



FCT Fundação
para a Ciência
e a Tecnologia

R&D projects for the Côa Valley region

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Introduction

The knowledge that derives from scientific research and technological development is of paramount importance to the social, cultural and economic development of society. The strengthening of the scientific and innovative community in Portugal is a goal and a political commitment that has been met by the sustained increase of funding for science, the support given to institutions and various mechanisms that underlie the country's knowledge ecosystem. The Fundação para a Ciência e a Tecnologia, FCT, is the national funding agency for R&D across all scientific areas and encompassing support for various actors and paths of science, from the funding of R&D units and infrastructures, to researchers employment and advanced formation, international cooperation and R&D projects.

In complement to the sustained promotion of knowledge across all scientific and technological domains, FCT also strategically targets specific thematic areas and R&D programs that are considered priorities for the progress of science and the building of competencies, with potential positive impacts on economic and societal growth, and cultural development.

It is under this framework that FCT embraced the R&D program for the Côa Valley region.

Located along the banks of the Côa river in the north of Portugal, this region is classified by UNESCO as a World Heritage Site. The Vale do Côa Archaeological Park, which extends over 200 square kilometers, contains the largest concentration of open-air pictorial art in the world. In addition to the well-known prehistoric engravings of the Upper Paleolithic and the Iron Age, we find in the Côa Valley the uninterrupted recording of almost all phases of human occupation of that territory.

Taking into account the conceptual framework of this region in discovering the origin of life, in preserving the memory of the interaction of peoples and cultures and the biological diversity it contains, FCT intends to promote international research on the heritage of Vale do Côa, including:

1. Earth observation and knowledge;
2. Climate and climate change;
3. Origins of life and dynamics of socio-cultural interactions over time;
4. Biodiversity and biological resources, natural and cultural heritage and sustainable regional development.

FCT created an R&D Program for research in these thematic areas, aiming to promote the scientific valorization of Vale do Côa's heritage and to attract research groups of international excellence to work in close cooperation with teams from Portuguese institutions.

Seven projects were financed in the 2019 call with a total funding of 2 million euros, after a selection evaluation process carried out by an international panel of independent evaluators. Portuguese and Spanish entities of different types participate in the financed projects, including higher education and research institutions, several associations and foundations that are committed to the cultural and environmental preservation and sustainable development of Vale do Côa. The themes covered in the projects will allow a better understanding of the natural and cultural dimension present in the Côa Valley, although the scope of their findings potentially extends beyond this territory. This is the case of research on climate change, biodiversity or cultures of ancient populations, which have also occupied other territories.

The funded projects are presented here.



R&D PROJECTS
promotion of
R&D activities
in the Côa Valley
region, listed as a
World Heritage
site by UNESCO



**Biodiversity
and biological
resources,
natural and
cultural heritage
and sustainable
regional
development**

CENTENARIAN OLIVE TREES OF CÔA VALLEY REGION: REDISCOVERING THE PAST TO VALORISE THE FUTURE

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FUNDING	€ 278 558

This project aims to characterize and bring value to the ancestral olive heritage of the Côa Valley region, taking into account its historical importance from the economic, historical, cultural and landscape points of view, for its present and future valorisation. The project objective will be achieved by performing six interconnected tasks that contribute to a common goal. Task 1 is dedicated to global management and coordination while in task 2 the centenary olive trees of the Côa Valley region will be inventoried, mapped and georeferenced to select the specimens to work on the following tasks. At this stage, 10 spots will be selected, selecting 15 to 20 centenary olive trees on each, in a total of 200 specimens. In task 3 different molecular markers, as SSR and EST-SNP; together with morphological data, will be used to build a database of the germplasm biodiversity of the Côa Valley region, while allowing it to be compared with worldwide collections. This information will be complemented with the extraction of olive oils from each specimen and their characterization by physicochemical parameters, composition data (fatty acids, tocopherols, phenolic and volatile compounds), together with sensorial attributes, contributing for the characterization of the chemical and sensorial diversity of the olive oils from the Côa Valley region centenary olive trees. Linking with community and product enhancement will be the focus of task 5, where the information gathered in the previous tasks will support proposals for the development of new products and services, thus contributing to maintain population in this low-density populated territory, creating value and resources for the region. Together with local stakeholders, a new line of products from centenary olive trees on the Côa Valley region will be developed and characterized, using olives, olive oil and olive leaves. Simultaneously, the Côa Valley Region region “Old Olive Tree Open Gallery” will be developed, which aims to be a living gallery of the “Côa Museum”. Using a QRcode, each centenary olive tree will be identified, and all the knowledge obtained in the project will be made available. Finally, task 6 will be dedicated to the dissemination of results obtained throughout the entire project. The execution of this project, in addition to the development and enhancement of the olive tree in Côa Valley region, will promote scientific knowledge increase, rural development and settlement of populations in an area of low population density.

ECOLOGICAL CHALLENGES AND OPPORTUNITIES OF TROPIC REWILDING IN CÔA VALLEY

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FUNDING	€ 299 507

The Côa Valley is characterized by a typical Mediterranean habitat interspersed by fields of olives, almonds, and cereals. This area, defined by an unparalleled level of land abandonment, is envisioned as an opportunity for the comeback of wildlife through rewilding, i.e. an environmental management option that can foster the restoration of biodiversity and ecosystem functioning with minimal ongoing intervention. Trophic rewilding, defined as the process by which medium and/or large herbivores are reintroduced in areas from where they were extirpated, is deemed as a sine qua non future-oriented approach to reverse biodiversity loss, restore ecosystem structure and reestablish trophic food chains. As an emerging concept, trophic rewilding is controversial and there is no empirical knowledge to support its local implementation, which raises several questions regarding its social acceptance and ecological sustainability: How does trophic rewilding adjust to human activities? What are the opportunities for natural recolonization? Where, when, how many and what species to reintroduce? Is there a scale for trophic rewilding? And very importantly, how to assess trophic rewilding impacts on ecosystems functioning? The Côa Valley represents an outstanding outdoor laboratory to test and quantify the potential role of wild ungulates as ‘engineers’ of Mediterranean ecosystems. Albeit our previous studies showed that western Iberia present suitable environmental conditions to support trophic rewilding they also demonstrated that the scientific evidence available to implement rewilding initiatives is elusive and can entail unintended consequences. rWILD-COA will produce a wealth of knowledge to assist the implementation of self-sustainable ecosystems and to increase the predictability of rewilding outcomes. rWILD-COA is aimed to i) predict how ungulates impact soil ecological processes and functioning (e.g. soil microbial activity, biogeochemical cycling) by grazing, grubbing, trampling and dunging, and study how these activities influence vegetation structure and invertebrate communities through soil nutrient mediation, ii) explore the direct and indirect pathways by which ungulates buffer or strengthen changes in species richness and diversity in the face of other environmental perturbations, such as climate warming, iii) evaluate the effects of extensive and intensive grazing and/or browsing on fire risk mitigation, and iv) analyse plant-soil feedback effects and the role of inter and intraspecific competition on foraging efficiency, diet quality and animal health of reintroduced individuals.

PRESERVATION OF NATURAL AND CULTURAL HERITAGE AND SCIENTIFIC VALIDATION OF PRACTICES WITH MEDICINAL PLANTS FROM CÔA VALLEY

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FUNDING	€ 299 771

A UNESCO World Heritage Site since 1998, the Foz Côa Valley is considered “the most important open-air Palaeolithic rock art site”. However, the natural heritage of the Côa Valley should also be preserved and valorized. Bearing this in mind, our interdisciplinary research project aims at the preservation of the cultural heritage related to the practices with medicinal plants in Côa Valley, and the valorization through the scientific validation of their properties based on biochemical characterization, study of biological activities, and mechanisms of action of their extracts. This project will bring to light the traditional knowledge of medicinal practices in Côa Valley, with information from the ethnobotanical survey and understand that it summarizes the results of experiments made by trial and error over centuries, and create an interface of science, medicine, and humanities, which bridges past and present, and inspire fresh investigations and innovative research strategies for tomorrow’s health care. It addresses a fundamental challenge of the 21st century, the need for new drugs and new strategies for the discovery of such medicines. By linking medical tradition with contemporary medical needs in a creative association, it will suggest new avenues for fresh pharmacological investigations and innovative research strategies. After the ethnobotanical survey, herborization of all species, and photographic record of the plants and respective habitats, a group of the more cited plants will be biochemically characterized and a screening of the extracts obtained will be performed to select the species which will be studied in depth in an animal model of one selected widespread condition. Because of its growing incidence in the EU and world, resulting from bad lifestyles, we will test the most suitable extracts in in vitro and in vivo models of non-alcoholic fatty liver disease/non-alcoholic steatohepatitis. Overall, the main purpose of this project is defining integrated strategies to add value to the plant species of Côa Valley. In addition to the preservation of the cultural and natural heritage regarding practices with medicinal plants, we also aim to valorise this knowledge through scientific validation of medicinal uses. This project will make possible communication of science to the citizens and to attract more visitors to the Côa Valley, through the promotion of new activities and pedestrian paths. As the first step in developing a successful strategy to conserve, enhance and sustainably utilize medicinal-plant resources is to document the medicinal plants and their use in herbal formulations, and establish cultivation programs in collaboration with farmers, beyond the timeline of the project, we intend to implement a sustainable plan to cultivate the species with more potential.





Climate and climate change

CLIMATE CHANGE IMPACT ASSESSMENT AND ADAPTATION MEASURES FOR THE MAIN CROPS IN THE COA VALLEY REGION

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FUNDING	€ 221 885

In the Côa region, vineyards, and olive trees account for nearly 10% of the total land use area. Permanent grasslands account for 2% and all cereal crops, such as wheat and maize account for 12%. Other important tree crops include chestnuts (0.6%) and almonds (0.2%). These numbers highlight the fact that agriculture is the economic base of this region, which is considered World Heritage Site by UNESCO since 1998. Future projections for the Côa Valley are in line with large-scale trends since significant warming and drying are projected for the next decades. As the current Mediterranean warm-dry summers already limit crop suitability, mainly due to summertime water scarcity, these crops are particularly vulnerable to a changing climate. Although climate change may represent an important threat, it is also an opportunity to develop suitable and cost-effective adaptation measures and risk management policies. Their implementation can significantly mitigate the impacts of climate change on these crops and on the regional/national economy in general. Our proposal aims to assess the climate change forcing on the main crops in the Côa Valley. For this purpose, an ensemble of state-of-the-art regional climate models, driven by newly developed greenhouse gas emission scenarios, combined with innovative downscaling and bias correction techniques, will be used to develop high-quality projections. This will allow a very-high resolution bioclimatic zoning (at a spatial resolution of about 1 km) of the selected crops in present and future climates (up to 2100). This zoning will reveal not only current, but also future suitability of a given region to a specific crop. Subsequently, dynamical crop models will be used to assess climate change impacts on crop potential yields (and possibly on other crop parameters) at local scales. Then, the economic impact analysis will establish a link between the economic activities that contribute to regional GDP, by defining direct and indirect indicators of climate influence (e.g. sales volumes and cost levels). This link will be the basis to build regional socioeconomic macro-scenarios that represent the exposure to climate change of the various socio-economic activities. State-of-the-art climate model simulations, emission scenarios and crop models need to be tested. The study of adaptation measures is also within the scope of the current project. As such, adaptation measures will be simulated under future climates, such as irrigation, cover crops, mulching and varietal selection. The selected crops embrace vital sectors, from agriculture to industry and business, already threatened by the ongoing climatic change.

CLIMATE AND HUMAN ADAPTATION DURING THE LAST GLACIAL PERIOD IN THE CÔA VALLEY REGION (PORTUGAL)

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PARTICIPATING INSTITUTIONS	CÔA PARQUE - Fundação para a Salvaguarda e Valorização do Vale do Côa
FUNDING	€ 274 414

In North Atlantic, the Last Glacial Period (LGP) was characterized by secular climate oscillations of the order of 8 to 15°C, comprising abrupt Dansgaard-Oeschger (D-O) warming cycles and Heinrich Events (HE) cold phases associated with ice-rafted debris. These large and rapid climate changes had a recognized impact on bioclimatic zones and possibly on the behaviour of Middle and Upper Palaeolithic hunter-gatherers. During HE, the western Iberia coast was the southernmost border of polar front/water masses and the locus of the final melting of iceberg flotillas. As in these periods the region had no influence of subtropical waters and its moderating effect on land climate, the western Iberia was prone to the record of extreme changes on the climate pressure over continental ecosystems and human communities. Based on the study of Iberian karst and open-air records, a correlation framework with climate shifts has been proposed to explain the observed discontinuities between sequences containing late Middle and early Upper Palaeolithic occupations. Also, a climate driven model has been advanced to explain the later dispersion of Anatomically Modern Human (AMH), the persistence of last Neanderthals and the chronological differences between northern and southern Pyrenean data, which were interpreted as a direct impact of HE4 in the distribution of large ungulate populations. Iberian typological regionalization of Upper Solutrean hunting lithic tool types and the variation of foragers' social network ranges have also been directly related to climate oscillations. However, the exact impact of HE on terrestrial systems, the evaluation of the latitudinal differentiation of its impact and time-gap, as well as the correlation between periods of relative stabilization/soil formation and the D-O events, remain to be clearly established. Also, the whole question relating to the Middle-to-Upper Palaeolithic transition has been excessively dependent on the karst archives and should now be investigated in other geomorphological contexts - among which the fluvial and plateau stands out. In this sense, new data will be produced through fieldwork/laboratory analyses of the terrestrial record (natural and cultural) preserved in the Côa River Valley and surrounding plateau areas. A multidisciplinary approach based on the geological, geomorphological, geochemical, archaeological, zoo-archaeological and geochronological analyses of various terrestrial archives will allow the detailed reconstruction of local/regional climate variations and hunter-gatherer behaviour during Late Pleistocene, enabling to establish a chronological framework for Neanderthal and AMH cognitive archaeology evidences in its environmental context. The knowledge produced, as well as the development of tools for mapping, assessing and managing the cultural landscape of the Côa Valley region can contribute to create conditions for a sustainable economic use of this territory.



**Origins of life
and dynamics
of socio-cultural
interactions
over time**

LANDCRAFT - THE SOCIO-CULTURAL CONTEXTS OF LATE PREHISTORIC ROCK ART IN THE CÔA VALLEY

PRINCIPAL INVESTIGATOR	Lara Beirão Amaral Bacelar Alves
CO-PRINCIPAL INVESTIGATOR	João Carlos Muralha Cardoso
LEADING INSTITUTION	Universidade de Coimbra
FUNDING	€ 299 810

The Côa valley World Heritage site is well known for its open-air Palaeolithic Art. Although the rock art sequence extends from the Gravettian to the early Holocene, it also includes an important sequence of Neolithic, Iron Age and historical carvings up to the 20th century. The Côa valley is then a critically important area in Western Europe to investigate what may be called the 'dark ages' of prehistoric art, i.e. the period of transition from the last hunter-gatherer's art to the agriculturalists' Schematic Art (SA) of the Neolithic. Rock art research in the Côa valley has been mainly focused on the earliest (Palaeolithic) evidence, and Neolithic Art has been overlooked until recently. Between 2012-2014, a pioneering study of the archaeological contexts of SA covered field surveys, rock-art recording, and small-scale excavation in four painted rock shelters. LandCRAFT aims to expand research to cover the entire assemblage of Late Prehistoric Art listed in the archaeological park's area and understand its relationship with human settlement. It shall therefore be driven by the following research questions: To what extent do diachronic sequences proposed for SA relate to socio-cultural dynamics, landscape perception, settlement and environmental management from the emergence on to the stage of consolidation of agricultural societies? To what extent does the material evidence and site occupation help us to consider the rock art sequence? How did regional climatic changes in the Pleistocene-Holocene transition create the conditions for the introduction of agriculture? How can we characterise the transition from the last hunter-gatherer's art to farmer's Schematic Art? How are rock paintings produced? Are there differences between subnaturalistic and SA paintings in terms of technique, processes and raw materials employed? Can the subnaturalistic style be attributed to the last hunter-gatherers or earlier agriculturalists? When was SA introduced in the Côa valley and how long did it last? The research strategy covers the production of the Côa valley Late Prehistoric Art corpus (both carvings and paintings) using novel techniques of recording based on digital enhancement of multi-spectral images and 3D modelling using structure-from-motion photogrammetry, physical-chemical analysis of pigments, palaeoenvironmental studies as well as the excavation of Lapas Cabreiras and other archaeological sites in the vicinities of painted rock shelters with evidence for Neolithic/Copper Age occupation. LandCRAFT aims to extend our understanding of the long-term sequence of Art History in the Côa valley relating to a crucial period of human evolution, in a motionless territory yet in presumed changing environmental conditions. It is not only concerned with the ways land has been crafted over time. It goes further to explore the role of the archaeologist as craftsman, as part of the knowledge production process, aspect to be highlighted in outreach activities.

ROCK ART OPEN ACCESS REPOSITORY

PRINCIPAL INVESTIGATOR	Nátália Maria da Costa Botica
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LEADING INSTITUTION	Universidade do Minho
FUNDING	€ 296 023

The Côa valley has been well known for its amazing prehistoric rock art, classified as World Heritage in 1998. Since its discovery, over 1000 decorated rocks have been identified, with chronologies ranging from prehistory to the contemporary times. According to the latest inventory, 533 rocks display paleolithic figures, 65 show motifs from late prehistory, 455 display iron age figures and 103 are related to historical times. The impressive number of Iron Age engravings in the Côa Valley, with no parallels in the Iberian Peninsula, make it into one of the most important sites in the world regarding this chronology. Nevertheless, and despite Iron Age being the second most important artistic phase of the Côa valley and the impressive number of engraved rocks, in 20 years, only 8 have been the object of archaeological recording, and only 4 have the complete survey published. With this proposal, we aim to increase our knowledge about Iron Age rock art and the societies that created it, making a real quantitative and qualitative leap regarding the last two decades. Therefore, we propose the integral study of 4 sites with a total number of 58 engraved rocks and the archaeological intervention of 3 sites with proto-historical occupation in the Côa valley. The data recording will consider FAIR data principles and CIDOC CRM ontology, implementing an innovative methodology. This project will also create the first national Rock Art platform, which will give visibility to the Iron Age data, metadata, images and 3D models, to make them available in open access, key to encouraging their reuse in further studies and offering also the possibility of analysis in the light of new technologies. Through workshops and dissemination in seminars and digital networks, we will encourage the use of this repository to host more Rock Art data. Furthermore, we expect to establish the groundwork for a future proposal to integrate the 4 rock art sites in the UNESCO World Heritage Classification, expanding the number of classified sites in the Côa valley as well as the associated chronologies. Additionally, the study of 2 of the 4 selected sites (Vermelhosa and Vale de José Esteves) will allow its opening to the public, diversifying the cultural resources of the Côa Valley Archaeological Park, considering that these 2 sites will shortly be connected to the Côa Museum through a walkway, as well as to the railway through the rehabilitation of the old train station.

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