like the WRF-Chem model [26] allow to estimate compound occurrence of CHD and pollutants. The use of both modelling and statistical approaches complements one another, as both have advantages and caveats. WRF-Chem can predict meteorological conditions along with pollution level [32], although having limitations on the parametrizations (e.g., terrain). Conversely, statistical approaches require much less computational power allowing for similar results, but large training data sets are usually required to improve outputs’ accuracy and minimize uncertainty [39]. This two-fold approach will be complementary and secure the proposed outcomes.

Moreover, it is important to assess the drivers to the development and amplification of compound events [9, P3], particularly to characterize the local and remote land-atmosphere interaction mechanisms responsible for the amplification of hazards. Local land-atmosphere interactions, through disturbances on the normal partitioning of the incoming energy in latent and sensible heat fluxes, may lead to several impacts on air temperature, boundary-layer stability and precipitation [9]. Moreover, heatwaves can be amplified by heat torrents fueled by upwind drought conditions and by remote land-atmosphere feedbacks. The assessment of these local and remote land-atmosphere mechanisms can be accomplished through the analysis of soil moisture-temperature coupling metrics [9] and Eulerian [37] and/or Lagrangian heat- and moisture-tracking methodologies.

DHEFEUS proposes to investigate the relationship between CHD events, forest fires and pollution events in EU, through the following:

1. Identification of the key moments (months, seasons) and timescales of dry and/or hot conditions involved in the reinforcement and triggering of fires and consequent smoke waves [23,37].
2. Assessing the contribution of combined CHD (**DS1-DS4**) and fire events (**DS8**) to local and regional emissions of carbon by combined events and their impact on regional carbon balance (**DS5, DS9-DS10**).
3. The development of Copula-based models and multi-hazard approaches to characterize the joint behavior of multiple hazards and the consequent risks [P2,12,19] (**DS1-DS4, DS8-DS10**).
4. Assessing the role played by preceding and simultaneous dry and/or hot conditions in the exacerbation of forest fires and consequent smoke-waves [23,37] (**DS1-DS4, DS8-DS10**).

The output of this task will consist of:

- Maps of consecutive or overlapped droughts, heatwaves, fires and smoke-waves days.
- Maps of the main large scale and synoptic atmospheric conditions associated to the combined multi-hazard, forest fires and pollution events.
- Figures of the conditional response of air pollution to the interaction between droughts, heatwaves and fires.
- Figures of excessive risk resultant from compound hazards to pollution events, smoke-waves and fires.

All the 3 consultants will participate.

7 T6 - Carbon balance

18 meses

De 01.07.2024 a 31.12.2025



Membros

Pessoas / Mês	Alocados
1.44	Ana Cristina Machado Russo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Carlos do Carmo de Portugal e Castro da Camara FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.81	João Lucas Marcelino Geirinhas FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.54	Renata LIBONATI DOS SANTOS FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Ricardo Machado Trigo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
3.6	BI-b - 06 Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG Instituto Português do Mar e da Atmosfera, I. P.
8.1	BI-b - 07 Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG Instituto Português do Mar e da Atmosfera, I. P.
1.08	Célia Marina Pedroso Gouveia Instituto Português do Mar e da Atmosfera, I. P.

Pessoas / Mês	Alocados
0.54	Pedro Miguel Ribeiro de Sousa Instituto Português do Mar e da Atmosfera, I. P.
0.54	Rita de Melo Durão Instituto Português do Mar e da Atmosfera, I. P.

Descrição

The most extreme ozone pollution episodes are linked to heatwaves [10] and droughts, which are increasing in frequency and intensity over Europe [41]. On the other hand, CHD events introduce disturbances into the dynamics of ecosystems, through high water stress on vegetation, leading to changes in the vegetation cycle with significant reductions in vegetation productivity and growth rates [P5]. The responses of the ecosystem can exceed the duration of the climate impacts due to the lagged effects on the carbon cycle. Wildfires are known to cause substantial ecological and economic burdens [5]. Carbon emissions from fires are one of the most uncertain components of the global carbon cycle. Fires are also important sources of ozone precursors and tropospheric ozone (O3) poses adverse effects on vegetation, as plant stomatal uptake of O3 decreases chlorophyll contents and increases deformities on chloroplast, reducing gross primary productivity (GPP) [33]. A GPP reduction of 8 to 20% over Western Europe was reported [33]. On the other hand, vegetation damage has a strong impact on O3 sources and sinks through biogeochemical and biogeophysical feedbacks. Interactions between air quality and terrestrial ecosystems remains a challenging task due to the limited knowledge of the interactions between ozone and vegetation. The compound occurrence of hazards is also expected to have bigger impacts than individual ones [12]. Therefore, it is vital to understand how levels of pollutants generated specifically from wildfires (**DS8**), namely CO and O3 extremes (**DS9**) may exacerbated vegetation productivity losses (**DS5**), namely in water stress conditions (**DS1**). Therefore, **T6** goals are to assess the impacts on the vegetation resultant from the synergy between carbon and ozone emissions from fires and CHD extremes, namely in terms of gross primary productivity. Therefore, **T6** task proposes to:

1. To explore the impact of the single or composite impacts of climate extremes, fires and ozone exceedances on vegetation dynamics and carbon cycle. Vegetation parameters available from the LSA-SAF (LAI, FAPAR) (**DS4**) and the NPP MODIS datasets (**DS5**) will be used with the aim to assess CDH direct and indirect contribution to disturbances in vegetation productivity and carbon balance in the short and medium/long term.
2. To evaluate the effect of ozone exceedances (**DS9**) associated with severe wildfire events (**DS8**) to exacerbated vegetation productivity losses (**DS5**), namely in water stress conditions (**DS1**).

The output of this task will consist of:

- Results on the association between ozone, fire events, CDH and vegetation productivity disturbances.
- Maps of vegetation productivity losses associated with fires and ozone extremes

Ana Bastos will contribute to this task.

8	T7 – Climate Change assessment	24 meses	De 01.01.2024 a 31.12.2025	
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Membros

Pessoas / Mês	Alocados
0.54	Coral Salvador Environmental Physics Laboratory
1.08	Raquel Olalla Nieto Muñiz Environmental Physics Laboratory
1.44	Ana Cristina Machado Russo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.54	Andreia Filipa Silva Ribeiro FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
4.8	BI-b - 04 Bolsa de Investigação - Estud. mestrado, mestrado int. ou lic. e mestre em CNCG FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Carlos do Carmo de Portugal e Castro da Camara FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
3.6	Daniela Lima FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
3.6	DL57-RDE - 02 DL 57/2016 - Regime de dedicação exclusiva FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

Pessoas / Mês	Alocados
0.81	João Lucas Marcelino Geirinhas FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
2.7	Pedro Soares FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
0.54	Renata LIBONATI DOS SANTOS FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Ricardo Machado Trigo FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
3.6	Rita Margarida Cardoso Tavares FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências
1.08	Pedro Miguel Ribeiro de Sousa Instituto Português do Mar e da Atmosfera, I. P.
1.08	Rita de Melo Durão Instituto Português do Mar e da Atmosfera, I. P.

Descrição

Data from models (**DS6-DS7**) allow assessing future climatic projections of compound extreme events and how the soil-atmosphere coupling will evolve considering additional radiative energy forcing due to enhanced greenhouse concentrations. This is expected to allow building robust projections regarding concurrent hazards for the IP and to infer the implications of their combined or cascading occurrence for the environment and human health.

This task will be devoted to:

1. The analysis of the expected impacts of the studied compound events under future climate change conditions (**DS6-DS7**) in terms of large burned areas and air quality. This will encompass the assessment of the full model simulations set of GCMs and RCMs from the EURO-CORDEX experiment [30,40, **DS7**]. Different pathways into the future of greenhouse gas emissions, atmospheric concentrations, aerosols and land use will be considered, namely RCP2.6, RCP 4.5 and RCP 8.5 (**DS7**). The climate models used, at the global scale and regional scale will rely on the CMIP6 runs, if available, if not on CMIP5 (**DS6**). These full set of models will be validated and ranked, allowing to build a multi-model ensemble based on the RCMs individual quality to represent the main drivers and hazards in the IP, in present climate. The statistical comparison of the multi-model ensembles, future and present climates, will permit the quantification of future changes on the drivers and properties of the selected extreme events, and to characterize the uncertainty of the projections. The RCM model quality evaluation and multi-model building will be based on the well-established methodologies such as by Soares et al. [30].

To explore the fire response in an ensemble of RCMs in EU, summer burned area models will be built, and then the identified relationships will be projected for different climate scenarios with and without taking into account how the long-term impact of climate on fuel productivity might affect the climate-fire relationships.

2. Regional climate change in EU for time periods when the global mean temperature will have an increment of 1.5°C, 2°C and 3°C when compared to pre-industrial conditions will be assessed in terms of CHD and air quality evaluation.

To achieve the proposed goal, single and CHD extremes’ changes will be investigated using methods similar to the ones presented in T2-T4 and the approaches proposed by [15, 23-24].

The output of this task will consist of:

- Maps and figures of the increment of change of duration, number of occurrences and severity of droughts, heatwaves, CHD events, air pollution and wildfires under 1.5°, 2°C and 3°C periods.
- Maps of possible impacts of climate change on fire risk and atmospheric emissions.

Calendarização e gestão do projeto

Lista de milestones

Data	Designação	Descrição
15.02.2023	M1 - Kickoff meeting	This will be the first meeting between the partner and collaborating institutions. This will be the first project-team event and will be organized by the PI and CO-PI to present and launch the project. During this meeting, the projects' tasks and milestones will be addressed.

Data	Designação	Descrição
15.01.2024	M2 - First annual meeting and report	This meeting between the the partner and collaborating institutions will be organized by the PI and CO-PI. The main outcomes of the project will be discussed. During this meeting the tasks and milestones for the second year will be addressed. All major outcomes will be included in the annual report.
15.06.2024	M3 - Single hazards assessment and Intermediate Workshop	Single hazards assessment should be concluded. A first workshop will present the preliminary results to the community and promote the knowledge shift between the scientific community and all the levels of possible end-users.
15.12.2024	M4 - Compound assessment, 2nd annual meeting and report	Two papers on compound events should be prepared. The annual metteing will focus on the main outcomes of the project, discussing the approaches on the forthcoming tasks and milestones. Lessons learned during the first two years and expected difficulties will be discussed.
01.11.2025	M5 - Impacts and Final workshop	All the tasks should be almost concluded and the papers prepared to be submitted or already submitted. The final workshop to disseminate the main outcomes of the project will be hosted at IDL and will be open to the research community as well as to society.
15.12.2025	M6 - Final meeting and report	This meeting will wrap up the main outcomes of the project which will be included in the final and layman reports.

Cronograma

[DHEFEUS_Cronograma.pdf](#)

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Descrição da estrutura de gestão

The project team brings together researchers with diverse scientific backgrounds and perspectives to address a subject that clearly requires a multidisciplinary approach. It is formed by members that have been working together with the IR in previous projects and partnerships, guaranteeing fruitful cooperation. The financial management of the project will be performed by the FCiência.ID, assisting the IR in all the administrative issues.

The Principal Investigator (IR) is the main responsible for the project and will directly coordinate Tasks 0, and 5, in close dialog with the other Task Coordinators (TC) and assisted by the CO-IR. In addition, the IR, assisted by the CO-IR, will be responsible for promoting permanent collaboration among researchers and coordinating the production of annual reports, with the collaboration of the BPD and of the junior researchers. The TCs were selected according to scientific criteria and involvement in the project (please see the **DHEFEUS_cronograma.pdf**). TCs are responsible for controlling the timely fulfillment of the task objectives and the preparation of the deliverables, supporting the IR and the CO-IR in all scientific and operational issues. Therefore, Task 1 and 6 will be coordinated by the CO-IR, whereas Tasks 2 and 3 will be respectively coordinated by Ricardo Trigo and Carlos DaCamara, due to their experience on natural hazards. Rita Durão will coordinate Task 4 as she is an experienced researcher in AQ monitoring/simulation and also on dispersion models used for decision making. Task 7 will be coordinated by Pedro Soares and Renata Libonati, due to their experience in producing and using climate change scenarios

Furthermore, three external and highly experienced consultants will cooperate with the team members in order to have a broader view about the topics and the international advances being made. Namely, Francesca Di Giuseppe will contribute to Tasks 3 and 5 , J. Zscheischler to Tasks 2 and 5, Ana Bastos to Task 6.

The project will have 3 annual meetings lasting a full day, which will take place at the participant institutions (FCUL, IPMA). The project will start with a kick-off meeting for the project implementation and the two other annual meetings will take place to guarantee the successful timely production of all deliverables. Additionally, shorter skype meetings (1h-2h length) are planned at least every 3 months. Both the annual and skype meetings will serve to evaluate the current state of project progress and to verify the quality of the project management and finally to close all activities and present the most important findings. The most important tools for measuring and verifying project progress are major milestones (see timeline in annex), which have been defined to highlight major goals of the project.

Questões éticas

Existem questões éticas identificadas neste projeto?

Não

Declarações de ética que considera apropriadas

-

Fundamentação

-

Agenda 2030

Enquadramento da candidatura nos OSD da Agenda 2030

- ODS 5: Igualdade de Género
- ODS 13: Ação Climática
- ODS 4: Educação de Qualidade

Fundamentação

DHEFEUS aims to provide a new way of addressing compound heatwaves and fires, allowing to assess the role played by preceding and simultaneous hot conditions in the exacerbation of fires and consequent impacts in terms of pollution and health outcomes. This is particularly important under projected climate change. The challenging endeavour of looking to extreme events on an interdisciplinary way, will enable the analysis of extreme events on a radically different manner than usual approaches, providing cues of current and future risk which is valuable information to strategic decisions on health and environmental sectors. Moreover, as climate change progresses, there is a need for additional knowledge on the interplay between hazards as some of the key drivers are changing rapidly. These compound effects need to be considered in estimating air pollution effects to set up adequate policy and public health actions to face future climate and pollution challenges.

DHEFEUS focus on climate change and its influence on weather, fires and pollution events (**Goal 13**). One of the main outcomes of the project is expected to be operative to help on defining strategies to prevent and mitigate environmental impacts under future climate conditions, tackling **Goal 13**.

Goal 5 on Gender Equity, will also be aimed, by ensuring a good balance of woman and man involved in this project proposal (~50% each), with a female PI and Co-PI. Moreover, we ensure gender equity when selecting students and grant holders.

During the course of the project we intend to contribute to **Goal 4 on Quality Education**, by supporting the graduation of 4 students (3 Msc and 1 degree students).

Outros projetos financiados

PTDC/CTA-CLI/28902/2017

FCT

IR

Ana Cristina Machado Russo

Estado do projeto

Homologado

Título do projeto

(em inglês)

IMPACTS OF EXTREME CLIMATIC EVENTS ON THE AGRICULTURAL AND FORESTRY SYSTEMS: DEVELOPMENT OF RISK ANALYSIS MODELS

Instituição proponente

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

Financiamento total

239 759,48 €

Data de início

Duração

(meses)

01.10.2018

42

Principais resultados do projeto que considera relevantes para esta candidatura

The IMPECAF team has dedicated a substantial amount of time to investigate hot and dry extreme events and how they affect agriculture and forests under present and future scenarios of climate change.

Under IMPECAF, Agricultural Risk Models were developed for the Iberian Peninsula based on drought, extreme temperatures and crop productivity. The individual and compound occurrence of hot and dry extremes was analysed regarding duration, intensity, severity and predictability.

The analysis of historical meteorological data and records of fires was performed aiming to classify large summer fires for four regions of Iberia (IB) according to their local-scale weather conditions (i.e. temperature, relative humidity, wind speed), fire danger weather indices from the FWI and its sub-indices and drought occurrence. The composite analysis was used to assess the impact of local and regional climate drivers at different time scales, and to identify the climatic conditions associated with the occurrence of large fires in IB.

The impacts of large fires, drought and heatwave events were assessed in terms of carbon balance over the Mediterranean area.

Several climate change scenarios were used to assess how drought will evolve under climate change conditions and will affect agriculture and forests.

The influence of teleconnections on fires was analysed for the Iberian Peninsula.

The deliverables obtained within the framework of IMPECAF project include 23 published papers and 30 conferences presentations, 1 PhD thesis, 2 MSc thesis and 1 degree project.

A webpage for the project (<http://impecaf.rd.ciencias.ulisboa.pt/>) was prepared as well as a page on ResearchGate (<https://www.researchgate.net/>). Both dissemination initiatives include information on the project aims and results, team members, partners and news.

In addition, two workshops were organized which allowed for direct contact with the stakeholders.

Ficheiros anexos

[Dhefeus_flowchart_vf.pdf](#)

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Indicadores de realização previstos

Descrição	2023	2024	2025	2026	Total
A • Publicações	0	0	0	0	
Livros	0	0	0	0	0
Capítulos de livros	0	0	0	0	0
Artigos em revistas internacionais	2	4	4	0	10
Artigos em revistas nacionais	0	2	1	0	3
B • Comunicações	0	0	0	0	
Comunicações em encontros nacionais	0	4	4	0	8
Comunicações em encontros científicos internacionais	1	4	5	0	10
C • Relatórios	1	1	1	0	3
D • Organização de seminários e conferências	0	1	1	0	2
E • Formação avançada	0	0	0	0	
Teses de Doutorado	0	0	0	0	0
Teses de mestrado	0	2	1	0	3
Outras	0	0	1	0	1
F • Modelos	0	0	1	0	1
G • Aplicações computacionais	0	0	0	0	0
H • Instalações piloto	0	0	0	0	0
I • Protótipos laboratoriais	0	0	0	0	0
J • Patentes	0	0	0	0	0
K • Outros	0	0	0	0	
Web page	0	0	1	0	1
	0	0	0	0	0
	0	0	0	0	0

Divulgação

Ações de divulgação da atividade científica previstas no projeto

A bottom-up approach will be followed to guarantee all the stakeholders’ involvement. This will ensure that researchers and end-users can share their needs, research advances and solutions adapted to the society's demands and necessities. Extensive communication and dissemination actions will be pursued, aiming to highlight the advances of the research and to overcome eventual lack of a clear understanding and communication between all the involved stakeholders.

DHEFEUS includes a dissemination plan which include:

- 1) **Organization of two workshops:** the first one will take place in the beginning of the 2nd year of the project and will be held at the IDL, aiming to disclose the preliminary results to the community and also promote the knowledge shift between the scientific community and all the levels of possible end-users. This will also allow for citizens engagement with the scientific community, end-users, decision makers. This action will focus on the key sectors and will alert possible future users for the potential of employing a risk analysis tool to prepare for their decision-making processes, and also to the general community as to the impacts of natural hazards on air quality. The final workshop, to disseminate the main results, will be hosted at IPMA. This forum will constitute an excellent opportunity to comment on scientific results and recommendations on socioeconomic impacts and the vulnerability assessment. This will help in the development of appropriate plans of measures for hazards mitigation, both prior and during occurrence.
- 2) **Publication of** a total of **10 scientific articles** in international peer-reviewed scientific journals (preferable on open access journals).

- 3) **Participation in conferences** (8 national and 10 international presentations). The respective effort is distributed among related tasks.
- 4) **Layman report:** The knowledge gained in the project will be translated into layperson language to be accessible to the public through a newsletter available on the project's website, which will include regularly relevant news concerning **DHEFEUS**, the evolution of the project and its main outcomes.
- 5) **Outreach:** Participation on several initiatives to increase the public awareness on natural hazards, compound events and resulting impacts (e.g. FCUL's open days activities, "Ciência Viva" activities, European Researchers' Night).
- 6) **Social networking** accounts will be created for the project (e.g. Twitter), to interact with fellow researchers and scientific associations, as well as universities and research units. A visible presence in such platforms is aimed to ensure that **DHEFEUS** diffusion actions reach a broad audience.

Instituição proponente

FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências

Rubrica	2023	2024	2025	2026	Total
Recursos Humanos	43 323,69 €	55 757,53 €	0,00 €	0,00 €	99 081,22 €
Missões	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Instrumentos e equipamento científico e técnico	7 400,00 €	0,00 €	0,00 €	0,00 €	7 400,00 €
<div>Justificação do financiamento solicitado</div> <div><ul style="list-style-type: none">Expected costs of two (2) powerful all-in-one desktop computers with high data processing and visualization capabilities to be used by the IDL PI and PhD researcher to be hired.Expected expenses of one (1) powerful potable computer with site independence for data processing and visualization to be used by the PI during oral presentations, project meetings and to connect to the IDL resources when working away from office.Expected costs of one (1) powerful desktop computer and one (1) monitor with high data processing and visualization capabilities to be used by the IDL MSc student to be hired.Expected costs of a laser printer to be used during project tasks and also on the preparation of dissemination activities (flyers, posters).</div>					
Subcontratos	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Registo de patentes	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Demonstração, Promoção e Divulgação	6 000,00 €	12 000,00 €	9 000,01 €	0,00 €	27 000,01 €
<div>Justificação do financiamento solicitado</div> <div><ul style="list-style-type: none">Estimated expenses to publish of six (6) articles on open assess high-impact index JCR journals. These expenses include the article processing charges that several journals of these scientific fields request for publication.Estimated expenses for six (6) registrations and travel arrangements to the European Geophysical Union General Assembly or other international conference abroad to present oral and/or poster communications during the Project.Estimated expenses for four (4) registrations and travel arrangements to a national conference to present oral and/or poster communications during the Project.</div>					
Adaptação de edifícios e instalações	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Aquisição de bens e serviços	5 000,00 €	5 000,00 €	4 000,00 €	0,00 €	14 000,00 €
<div>Justificação do financiamento solicitado</div> <div><ul style="list-style-type: none">Value assigned to support the Consultants (Francesca Di Giuseppe - Task 3, Jakob Zscheischler - Tasks 2 and 5, Pedro Lind - Task 4 and 7)Estimated expenses with consumables to be used during the project.Estimated expenses with SSD Portable Disks to be used to storage project data.</div>					
Gastos gerais	15 430,92 €	18 189,38 €	3 250,00 €	0,00 €	36 870,30 €
Total	77 154,61 €	90 946,91 €	16 250,01 €	0,00 €	184 351,53 €

Instituições participantes

Instituto Português do Mar e da Atmosfera, I. P.

Rubrica	2023	2024	2025	2026	Total
Recursos Humanos	12 433,84 €	12 433,84 €	6 216,92 €	0,00 €	31 084,60 €
Missões	0,00 €	500,00 €	500,00 €	0,00 €	1 000,00 €

Rubrica	2023	2024	2025	2026	Total
<div>Justificação do financiamento solicitado</div> <div>Expected costs of national dislocations to attend meetings.</div>					
Instrumentos e equipamento científico e técnico	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Subcontratos	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Registo de patentes	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Demonstração, Promoção e Divulgação	4 000,00 €	7 915,00 €	7 000,00 €	0,00 €	18 915,00 €
<div>Justificação do financiamento solicitado</div> <div><ul style="list-style-type: none">Estimated expenses to publish of three (3) articles on open assess high-impact index JCR journals. These expenses include the article processing charges that several journals of these scientific fields request for publication.Estimated expenses for four (4) registrations and travel arrangements to the European Geophysical Union General Assembly or other international conference abroad to present oral and/or poster communications during the Project.Estimated expenses for four (4) registrations and travel arrangements to a national conference to present oral and/or poster communications during the Project.</div>					
Adaptação de edifícios e instalações	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Aquisição de bens e serviços	750,00 €	250,00 €	0,00 €	0,00 €	1 000,00 €
<div>Justificação do financiamento solicitado</div> <div><ul style="list-style-type: none">Estimated expenses with consumables to be used during the project.Estimated expenses with SSD Portable Disks to be used to storage project data.</div>					
Gastos gerais	4 295,96 €	5 274,71 €	3 429,23 €	0,00 €	12 999,90 €
Total	21 479,80 €	26 373,55 €	17 146,15 €	0,00 €	64 999,50 €

Orçamento global

Rubrica	2023	2024	2025	2026	Total
Recursos Humanos	55 757,53 €	68 191,37 €	6 216,92 €	0,00 €	130 165,82 €
Missões	0,00 €	500,00 €	500,00 €	0,00 €	1 000,00 €
Instrumentos e equipamento científico e técnico	7 400,00 €	0,00 €	0,00 €	0,00 €	7 400,00 €
Subcontratos	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Registo de patentes	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Demonstração, Promoção e Divulgação	10 000,00 €	19 915,00 €	16 000,01 €	0,00 €	45 915,01 €
Adaptação de edifícios e instalações	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Aquisição de bens e serviços	5 750,00 €	5 250,00 €	4 000,00 €	0,00 €	15 000,00 €
Gastos gerais	19 726,88 €	23 464,09 €	6 679,23 €	0,00 €	49 870,20 €
Total	98 634,41 €	117 320,46 €	33 396,16 €	0,00 €	249 351,03 €

Plano de financiamento

Rubrica	2023	2024	2025	2026	Total
Financiamento FCT	98 634,41 €	117 320,46 €	33 396,16 €	0,00 €	249 351,03 €

Rubrica	2023	2024	2025	2026	Total
Autofinanciamento	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Outros financiamentos públicos	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Outros fundos privados	0,00 €	0,00 €	0,00 €	0,00 €	0,00 €
Total	98 634,41 €	117 320,46 €	33 396,16 €	0,00 €	249 351,03 €



Investigador responsável

Eu, investigador responsável da presente candidatura, declaro:

- 1- Ter conhecimento de todos os dados e informações constantes da presente candidatura e que me responsabilizo pelo seu conteúdo e veracidade.
- 2- Ter conhecimento das disposições expressas no Regulamento nº 999/2016, de 31 de outubro, que estabelece as condições de acesso e as regras de apoio a projetos financiados exclusivamente por fundos nacionais através da Fundação para a Ciência e a Tecnologia, I.P. e do Aviso de Apresentação de Candidaturas do Concurso.
- 3- Não me encontrar em situação de incumprimento injustificado dos requisitos regulamentares no que respeita à apresentação de relatórios de execução científica de projetos concluídos em que também tenha desempenhado o papel de Investigador Responsável.
- 4- Comprometer-me a assumir a liderança do projeto e responsabilidades decorrentes da sua boa execução.
- 5- Assegurar o acesso aberto a publicações científicas (peer-reviewed) resultantes da investigação financiada no âmbito deste Aviso para a Apresentação de Candidaturas, de acordo com as Políticas de Acesso Aberto da Fundação para a Ciência e a Tecnologia, I.P..
- 6- Caso tenha identificado em candidatura ou venham a ser futuramente identificadas questões de ética relacionadas com a execução do projeto, comprometo-me a:
 - a) diligenciar junto das instituições beneficiárias no projeto que, durante o período de execução do projeto, terão as permissões necessárias para executar projeto;
 - b) recolher toda a documentação necessária e a disponibilizá-la à FCT;
 - c) cumprir e a fazer cumprir pela equipa de investigação do projeto, toda a legislação nacional e comunitária aplicável neste domínio a este projeto de investigação.

☒ Tomei conhecimento e concordo com os termos enunciados na declaração de compromisso

Instituição Proponente

Aceite por **TERESA LUÍS** em 21.03.2022 - 12:24 em nome de **FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências** por delegação competências dos responsáveis da instituição.